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PRODUCTION LABOR REQUIREMENTS IN SOUTHERN RICE MILLS

U.S. DEPARTMENT OF AGRICULTURE • ECONOMIC RESEARCH SERVICE • MARKETING RESEARCH REPORT NO. 714

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Washington, D.C. June 1965

SUMMARY AND CONCLUSIONS

Work sampling data collected in a survey of selected rice mills in the South shows that the pattern of production labor utilization varies widely among plants. The amount of production labor needed to process one unit of rice is influenced by methods and techniques used and by the way in which management employs labor.

From these data, labor standards were developed for each major method and technique used in performing each major function of the rice milling process. These standards were used to compare output of labor for various operating methods. For example, labor requirements for receiving rice by rail varied from 10.1 man-hours per 1,000 cwt. when unloaded with hand shovels to a low of 3.7 man-hours when unloaded by pneumatic-conveyor.

A large mill requires about 20 man-hours of production labor for its milling department per 1,000 cwt. of rough rice milled. A small mill may require as many as 59 man-hours to perform the same functions, using essentially the same techniques.

Most variation in labor requirements was found in the clean-rice department, where total labor requirements per 1,000 cwt. of rough rice milled varied from as few as about 11 man-hours to as many as 52, depending on methods and techniques used.

Without changing their methods and techniques the mills surveyed could have saved about 27 percent of their production labor costs on a plant-wide basis if they had maintained peak operation productivity during the whole year. Without changing methods and techniques, the survey mills could have saved even more (about 38 percent of their production labor costs), if they had attained the production labor standards developed in this study and maintained these throughout the milling year.

Findings of this study indicate that if the rice milling industry were to use only the most efficient methods used by the mills studied and perform work at the rates of the standards set in this study, there would be a potential saving in production labor costs of roughly 50 percent. Assuming these conditions, total rice milling costs (operating, administrative, and management) could possibly be reduced by about 10 cents per 100 pounds of rough rice milled. This would have meant a saving of nearly $7 million on the 68.3 million cwt. of rough rice processed from the 1963 crop. Since the rice milling industry is highly competitive, it is conceivable that this saving would result in higher returns to rice producers and lower prices to the consumer.

PRODUCTION LABOR REQUIREMENTS IN SOUTHERN RICE MILLS

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INTRODUCTION

United State rice growers received over $340 million for their 1963 crop. Milling and related operations added an estimated $85 million to the net value of this product.

In 1963, 74 mills were operating mainly in 3 major southern States (Louisiana, Texas, and Arkansas) and in California. 1/ These mills processed approximately 68.3 million cwt. of rough rice from the 1963 crop. 2/ The mills vary in size, capacity, equipment used, technology, and operating practices. The cost of processing rice in these mills also varies.

An earlier study by the U.S. Department of Agriculture revealed that in many rice milling plants nearly 45 percent of costs of operation are for employees. 3/ Over half of these costs were paid as salaries and wages to production workers while the remainder went to other salaried employees, including clerical and executive personnel. Among the rice mills studied, labor costs per unit of output were highly variable, indicating a wide range in efficiency and utilization of labor. These findings suggested a need for information concerning labor requirements or standards for rice milling in order to utilize human resources more efficiently.

SCOPE AND METHODOLOGY

The primary objective of this report is to develop labor standards for different phases of rice milling and handling. A comparison is made of labor requirements for different methods used by the rice milling industry in plant operations. Secondary objectives include (1) analysis of actual labor performance in relation to these standards and (2) determination of potential savings if human resources were to be utilized according to the standards established.

1/ U.S. Bureau of the Census. 1963 Census of Manufacturers. Preliminary Report. Industry Series. Rice Milling.

2/ Grain Division, Agricultural Marketing Service. Rice Annual Market Summary 1964. U.S. Dept. Agr., AMS 277 (1964), Oct. 1964.

3/ Thuroczy, Nicholas M., and Schlegel, Woodrow A. Costs of Operating Southern Rice Mills. U.S. Dept. Agr., Mktg. Res. Rpt. 330, June 1959.

Labor standards are based on a survey of 6 selected rice mills in Louisiana and Texas. These mills vary in size, milling capacity utilized, equipment used, length of season, and efficiency. They were, however, uniform in one respect; they confined their operations to milling and did not parboil or package rice in consumer-size packages. In the rough- and clean-rice departments, the survey included detailed work sampling (often termed "ratio-delay") and output data for each function (work category) and for each method used to perform it. The milling department, however, was observed as performing one overall function--milling rice. By design, the survey was made during the busiest time when labor productivity was at its peak.

These standards include an allowance or standard for delay or nonworking time (20 percent of labor's total time). This standard allowance is based on industrial engineering research of similar industries and represents time lost through periods of equipment-down time, lot changeover, waiting on other operations, or other breaks in the flow of material. 4/ Standards also include time for rest and other personal needs of workers. Standard time for cleanup and related preparatory work (not resulting directly in an output of rice) is determined to be 21 percent of labor's total time and is also included in labor standards for each work function.

Standards represent a pace at which work can be performed by trained workers with relative ease in a well-organized and well-managed mill. The standards were set at a point between the plant with the most efficient labor utilization during the period observed and the average for all the plants. Detailed explanations of the development of standards are shown in appendix A.

A TYPICAL RICE MILL

There are 3 distinct stages in the conventional rice milling process, which are represented by the rough-rice, milling, and clean-rice departments. Functions within each department are the divisions of work that provided the basis for comparative study of detailed methods. Definitions of the work functions are given in appendix B. A brief description of the 3 departments follows.

Rough-Rice Department

The functions of the rough-rice department begin with receiving the rice and end with sending it to the milling department (fig. 1).

In performing the overall function of this department, workers were observed in these work categories: Receiving and holding rough rice for processing; drying any wet rough-rice receipts; serving the milling department's needs for rough rice; cleanup and other; and delay (appendix B).

4/ Askew, William R., Vosloh, Carl J., Jr., and Brensike, John V. Case Study of Labor Costs and Efficiencies in Warehousing Formula Feeds. U.S. Dept. Agr., Mktg. Res. Rpt. 205, Nov. 1957.

Greene, C. H., and Davis, G. B. Labor Performance Standards in Seed Warehousing. Oreg. State Univ. Agr. Expt. Sta. Spec. Rpt. 135, Aug. 1962.

