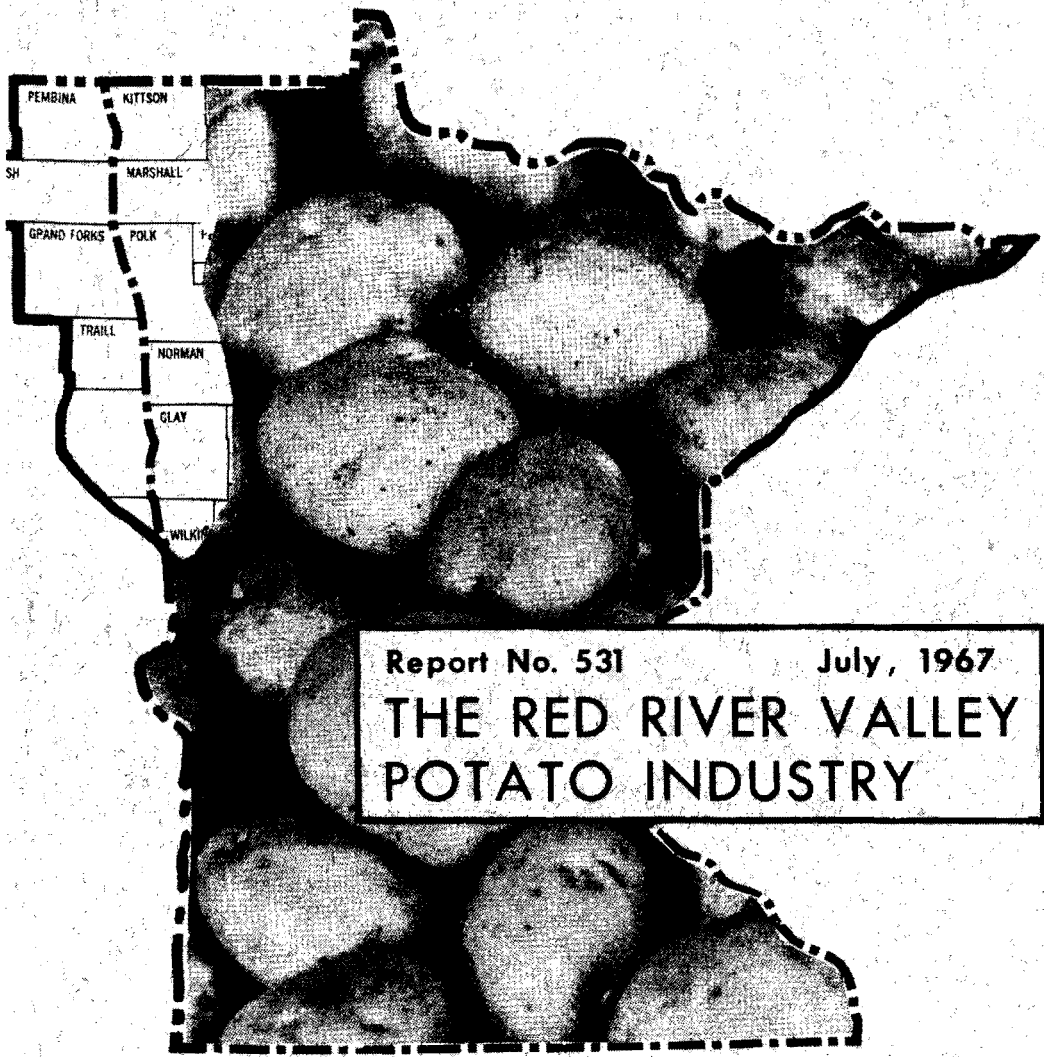
ECONOMIES OF SIZE IN STORING AND PACKING POTATOES



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THE RED RIVER VALLEY POTATO INDUSTRY

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LIST OF TABLES AND FIGURES

Tables

Figures

FOREWORD

This is the first of three reports that examine various aspects of the Red River Valley potato market. This study evaluates costs of storing and packing potatoes per hundredweight burlap bag as related to five storage capacities and three input rates common to Red River Valley potato packing plants.

This report is part of a continuing program of research by the Minnesota Agricultural Experiment Station in cooperation with the Economic Research Service, U. S. Department of Agriculture, to provide information to agricultural marketing firms as a basis for making decisions in adjusting to changing economic and technical conditions.

INTRODUCTION

The Red River Valley potato industry has undergone rapid and dramatic changes during the past decade in the number and size of production units and marketing firms. The number of farms producing potatoes has declined to less than one-third of the 1954 level and the average size of production units has increased more than fourfold. Census data for the 10 northern Valley counties indicate that the number of farms harvesting potatoes declined from 4,560 in 1954 to only 1,313 in 1964. While the number of production units declined, total acres harvested increased from 136,500 in 1954 to 160,200 in 1964.