FLOW DIAGRAM FOR ROUGH-RICE DEPARTMENT

Typical Southern Rice Mills

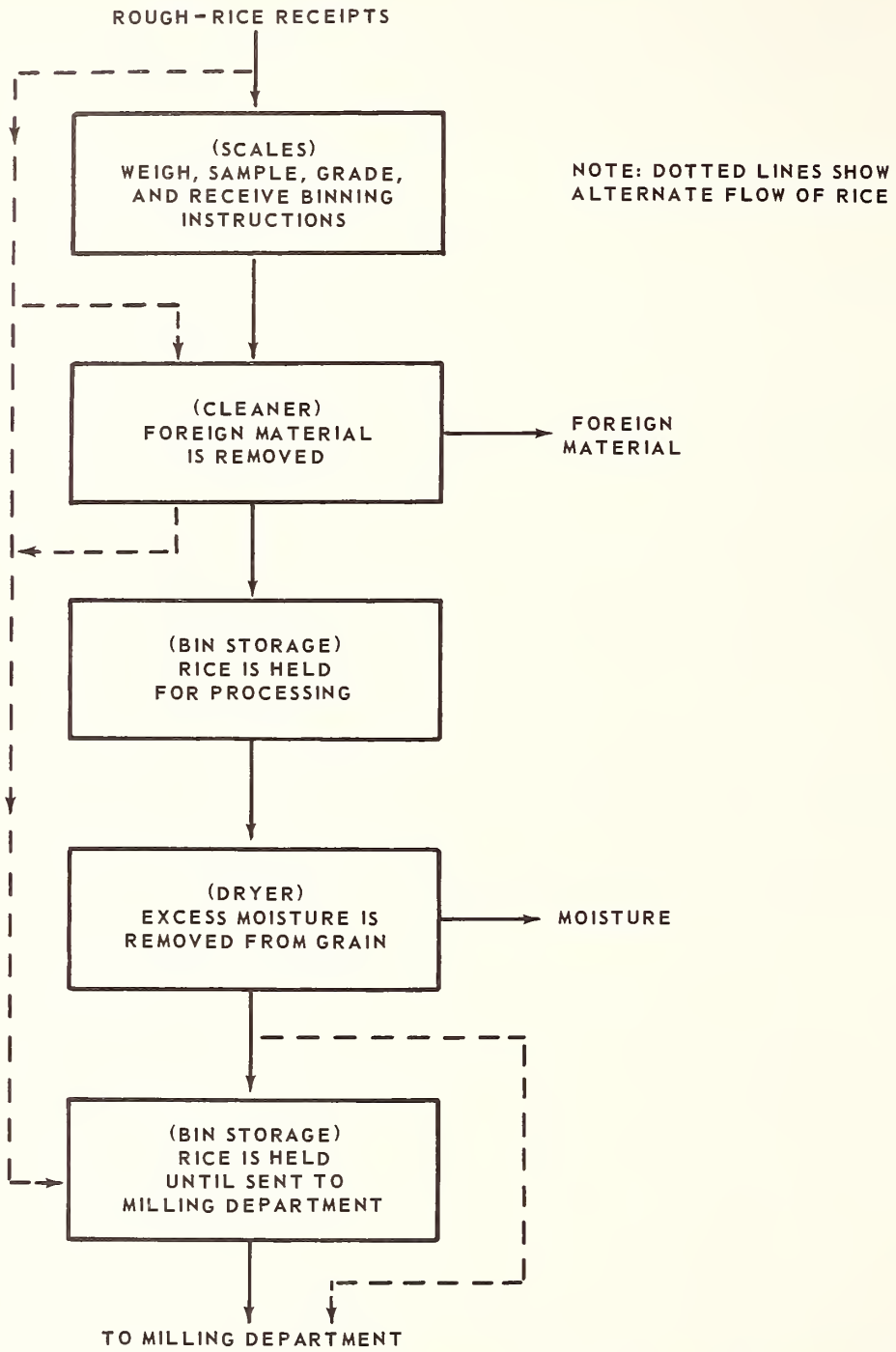

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Figure 1

Milling Department

The functions of a typically organized rice-milling department begin as the rice is received from the rough-rice department and end when the milled rice is put in bin storage or when it enters the bagging machinery and the byproducts are bagged and then stored or shipped. The functions performed and products derived from each are indicated in a flow diagram (fig. 2). There was variation among mills as to where the functions of the milling department end, but for this study, the disposition of the milled rice after it passes the last milling stage is a function of the clean-rice department.

A typical rice milling department is constructed on 4 floors. No particular function is necessarily completed on any one floor. Rather, machinery is arranged to effectively use the floor space. Thus, since workers are usually assigned to a particular floor, it is necessary for some employees to perform more than one part of the milling function.

Clean-Rice Department

In the clean-rice department, milled rice and byproducts are binned or bagged and held in warehouse, then blended, bagged, and loaded for shipment. Figure 3 shows the flow of products through the main steps involved and indicates by alternate paths some of the variations in patterns of operation (treatment of milled rice and byproducts by this department).

Workers were observed performing following functions: Trucking bagged rice and other milled products, blending milled rice, handling bagged rice and other milled products, scaling and bagging rice, sewing the bagged rice, cleanup and other work, and delay (appendix B).

STANDARD LABOR REQUIREMENTS

Labor requirements, as explained in appendix A, are stated in terms of man-hours per 1,000 cwt. of rough dry rice or milled-rice products. For the rough-rice and milling departments, they are stated in terms of rough dry rice. For the clean-rice department, requirements are developed and stated first in terms of milled products and later in terms of the rough-rice equivalent.

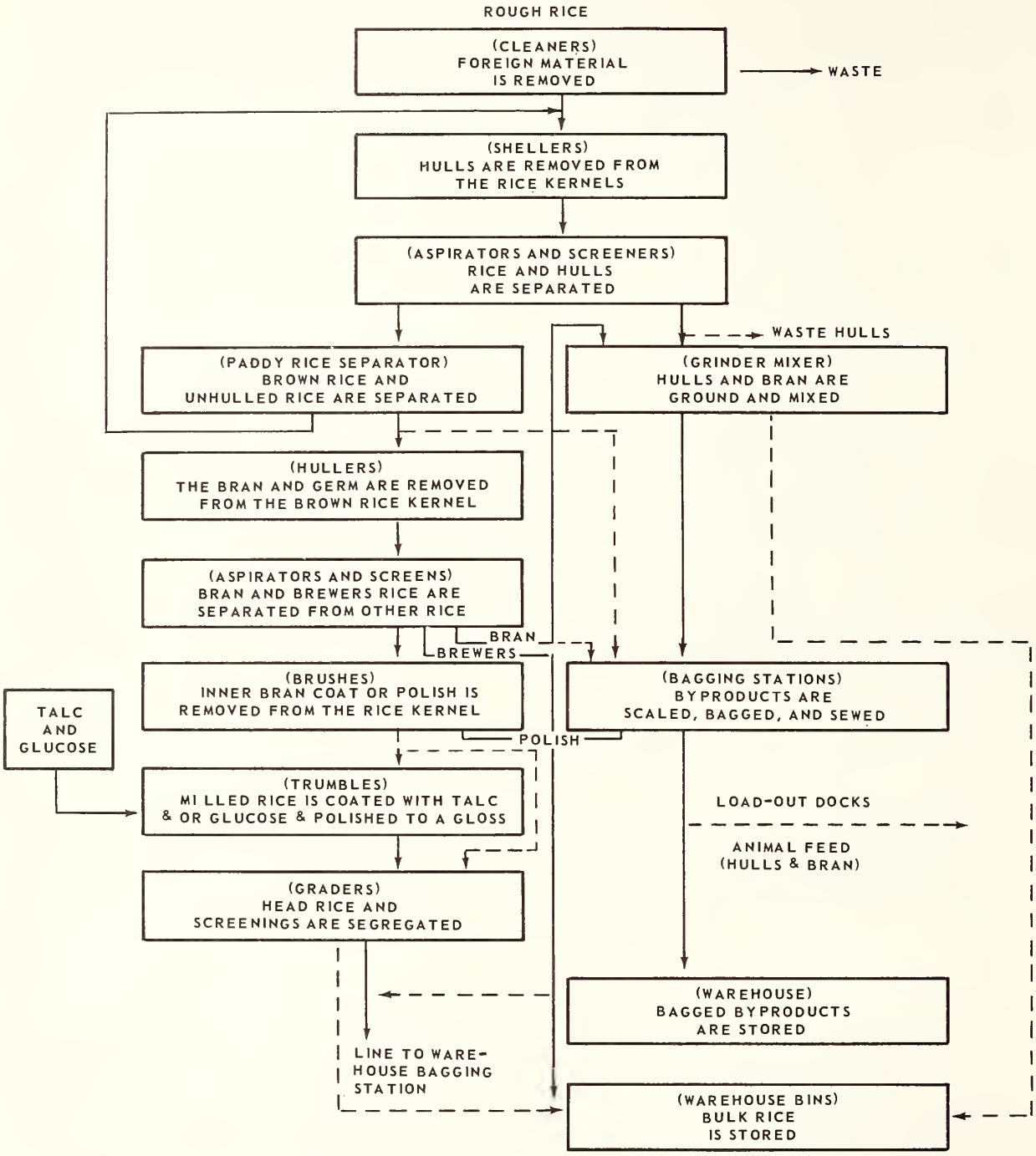
Rough-Rice Department

In the rough-rice department, total labor used was allocated among 3 major work functions: Receiving, drying, and sending rice to the milling department in preparation for milling. Based on observed time that workers spent in each work function (including cleanup, other work, and delay time) standard labor requirements were developed by functions and by the technique or method used for each (table 1).

Standards vary with method or technique used to perform each function. For example, it requires nearly 3 times as much labor to receive rice by rail when unloaded by 2-wheel hand shovels as when unloaded by pneumatic conveyors

FLOW DIAGRAM FOR MILLING DEPARTMENT

Typical Southern Rice Mills



DOTTED LINES SHOW ALTERNATE FLOW OF RICE AND OTHER PRODUCTS.

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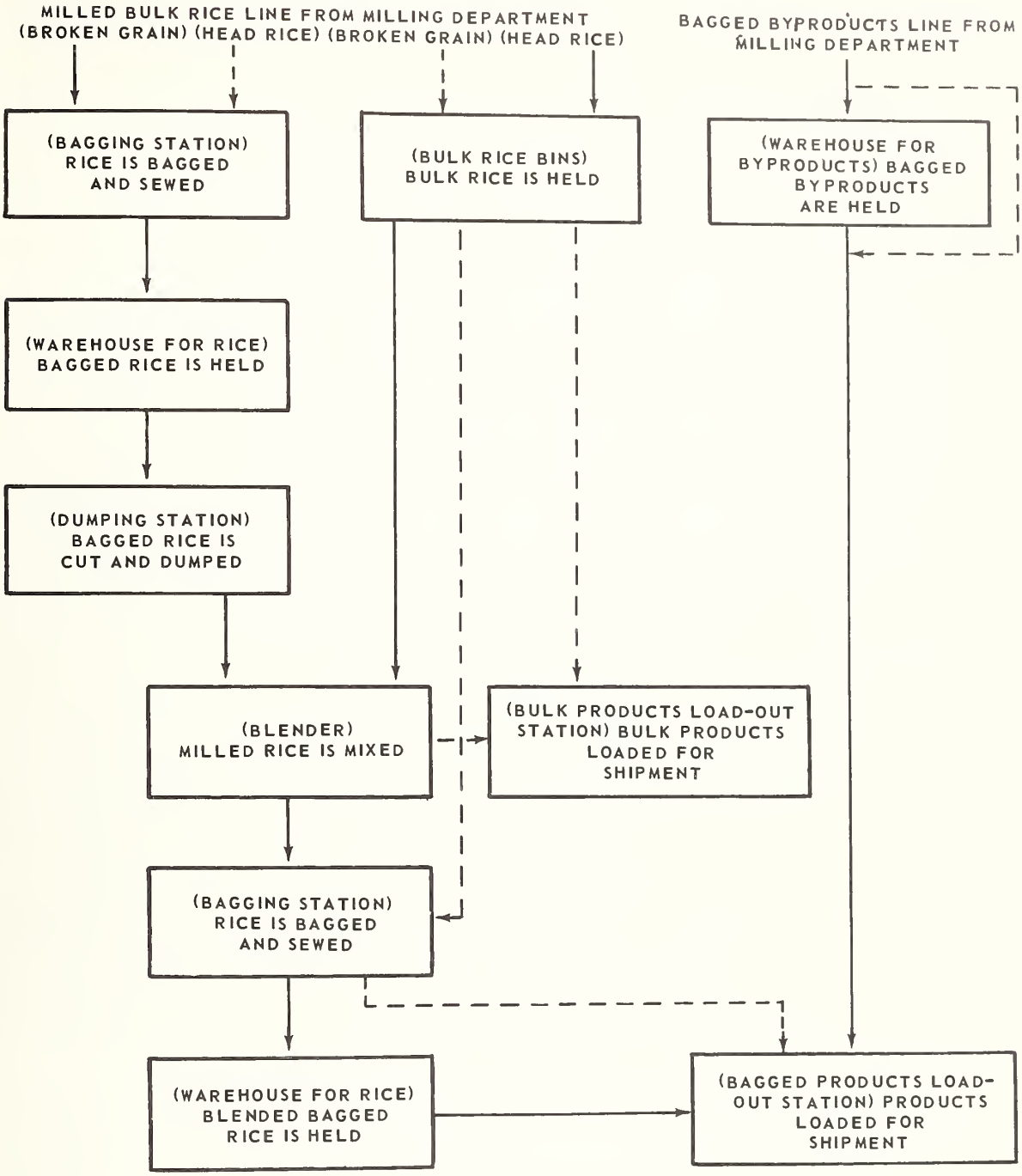
Figure 2

FLOW DIAGRAM FOR CLEAN-RICE DEPARTMENT

Typical Southern Rice Mills



DOTTED LINES SHOW ALTERNATE FLOW OF PRODUCTS.

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Figure 3

Table 1.--Rough-rice department: Standard production labor requirements and average labor observed by work function and method used to perform each function, Southern rice mills, 1961

Functions and methods	Machine capacity in rough rice per hour 1/	Labor per 1,000 cwt. of dry rough rice	
		Standard	Average observed time
	Cwt.	Man-hours	Man-hours
Receiving rice:			
By rail 2/--			
1. Unloaded by pneumatic conveyor.....	567	3.7	4.0
2. Unloaded by power dragboard.....	972	8.0	8.3
3. Unloaded by wheel-type hand shovels.	400	10.1	10.4
By 4-wheelbase truck--			
4. Unloaded by cradle or hook hoist....	600	3/ 3.4	3/ 3.7
5. Unloaded by hook hoist, small pit, no preliminaries 2/ 4/.....	324	2.5	3.5
By 6-wheelbase truck--			
6. Unloaded by platform truck lift.....	1,134	3/ 3.3	3/ 8.9
7. Unloaded by hand shovel, drop hatched truck bed 2/.....	1,620	5.4	5.5
Drying rough rice (removing about 7 percentage points of moisture) continuous process.....	350	3/ 4.9	3/ 7.5
Serving milling department needs or sending rice through machinery to milling department.....	225	3.0	4.2

1/ Capacity of the machine or equipment which would pace the operation if obtained.

2/ Did not include the preliminaries of weighing, sampling, or grading the rice.

3/ Figures were developed for wet rice but adjusted and expressed in terms of the rice after it is dried. The rice was assumed to be dried from 20 to 13 percent moisture content. The standard labor of receiving dry rice would be 3.1 and 3.0 man-hours, respectively, for methods No. 4 and 6 of receiving rice.

4/ An employee was used on the pit or the bins only when rice was being unloaded.

Factors other than method used to perform a function may cause standard labor requirements to vary among mills and to deviate from actual operating performance. When work functions are partially or altogether machine paced, the output measured per man-hour is related to capacities of machines. For this reason machine capacities are given (table 1). However, some methods may be more dependent upon the human factor than are other methods for doing the same job. For example, rice received by truck and unloaded by hand shovel is more likely to be man paced than machine paced.

Differences in the work involved in the receiving function affect the labor required. For example, in the observed mills, unloading 4-wheelbase trucks by hook hoist using a small pit required less labor than unloading similar trucks by hook hoist with higher capacity machinery. The first method unlike the second, required less labor because of a simpler operation: there was no weighing, grading, and other preliminaries, and only one man was engaged part time when grain was being unloaded.

Milling Department

A large mill uses less production labor than a smaller mill in the milling department per unit of rough rice milled. This results partially from the fact that the milling operation usually is spread over 4 floors, regardless of milling capacity. Workers are assigned by floors with at least one worker per floor. Other factors that influence labor requirements in the milling operation are (1) whether hulls are processed, (2) whether the mill has a power plant which requires additional labor, or uses public power, and (3) what method is used for disposing of rice and byproducts.

Size of operation is probably the most important factor influencing labor requirements of the milling department. Large and medium-size mills with hourly milling capacity of 200 cwt. or more can include the processing of hulls in their operations with less total labor used per unit of rough rice milled than smaller mills use when they dispose of hulls as waste. Also, a large mill can process hulls and operate a power plant with less labor per unit than a small mill that does neither (table 2).

Clean-Rice Department

In the clean-rice department, labor performed 5 functions: trucking rice and byproducts, blending rice, scaling and bagging rice, sewing bagged rice, and handling bagged rice and byproducts. Standard labor requirements by functions in this department, unlike the rough-rice and milling departments, are first expressed in man-hours per 1,000 cwt. of milled rice or byproducts (table 3).

Machine capacities as well as methods and techniques cause standard labor requirements for a particular function to vary considerably in this department. About 2.6 man-hours are required to bag 1,000 cwt. of rice in 100-pound bags using a bagging machine with a capacity of about 600 cwt. of rice per hour, compared with about 6.5 man-hours using a machine with a capacity to bag about 250 cwt. per hour.

To handtruck 1,000 cwt. of rice about 100 feet requires 5.2 man-hours. The same job plus stacking the pallets of rice can be accomplished with a forklift truck with 1.3 man-hours of labor. Whenever rice is stacked and later moved again, the forklift method also saves 3.9 man-hours required to load the rice onto handtrucks.

Table 2.--Milling department: Standard production labor requirements and average labor used, Southern rice mills, 1961

Mill size and functional characteristics	Labor per 1,000 cwt. of rough-rice output 1/	
	Standard	Observed time
	Man-hours	Man-hours
Small mills: under 200 cwt. per hour		
Hulls not processed--		
Only public power used	40.3	48.3
Operated a power plant	49.2	55.5
Hulls processed--		
Only public power used	49.2	55.5
Operated a power plant	59.4	65.0
Medium-size mills: 200-300 cwt. per hour		
Hulls not processed--		
Only public power used	23.2	27.8
Operated a power plant	33.6	41.2
Hulls processed--		
Only public power used	31.2	36.4
Operated a power plant	41.6	49.8
Large mills: over 300 cwt. per hour		
Hulls not processed--		
Only public power used	19.9	21.0
Operated a power plant	25.4	26.7
Hulls processed--		
Only public power used	25.4	26.7
Operated a power plant	31.2	32.9

1/ Some figures are projected on the basis that it requires 2 employees in a large or medium-size mill to operate a power plant or process hulls and 1 employee for each of these functions in a small mill.

Table 3.--Clean-rice department: Standard production labor requirements and average labor used, by work function and by method used to perform each function, Southern rice mills, 1961

Functions, methods, machine capacity, etc. 1/	Labor per 1,000 cwt. of milled rice or byproduct	
	Standard	Observed time
	Man-hours	Man-hours
Handtruck milled rice and byproducts: 2/		
20 feet	1.0	1.5
60 feet	3.1	4.6
100 feet	5.2	3/ 7.7
Forklift truck bagged milled rice:		
20 feet	.5	--
60 feet	.9	--
100 feet	1.3	3/ 1.3
Blend milled rice or load bulk rice:		
Cut and dump bagged milled rice	13.4	18.7
Regulate flow of rice from bin (750 cwt. capacity)	2.7	3.9
Scale and bag milled rice:		
Machine capacity 250 cwt. per hour	6.5	7.4
Machine capacity 600 cwt. per hour	2.6	3.3
Sew bagged rice:		
Machine capacity 250 cwt. per hour	6.5	7.4
Machine capacity 600 cwt. per hour	2.6	3.3
Handle bagged milled rice and byproducts:		
Stack on handtruck or pallet	3.9	5.8
Stack in warehouse 14 bags high by hand	7.6	11.1
Stack in warehouse 18 bags high with elevator 4/	4.9	5.8
Stack on transport vehicle	6.5	10.1

1/ Capacity of the machine or equipment that would pace the operation if obtained.

2/ 2-wheel truck, 1 man, with 5 cwt. per load; or 4-wheel truck, 2 men, with 10 cwt. per load.

3/ Average time was expressed first per 100 feet. Other figures are estimated.

4/ Since the elevator capacity was not reached, this in fact was a man-paced function.

Blending milled rice from bin storage requires only 2.7 man-hours of labor per 1,000 cwt. compared with 13.4 man-hours needed for cutting and dumping bagged rice from storage to accomplish the same job. In addition, if the bagged rice is handtrucked into position for the blending operation, it requires another 3.9 man-hours to load and 5.2 man-hours per 100 feet to truck.

LABOR STANDARDS AND LABOR USED

Standard labor requirements per unit of output were lower than average labor used during the study period. This deviation was larger for some functions than it was for others (tables 1 and 3), and resulted from variations in labor used per unit of output. Standard requirements also varied with methods used to perform certain functions. For example, the standard time for each method of unloading grain received by rail did not deviate from the average time as much as it did for grain received by 6-wheelbase trucks that were unloaded by a platform truck lift. Similar comparisons of functions in the clean-rice department show variations between standard time and average time used (table 3).

How often observed time falls above or below the standard can be used as an indication of the reliability of the standard. Theoretically about 10 percent of the time during the observation period, labor efficiency should exceed the standard. On the average, labor was more efficient than the standard 16 percent of the time during the period observed.

Since standards were developed from observations made during the peak of the season, when the use of labor was more efficient than during the rest of the year, it appears doubtful that any of these mills could operate at these standards over a period of a year without altering their operating pattern.

Later analysis applies these standards (in a model synthesized to represent the mills studied) to show how much total labor was used relative to the standard requirements. Analysis is made of monthly data to show how the relationship between standards and labor actually used is affected by seasonal variations in volume. Since this is a question of volume as well as of seasonality, it will be discussed under the section on volume of business and labor use.

MODEL LABOR REQUIREMENTS

Labor standards for the work functions in tables 1 and 3 were used to synthesize operating models for the rough-rice and clean-rice departments. Labor requirements for the milling department were developed for the overall function of milling; therefore, the requirements in table 2 for each size of mill and operating setup represents models comparable to the ones developed here for the rough-rice and clean-rice departments. These departmental models may be used to develop models for a total plant operation. They may be used to indicate the effects of methods and techniques used in performing work functions in broader divisions and at the plant level.

Models for the Rough-Rice Department

Standard labor requirements per 1,000 cwt. of rough rice for several rough-rice department models show that the method of receiving rice may cause labor used to vary considerably (table 4). For example, this department requires over twice as many man-hours of labor per 1,000 cwt. of rough dry rice when it is received by rail and unloaded with hand shovels, as when it is received by 4-wheelbase truck and unloaded with a cradle hoist or hook-type body lift.

Additional labor in the receiving and drying operations is required when an equivalent quantity of rough dry rice is received as wet rice. On the average, about 8.8 percent more weight, or about 1,088 cwt. of wet rice is required to make 1,000 cwt. of rough dry rice. About 4.9 more man-hours of labor are required for drying this rice and about 8.8 percent more labor for receiving it (assuming that equal weights of wet and dry rice can be received in an equal period of time). For example, the total labor required for the department shown in table 4, model 4, for dry rice received is increased by 4.9 man-hours for drying the rice plus 0.3 man-hour for receiving the additional rice, or an increase from 6.1 to 11.3 man-hours per 1,000 cwt. For other methods of receiving, the drying labor would be the same but the added labor of receiving the wet rice would be 8.8 percent of the requirement for the specific method of receiving dry rice.

If a mill used 2 or more methods of receiving rice, or other factors varied, the rough-rice department's average labor requirements per 1,000 cwt. of rough dry rice received could be developed from table 4. It would mean multiplying the specific requirements in table 4 by the percentage of the total rice received by each specified method or other factor. For example, if 75 percent of the rice were received dry by rail and unloaded by method 3, and 25 percent were received wet by 4-wheelbase truck and unloaded by method 4, the average labor required by the rough-rice department would be 12.6 man-hours per 1,000 cwt. of rough dry rice handled (.75 x 13.1 + .25 x 11.3).

Table 4 shows the rough-rice department's total labor required per 1,000 cwt. by method received, and may be applied to any selected annual volume of rough rice handled to show the effects of methods employed on total annual labor used. This illustrates the effect of method used on total labor requirements when work is performed at a constant rate. Labor in these examples would vary directly in proportion to the volume of rice milled.

Models for the Milling Department

Since estimated labor requirements for the milling department were made for the overall milling function, estimated labor requirements per 1,000 cwt. of rough rice milled for various operating models are the same as shown in the section on "Standard Labor Requirements" (table 2). For example, for a mill that has a large milling department, operates its own power plant and processes hulls, estimated labor requirements are about 31 man-hours per 1,000 cwt. of rough dry rice milled. This is only a little over three-fourths of the 40 man-hours required by a small mill which neither operates a power plant nor processes the hulls.

Table 4.--Model production labor requirements for rough-rice departments, when rice was received wet and when received dry, for 7 methods of receiving, Southern rice mills

Model	Hourly capacity of elevating machinery 1/	Labor requirements per 1,000 cwt. of rough dry rice 2/	
		Received dry	Received wet
	Cwt.	Man-hours	Man-hours
A. Rice received by rail, cleaned, binned, (dried and rebinned if received wet) and sent to milling department:			
1. Unloaded by pneumatic scoop conveyor 3/	567	6.7	11.9
2. Unloaded by power drag board 3/	972	11.0	16.6
3. Unloaded by wheel-type hand shovel 3/	400	13.1	18.9
B. Rice received by 4-wheelbase truck, cleaned, binned, (dried and rebinned if received wet), and sent to milling department:			
4. Unloaded by truck or body hoist	600	6.1	11.3
5. Unloaded by hook body hoist 3/ 4/	324	2.5	7.6
C. Rice received by 6-wheelbase truck, cleaned, binned, (dried and rebinned if received wet), and sent to milling department:			
6. Unloaded by platform truck lift	1,134	6.0	11.1
7. Unloaded by hand shovel, drop-hatched truck bed 3/	1,620	8.4	13.7

1/ Average capacity of those mills studied that are relevant to each standard developed. Capacity may or may not have been obtained and may not be the only limiting factor.

2/ In patterns 1, 2, 3, 5, and 7 only dry rice was received, in 4 and 6 only wet rice was received. As a result, standards were developed as the rice was received. Standards for the other situation, either wet or dry rice received, were developed by assumption. It was assumed that when rice was received wet, the additional requirements over that for rice received dry would amount to the labor for (1) receiving 8.8 percent additional weight and (2) drying the rice from 20 to 13 percent moisture content. In either situation labor requirements are expressed in terms of dry rough rice.

3/ Weighing, sampling, and grading not included in the receiving function and, therefore, no labor is allowed for these work categories.

4/ No full-time employees assigned to the rough-rice department, an employee was assigned only when rice was being received.

Models for the Clean-Rice Department

In this department, model labor requirements were very complicated to develop, and in order to make them meaningful for comparative purposes as well as additive to determine overall plant labor requirements, standards must be expressed in terms of rough dry rice processed rather than milled products as shown in table 3. Labor requirements per 1,000 cwt. of rough rice processed for several model clean-rice departments are shown in table 5.

In order to develop these model requirements, certain conditions were necessary: (1) A specific outturn was assumed for each of the various milled products, since all products are not disposed of in the same way; and (2) a pattern was established of disposition of each of these products for each model developed. These conditions are stated for each model in table 5. With some factors held constant--such as the outturn of the various products, trucking distances, and the disposition of portions of the screenings, brewers rice, and other products (footnote 1, table 5)--certain other factors of operating patterns, methods and techniques are varied to show their influence on labor requirements.

When all milled rice is binned, blended, and bagged at about 250 cwt. per hour and shipped directly, there is little relative difference in labor requirements due to method of moving the grain (up to a distance of 100 feet) from the blender to the load-out station. Handtrucking rice would result in total labor, per 1,000 cwt. of rough rice milled, of about 19.6 man-hours. This is only about 3.5 more man-hours than if the rice were moved from the blending-bagging station by a belt-worm conveyor system, and about 2.6 man-hours more than if forklift trucks were used. At greater distances between the blending station and the load-out station, these differences would increase and vice versa.

In this department, the greatest difference in total labor requirements at a specific volume is between the methods of binning the rice and bagging it as it is milled. For example, bagging all rice, blending from bags and loading directly (model 12) requires 52.3 man-hours per 1,000 cwt. of rough rice--when hulls are not processed and the bagging and sewing rate is about 250 cwt. per hour. This is over 2 ½ times the labor required when rice is binned as it is milled, and other factors are the same (model 3).

Two Extreme Model Plants Compared

Possible combinations of models for the 3 departments (models described in tables 2, 4, and 5) into plant models are too numerous to detail in this report. However, 2 extreme plant models are shown here to illustrate the wide range of possibilities for mills to improve labor efficiency (table 6). For example, an operation with a high labor requirement could save nearly two-thirds of its labor, as shown here, by adopting methods and techniques used by the lower labor requirement operation.

In the type of mills studied, opportunities to save labor, or improve efficiency, were found to be greatest in the clean-rice department. Methods as well as the patterns of operation varied most in this department. Labor productivity also varied most in the clean-rice department. Standards for the 2 model plants show that for the model requiring more labor, nearly 50 percent is used in the clean-rice department (table 6).

Table 5.--Clean-rice department: Standard production labor requirements for several operating models, Southern rice mills 1/

Operating model (method, techniques varied)	Labor per 1,000 cwt. of rough rice processed when hulls are not processed 2/	
	Rice bagged at 250 cwt. per hour	Rice bagged at 600 cwt. per hour
	Man-hours	Man-hours
Milled rice is binned, blended, and:		
Shipped directly from blender--		
1. Belt-worm conveyor	16.1	10.9
2. Forklift truck	17.0	11.8
3. Handtruck	19.6	14.4
Warehoused from blender and shipped--		
4. Forklift truck	17.9	12.7
5. Handtruck	30.7	25.5
First-head rice is binned and other rice is bagged and warehoused; all rice is blended and:		
Shipped directly from blender--		
6. Belt-worm conveyor	20.8	14.7
7. Forklift truck	20.3	14.1
8. Handtruck	25.2	19.1
Warehoused from blender and shipped--		
9. Forklift truck	21.2	15.0
10. Handtruck	31.3	25.2
All rice is bagged, warehoused, blended, and:		
Shipped directly from the blender--		
11. Forklift truck	36.0	25.2
12. Handtruck	52.3	41.6

1/ Conditions assumed fixed for all models are:
(1) Outturn of products are as shown in appendix B.
(2) Rice is assumed blended on the average--
all first head.....59.2 percent of the rough-rice weight.
all second head..... 5.9 percent of the rough-rice weight.
one-half the screenings.. 1.6 percent of the rough-rice weight.
Total.....66.7 percent of the rough-rice weight.
(3) The other half of the screenings and all brewers are loaded for bulk shipment.
(4) All bagged rice warehoused that is handtrucked is stacked 14 bags high by hand.
(5) Bran, polish, and hulls (when processed) are bagged and warehoused by the milling department, and hand trucked and loaded for shipment by the clean-rice department.
(6) The average trucking distance one way is assumed to be 100 feet.

2/ If hulls are processed, this department would require an additional 3.3 man-hours for each model per 1,000 cwt. of rough rice processed.

Table 6.--Southern rice mills: Plant-wide production labor requirements for 2 model plants employing extremely different methods 1/

General characteristics of 2 extreme models	Labor requirements per 1,000 cwt. of rough dry rice			
	Rough-rice department 2/	Rice milling department	Clean-rice department	Total
	Man-hours	Man-hours	Man-hours	Man-hours
1. A low labor requirement operation 3/	6.1	25.4	14.2	45.7
2. A high labor requirement operation 4/	13.1	49.2	55.6	117.9
Difference	7.0	23.8	41.4	72.2

1/ Machine rates also differ but the level of processing is the same, except no weighing and grading of rough rice is done in model 2.

2/ For rice received wet rather than dry, add 4.9 man-hours for drying and 8.8 percent of the labor requirement for the method of receiving dry rice shown in table 1.

3/ For descriptions of each department as represented in this model plant operation, see table 4, model 4 for the rough-rice department; table 2, large mill, hulls processed, using public power for the milling department; and for the clean-rice department see table 5, model 1, with bagging and sewing done at 600 cwt. per hour and include requirements in footnote 2, when hulls are processed.

4/ For descriptions of each department as represented in this model plant operation, see table 4, model 3 for the rough-rice department; table 2, small mills, hulls processed using public power for the milling department; and for the clean-rice department see table 5, model 12 with bagging and sewing done at 250 cwt. per hour and include the added requirements in footnote 2, when hulls are processed.

VOLUME OF BUSINESS AND LABOR USE

This report so far has emphasized standard production labor requirements that were based on observing the performance of workers during peak season operations. These standards have been used to illustrate variation in labor requirements associated with different methods and techniques used in performing the conventional functions of a rice mill operation.

This section relates monthly volumes of rice processed with monthly labor used during the 1960-61 season by the mills of this study. It compares labor used with standard requirements to illustrate potential opportunities for the industry to save labor by better labor utilization, using present methods and techniques. This report also lends validity to labor standards developed by this study, and points out the opportunity for saving labor by comparing plant labor used by these mills in 1960-61 with that which would have been required

to maintain the September-October labor productivity through the rest of the milling year. Whereas earlier this report indicated ways to save labor mainly by using methods and techniques that require the least labor per unit of production, this section emphasizes the opportunity to save labor by better balancing of labor and production loads.

The rice milling industry could effect major savings of labor by eliminating seasonal fluctuations in volume of rice processed. When it is impractical to do this or to adjust the number of workers according to the volume of business, savings of labor could be realized by incorporating other functions of rice marketing or other lines of endeavor that offset seasonal demand for labor.

Rice Processed and Labor Used

A plant-wide output figure was needed to make an analysis of labor used and productivity for 1960-61, because accounting data on labor used were available only on a plant-wide basis. Rice processed is a term developed to combine the outputs of the rough-rice, milling, and clean-rice departments into 1 output figure (table 7).

If labor productivity could have been maintained throughout the season at the standards, or even at the levels realized by these mills during September and October, what effect would this have had on these mills' labor use and costs in 1960-61?

Behavior of Volume and Labor Used

Economic theory generally treats plant labor as a variable cost instead of a fixed cost. That is, total production labor used by an economic producing unit tends to vary directly and proportionately with the total volume of production from one period to the next. Assuming this, labor used per unit of production would tend to be fixed or constant. In reality, this rarely is the case even though equal volumes of production may be expected to demand equal amounts of human effort when conditions are the same.

Total labor.--Monthly volumes of rice processed and labor used by 5 of the mills in this study varied similarly but not to the same magnitude in 1960-61. Monthly volumes processed ranged from about 65,000 to 475,000 cwt. of rough rice. Labor used per month ranged from 21,000 to 44,000 man-hours. Production in the high month was over 7 times the low month, whereas, labor used in the high month was just over twice as high as in the low month. In the high month over 14 percent of the rice for the year was processed by these mills using only about 10 percent of their annual labor. In the lowest month these mills processed less than 2 percent of their annual volume but used over 5 percent of their annual labor (table 8).

Figure 4 illustrates that monthly volumes of rice processed and total labor used by these mills in 1960-61 varied in the same direction but not in the same proportion. The upper line represents the path along which total labor used tended to change as the volume of rice processed changed. For total volume of business and total labor used to have changed directly and proportionately (per

Table 7.--Rough rice processed: Rice received, milled, and shipped, converted and expressed in equivalent rough-rice processed, by months, 5 Southern rice mills, 1960-61 1/

Month	Rough rice received	Rough rice milled	Equivalent rough rice shipped	Equivalent rough rice processed 1/
	Cwt.	Cwt.	Cwt.	Cwt.
August	222,267	58,313	49,801	82,382
September	818,222	421,951	292,091	438,234
October	622,996	426,599	466,864	474,772
November	353,642	364,127	306,710	340,371
December	359,443	413,760	455,926	420,867
January	287,641	387,047	382,695	368,458
February	160,313	395,329	387,018	352,966
March	205,660	340,743	388,580	336,561
April	90,201	183,360	259,778	197,122
May	159,149	190,817	196,010	187,529
June	19,451	107,993	91,798	87,025
July	38,360	33,491	112,596	64,624

1/ Rough rice processed is a plant output figure that was arrived at by combining the outputs of the rough-rice, milling, and clean-rice departments (the annual figures for the 3 stages in rice processing may not be equal because the quantity received may not be the same as that milled or shipped. The clean-rice department's output was converted to an equivalent of rough rice by dividing the milled rice shipments by .70 (approximate outturn of milled rice). Then, duplicating each mill's operating pattern, standard production labor requirements by functions and methods used were applied in developing a weight to apply to each department's output in converting it into rough rice processed. For the rough-rice department that figure averaged .1667, for the milling department, .4500, and for the clean-rice department, .3833. Together they add to 1. When these weights are multiplied by the monthly figures for the respective departments, the products add to the equivalent rough rice processed.

Table 8.--Rough rice processed and plant labor used by 5 Southern rice mills, 1960-61

Month, total, etc.	Rice processed 1/		Labor used	
	Cwt.	Percentage of total	Man-hours	Percentage of total
August	82,382	2.46	24,277	6.14
September	438,234	13.08	38,917	9.84
October	474,772	14.17	40,049	10.13
November	340,371	10.16	40,728	10.30
December	420,867	12.56	44,320	11.20
January	368,358	10.99	34,787	8.79
February	352,966	10.53	35,773	9.04
March	336,561	10.04	39,303	9.94
April	197,122	5.88	25,476	6.44
May	187,529	5.60	27,425	6.93
June	87,025	2.60	23,566	5.96
July	64,624	1.93	20,921	5.29
Total	3,350,811	100.00	395,542	100.00
Average	279,250	--	33,000	--
Standard deviation	141,154	--	9,030	--
Coefficient of variation	--	50.55	--	27.36

1/ See table 7 for computation.

unit labor constant) the upper line in figure 4, if extended to the left, would pass through the zero point. However, the line would intersect the labor-used scale above the zero point when output was at zero. The lower line of the chart, however, meets this criterion. It represents the average number of man-hours used per unit of rough rice processed--during September and October 1960--extended through the range in monthly volumes of rice processed in 1960-61. It also represents labor working at the constant high rate of output realized during September and October.

If the average number of man-hours per 1,000 cwt. of rough rice processed during the remainder of the season had been the same as in September-October, the labor used for each month's volume processed would have fallen along the lower line in figure 4. The sum of the differences in man-hours between the lower line and each month's figure (observation) represents the savings of total labor these mills could have realized if labor productivity were at the September-October rate. The sum of these differences amounts to about 106,000 man-hours, or about 27 percent of the labor they used in 1960-61. These data

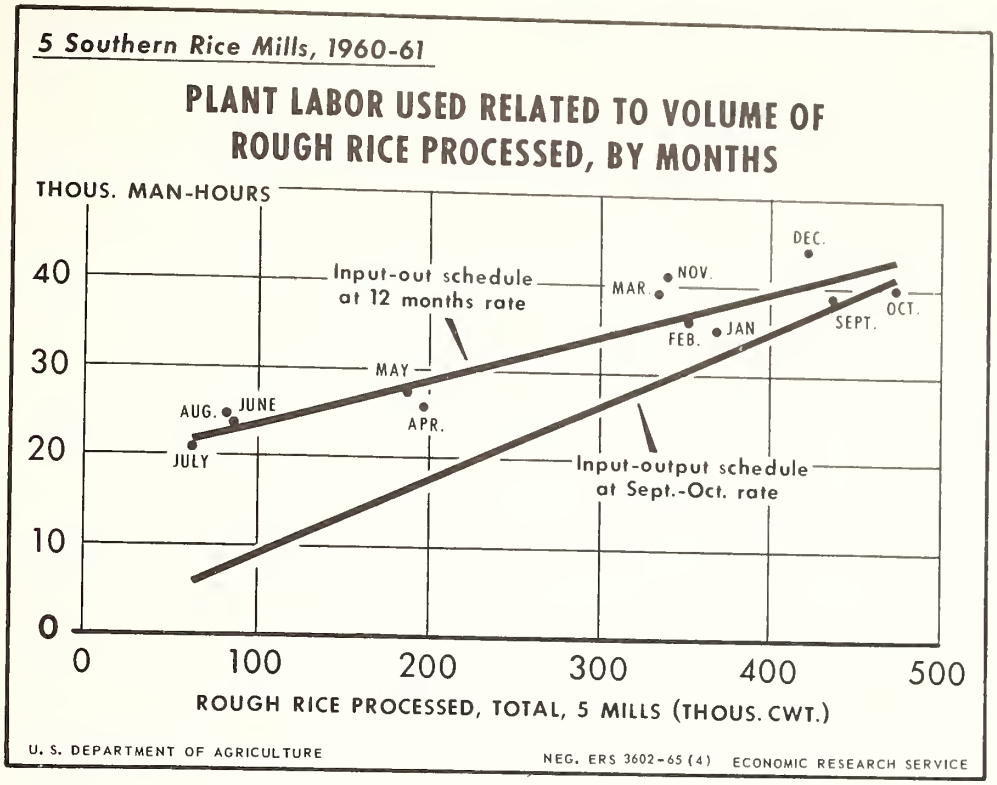

Figure 4

indicate some of the opportunities for the industry to save labor. They also lend validity to standard labor requirements for production labor by comparing them with requirements based on actual labor output for 2 months (tables 9 and 10).

With their methods unchanged, the survey mills could have saved about 38 percent of their production labor costs, if they had attained production labor standards developed by this study and maintained labor output at that rate throughout the milling year (table 10). These savings would have varied monthly from 13 percent of the production labor used in October to 75 percent in July and August.

Potential savings of production labor in man-hours, as well as percentage used, were greater in months of lower production. For example, potential total production labor savings based on standard labor required--after an allowance of 15 percent of the total labor used for maintenance and repair purposes--were greater during the summer months when volume of milling was low (fig. 5).

If these mills could have operated through the 1960-61 season and attained the standard for production labor, together they would have realized a saving of about 127,000 man-hours of labor (table 10). This would have been an average saving of about 25,000 man-hours of labor per mill for the year, or nearly 2,100 monthly. This would have amounted to the equivalent of saving the labor of about 13 men per mill in these mills that averaged nearly 670,000 cwt. of rice processed in 1960-61.

Table 9.--Rice processed, plant labor used, labor needed at the September-October output per man-hour and potential labor savings for 5 Southern rice mills, by months, 1960-61

Month	Rough rice processed 1/	Plant labor used 2/	Plant labor needed at the Sept.-Oct. output 3/	Potential labor savings	
	Cwt.	Man-hours	Man-hours	Man-hours	Percent
August	82,382	24,277	7,120	17,157	71
September 4/	456,503	39,483	39,483	--	--
October 4/	456,503	39,483	39,483	--	--
November	340,371	40,728	29,468	11,260	28
December	420,867	44,320	36,390	7,930	18
January	368,358	34,787	31,841	2,946	8
February	352,966	35,773	30,536	5,237	15
March	336,561	39,303	29,112	10,191	26
April	197,122	25,476	17,048	8,428	33
May	187,529	27,425	16,217	11,208	41
June	87,025	23,566	7,555	16,011	68
July	64,624	20,921	5,577	15,344	73
Total	3,350,811	395,542	289,830	105,712	27

1/ Receiving, milling, and shipping weighted in proportion to standard labor requirements for each department and each mill according to its methods and pattern of operation. See table 7.

2/ Total man-hours of plant labor reported used by these mills in 1960-61. Plant labor includes production labor and maintenance and repair labor.

3/ All plant labor needed to maintain output (rice processed) at the high level realized in September and October.

4/ An average for September and October. Data for either month did not deviate from the average more than 4 percent for rice processed, and 2 percent for labor used.

Labor per unit of rice processed. Theorectically, when factors other than volume are constant, production labor used per unit of rice processed is constant. This would be the situation if work were done at a constant rate, and resulted in total labor varying in direct proportion with volume of rough rice processed (conditions of a completely variable cost item). But, as already stated, total labor varied less than total volume in 1960-61. How did this affect per unit labor use and cost?

Because monthly total labor changed proportionately less than total volume of rice processed, average labor per unit of rice processed by these mills varied monthly in 1960-61 (fig. 6). When the monthly volume of rice processed by these mills was low, labor used per unit was high. Then, in months when the volume was higher, labor used per unit was lower. For example, from June through August, when monthly volumes of rice processed were lowest, nearly 300

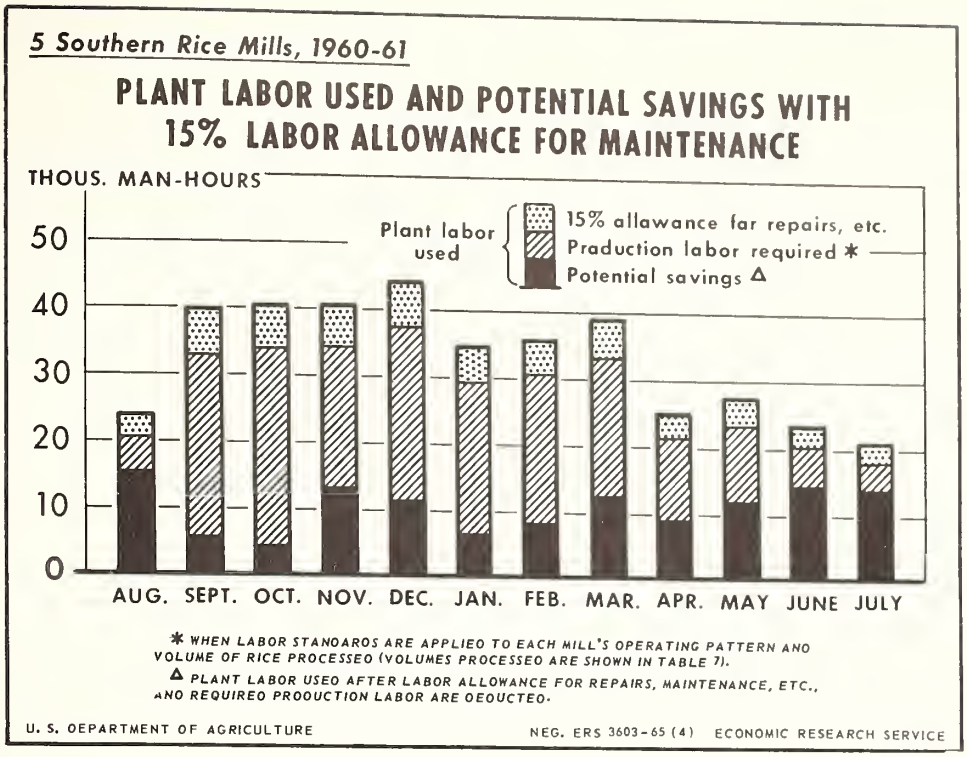

Figure 5

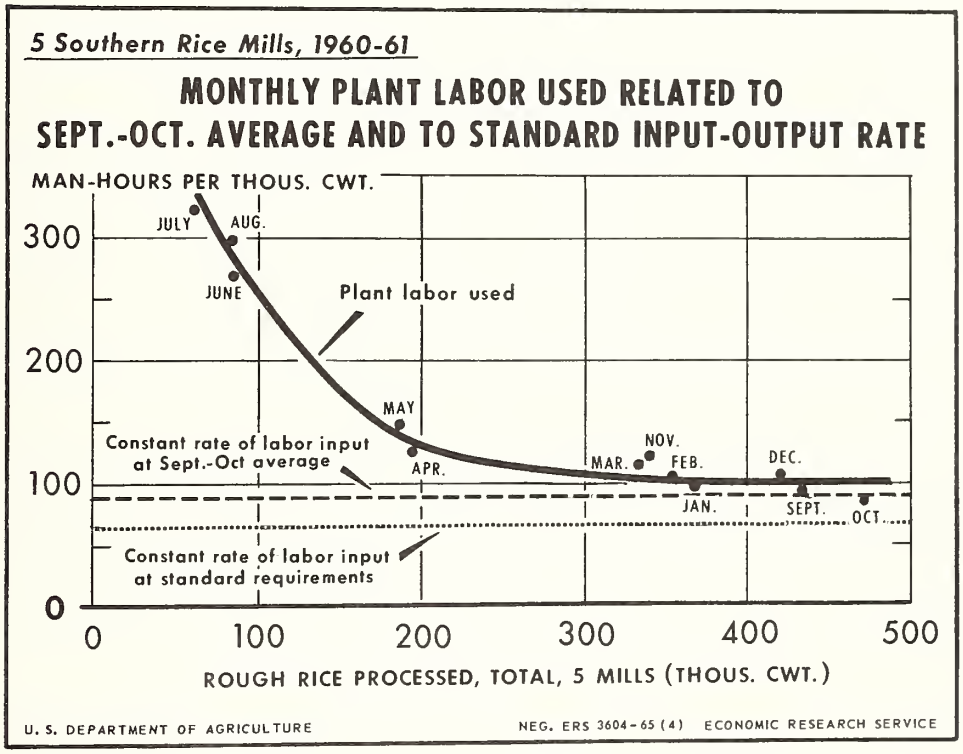

Figure 6

Table 10.--Rice processed, production labor used, production labor required at standard labor requirements, and resulting labor-saving potential for 5 Southern rice mills, by months, 1960-61

Month	Rough rice processed 1/	Production labor used 2/	Production labor required 3/	Resulting production labor saving (potential)	
	Cwt.	Man-hours	Man-hours	Man-hours	Percent
August.....	82,382	20,635	5,141	15,494	75
September...	438,234	33,079	27,346	5,733	17
October.....	474,772	34,042	29,626	4,416	13
November....	340,371	34,619	21,239	13,380	39
December....	420,867	37,672	26,262	11,410	30
January.....	368,358	29,569	22,986	6,583	22
February....	352,966	30,407	22,025	8,382	28
March.....	336,561	33,408	21,001	12,407	37
April.....	197,122	21,655	12,300	9,355	43
May.....	187,529	23,311	11,702	11,609	50
June.....	87,025	20,031	5,430	14,601	73
July.....	64,624	17,782	4,033	13,749	75
Total.....	3,350,811	336,210	209,091	127,119	38

1/ See table 7 for explanation of this output figure.
2/ This assumes 15 percent of the total labor reported by these mills in 1960-61 was for repairs, maintenance, and other services which are not included in the standard labor requirements developed by this study.
3/ Labor required for the volume processed (each department's output was weighted by relative labor standard requirements duplicating these mills' methods--a model duplicating the 5 mills' operations).

man-hours of plant labor were used per 1,000 units of rough rice processed. During the September-October period, when volumes were highest, these mills used an average of only 86.5 man-hours per 1,000 cwt. of rough rice processed. This indicates potential saving of over 200 man-hours per 1,000 cwt. of rice processed during the months of low volume (table 11 and fig. 6).

Figure 6 also compares the month-to-month labor used per 1,000 cwt. of rice processed (upper line in chart) with a model or standard labor use which duplicates the operating methods and patterns of these mills for 1960-61 (lower line in chart). It also makes the same comparison between monthly labor used per unit and the average for September and October (middle line in chart). Moreover, it compares standard production labor requirements with plant labor used during the peak season.

Allowing 15 percent of plant labor for repairs, maintenance, and other service labor, the September-October production labor used per 1,000 cwt. of

Table 11.--Plant labor used by 5 Southern rice mills by months in 1960-61 compared with plant labor required during the peak months of September-October, 1960

Month	Labor per 1,000 cwt. of rough rice processed			
	Used	Requirements	Potential savings	
	Man-hours	Man-hours	Man-hours	Percent
August	294.7	86.5	208.2	71
September 1/	86.5	"	0.0	--
October 1/	86.5	"	0.0	--
November	119.7	"	33.2	28
December	105.3	"	18.8	18
January	94.4	"	7.9	8
February	101.4	"	14.9	15
March	116.8	"	30.3	26
April	129.2	"	42.7	33
May	146.2	"	59.7	41
June	270.8	"	184.3	68
July	323.7	"	237.2	73
Average 2/	118.0	86.5	31.6	27

1/ September-October average.
2/ Weighted by cwt. of rice processed.

rough rice processed would have been about 73.5 man-hours, or only about 18 percent above the standard of 62.4 man-hours set for these mills. This tends to make the production labor standards developed by this study appear attainable.

A comparison of standard production labor requirements and estimated production labor used by months in 1960-61 is shown in table 12. On the average it is estimated that these mills could have saved from 9 to 213 man-hours of production labor per 1,000 cwt. of rough rice processed monthly if they had attained the standards developed by this study.

The rice milling industry is confronted with (1) the seasonality of demand for labor because labor resources cannot be engaged and released to coincide with seasonal fluctuations in the volume of rice processed, and (2) the variation in labor used per unit of rice processed due to the use of different methods and techniques in performing each of the functions of a rice mill operation. This analysis of production labor can help the rice milling industry to improve the processing costs and efficiency picture.

Table 12.--Standard production labor requirements compared with production labor used by 5 Southern rice mills, 1960-61

Month	Production labor per 1,000 cwt. of rouch rice			
	Estimated used 1/	Standard	Potential savings	
	Man-hours	Man-hours	Man-hours	Percent
August	250.5	62.4	188.1	75
September	75.5	"	13.1	17
October	71.7	"	9.3	13
November	101.7	"	39.3	39
December	89.5	"	27.1	30
January	80.3	"	17.9	22
February	86.2	"	23.8	28
March	99.3	"	36.9	37
April	109.9	"	47.5	43
May	124.3	"	61.9	50
June	230.2	"	167.8	73
July	275.2	"	212.8	75
Average 3/	100.3	62.4	37.9	38

1/ Allows 15 percent of reported total for repairs, maintenance, etc. See footnote 2, table 10.

2/ Annual labor requirements developed in table 10, as explained in footnote 3, divided by the annual volume of rough rice processed by these mills.

3/ Weighted by cwt. of rice processed.

APPENDIX A--METHOD OF DEVELOPING STANDARDS

The organization of a conventional rice mill reflects the 3 stages in the overall process. Consequently, in this study labor standards are established for 3 major areas in rice mill operations: (1) the rough-rice department, (2) the milling department, and (3) the clean-rice department.

Standard labor requirements were developed from work sampling data, or a ratio-delay analysis, for each work function, division, or category of work by methods and techniques used in the rough- and clean-rice departments. Since work of the milling department is more difficult to analyze by this method, standards were developed for the overall milling department , using daily total labor input-outputs. These observations were made during a 2- to 3-day period of the peak season in September 1961. Corresponding output data were collected during this period. These labor input-output data formed the basis for developing labor standards.

The first step in setting standards from these data was to develop the estimated percentages of the production labor's time devoted to each work function and to delay time. But applying these percentages to total man-hours employed in each department during the observation period each day, the man-hours used by each work function and for delay were determined for the rough-rice and clean-rice departments.

From these observations, standards were set first for delay and for cleanup and preparatory work (for which there was no measurable output in rice or rice products). The standard delay for all purposes was set at 20 percent of the total time. Cleanup and other work time was set at 21 percent. As actual work time standards were developed for each function, adequate time was added for delay and cleanup so that standards included the allowance set for each of these categories.

Standard times thus developed daily for each mill for each function were applied against their respective outputs to express the standards in terms of labor requirements per 1,000 cwt. of rough rice or clean rice. These daily standards were arrayed, averaged, and the midpoint between the most efficient day's observation and the average for each function was selected as a standard.

A standard labor requirement was set for the whole milling department but not for each function as in the other departments. Since the number of production workers does not vary in direct proportion to the size of the mill operation, and since standards were based on observed-plant inputs-outputs, they were set at different levels for mills of varying size. Also, standards are dependent upon whether the mill operates a power plant or whether it processes the hulls. Standards for the milling department for a mill of specified size and type were based upon daily operating observations which did not estimate delay time and which were set midway between the average and the highest output per man-hour.

A standard for the trucking function in the clean-rice department would vary with distance as well as method. Standards were developed for this function on the basis of 100-foot trucking distance, one way. These standards agree

with a study of cost and efficiencies in seed processing in which trucking standards for distances trucked were set in intervals of 20 feet. 5/ Standards for trucking distances in 20-foot intervals were adapted to the similar standards in the seed study.

Standards for each function thus developed were compared with the actual data and it was found that these mills attained or exceeded the standard about 16 percent of the time during the observation period. This set standards at levels that could be attained at peak performance by some mills, but for others these levels were more difficult if not impossible to attain unless operations were reorganized.

Standards thus developed for each department, if attained over a period of time, would place output per unit of labor input at a constant and relatively high rate. This permits these standards to be applied for comparative purposes to various volumes of rice milled. A constant rate of output per man-hour labor used is rarely attained in practice but nevertheless such a standard may (1) be a goal and (2) provide a basis for management to evaluate its labor performance.

APPENDIX B.--DESCRIPTION OF WORK DIVISIONS AND OUTPUT MEASURES

Receiving rough rice.--Receiving involves weighing and issuing scale tickets, sampling, grading (sometimes already performed in the case of dry grain), unloading, elevating, and binning or placing the grain in temporary storage when it is delivered. In most instances receiving includes cleaning the grain. It also involves supervision and binning instructions by the scale man, and includes keeping records and any storage.

Drying rough rice.--Drying involves operating the dryer, sending grain to dryer, and binning grain. It also includes instructions by scale man and keeping records.

Serving the milling department's needs for rough rice.--This includes sending rice from rough-rice department to milling department. It does not include binning when rice is binned in milling department prior to actual milling. It includes instructions and keeping records in the rough-rice department which are associated with the movement of the grain.

Milling rice.--There are several natural divisions or stages of work in this function (fig. 2). Milling is machine performed and involves conversion of rough rice into milled rice and byproducts. Because the output of the milling department determines the input of the clean-rice department, an average percentage distribution of output by form of product is given: 6/

5/ Greene, C. H., and Davis, G. B. Cost and Efficiencies in Seed Processing. Ore. State Univ. Agr. Expt. Sta., June 1962.

6/ Computed from reports of the American Rice Millers' Association for 1961-62, and from Conversion Factors and Weights and Measures for Agricultural Commodities and Their Products, Prod. and Mktg. Adm., U.S. Dept. Agr., May 1952.

Product	Percent
First head rice	59.2
Second head rice	5.9
Screenings	3.2
Brewers rice	3.3
Bran	6.2
Polish	1.2
Hulls	21.0
Total	100.0

However, among the 6 mills studied, some variations were observed in functions and in products derived in the milling departments. The following tabulation gives some differences in characteristics of the milling departments and the average percentage of milled products which were bagged.

Characteristics	Number of mills
Generated part of their power	4
Processed some or all hulls	4
Bagged under 20 percent of milled products	1
Bagged 20 to 40 percent of milled products	3
Bagged over 40 percent of milled products	2
	Percent
Average percentage of milled products bagged (and warehoused)	23

Moving milled rice.--When rice products are in bags, moving is done by 2- or 4-wheel handtrucks or forklift trucks. Bagged products are trucked from warehouse to blender. Trucking involves operating truck as well as bucking rice off after it is moved, but does not include loading, except when rice is bucked on truck. When milled rice is in bins, it is moved to the blenders by conveyors, with the blend controlled by machine. Also, a conveyor system may be used to move blended bagged rice from sewing operation to the load-out station.

Blending milled rice.--When binned rice is being blended, blending is a machine operation which involves observing and adjusting flow properly. When bagged rice is being blended, it is a hand operation involving cutting bags open and dumping them into blender. However, it may be a combination of the 2 methods.

Handling bagged rice and byproducts.--This comprises stacking bagged products on handtrucks or pallets (except when this is part of the sewing job) and stacking them in warehouse and in vehicle for shipment, also any other handling supplementary to these tasks.

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Scaling and bagging blended rice.--This involves placing bags on spout to catch rice as it is dumped by automatic scales. After rice is bagged, usually the person bagging lifts bag slightly onto conveyor which moves it into position to be sewed.

Sewing bagged, blended rice.--This consists of operating sewing machine and maneuvering bags into position to sew ends shut as they are conveyed from the bagging machine. The person doing this also places bagged rice onto truck or other facility used to move bagged rice to next position in operation.

Cleanup and other work.--This involves any work, such as sweeping, stenciling bags, preparing, opening, and closing shipment vehicles, etc. for which there is no measurable unit of output.

Delay.--This includes the time when workers are not working--for personal reasons, a break in flow of material, waiting on other operations, or any other reason.

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