Parallel to these changes, the number of potato marketing firms as measured by those paying federal-state inspections, which were required at that time, declined by one-fourth and their average size more than doubled. In 1955, 1,075 firms paid inspections; in 1963, only 750. But while the number of firms decreased, the average volume of inspections paid per firm increased from 8,000 cwt. in 1955 to 21,000 cwt. in 1963.

Changes in average size of firm is only one of the important changes that are taking place. The rapid growth of the largest firms between 1955 and 1963 has tended to change the organization and structure of the potato industry in the Red River Valley. During the 1962-63 season, 5 plants packed over 386,000 cwt. of potatoes each and 13 plants packed 240,000 cwt. or more. The volume of potatoes packed in individual plants is not available for other years, but the average size of firm is increasing at a rapid pace. During the 9-year period from 1955 to 1963, paid inspections by the 50 largest firms increased from an average of 82,000 to 158,000

cwt. per firm; the volume handled by the 20 largest firms increased from 132,000 to 255,000 cwt.; for the 8 largest firms volume increased from 196,000 to 377,000 cwt. per firm.

Relationship of Production and Marketing

Practically all potato producers in the Valley are involved in storage operations and, to a lesser degree, packing and selling functions. During the 1962-63 season there were 1,619 production units organized into 858 marketing organizations. All of these 858 organizations owned or controlled same storage space, but only 704 packed potatoes for shipment. Some firms did not use the storage space they controlled, and many sold their potatoes to, or through, other packers.

Potato storage design has changed in recent years to take advantage of modern bulk handling methods. A considerable number of large, modern, above-ground storage facilities have been constructed on rail sidings. As new trackside facilities have been constructed, the importance of farm storage has declined. During the 1962-63 season only 6.4 million cwt., or 25 percent of the 26.1 million cwt. total storage capacity in the Valley, were located on individual farms. On the average, however, storage and packing operations are still conducted on a rather small scale. During the 1962-63 season average storage per firm was only 25,800 cwt. Although this volume represents a sizable production unit (approximately 200 acres) it is extremely small relative to the larger storage and packing operations in the Valley.

Many firms in the industry have recognized that there are substantial gains in marketing efficiency as the size of the operation is increased. It has also been recognized that the potential economies are not limited to a few large producers

and packers, but are also within reach of the small firm as well. Although some of the new facilities have been constructed by single firms or individuals, most recent construction has been undertaken by small producers using various forms of group organization for the purpose of owning and operating large storage and packing facilities.

Purpose and Objective

The purpose of the overall project of which this study is a part is to provide information that can be used as a guide for decisions that are needed in making adjustments to changing economic conditions. The specific objective of this study is to determine the relationships between costs and scale of operation, measured in terms of plant size and packing rates. This information can be used as a basis for planning new, efficient storage and packing facilities.

Method of Analysis

Engineering data underlie the costs presented in this study. In developing engineering data, each stage or segment of the production process is studied to determine its physical input-output relationships for different sizes and rates of operation. Data on these components can be combined to give the overall input-output relationships for model plants of various sizes. By applying prices to the input requirements so obtained, optimum combinations of buildings, equipment, and other inputs can be determined for each size of plant. An economy of size curve is developed from the short-run average cost curves for various sizes of plants so synthesized.

The physical input-output data for this study were provided by the Transportation and Facilities Research Division, ARS. This division has the primary responsibility in the USDA for research relating to costs and efficiency in storing and

handling agricultural products. When this study was initiated, the Transportation and Facilities Research Division cooperated in providing access to these data.[1/]

Assumptions and Specifications

The basic layout design details for storage and packing structures covered in this study were prepared by USDA engineers at the Red River Valley Potato Research Center. Specifications were developed for five storage sizes--42, 60, 120, 240, and 386 thousand cwt. capacities--with attached packaging areas as required to handle packing rates of 100, 200, and 300 cwt. per hour. Building cost estimates reflect the cost situation for the 1963 construction season.

Equipment specifications for each size of plant were developed on the basis of the planned packing capacity of the plant. Equipment costs were obtained from Red River Valley equipment dealers to reflect prices for the 1963 packing season.

For the purpose of this analysis, labor requirements were based on the packing rates specified above and the following assumptions regarding quality of potatoes: Quality was assumed to be such that the pack-out would be 70 percent U.S. No. 1, 20 percent U.S. No. 2, and 10 percent culls and B size. U.S. No. 1 quality is packed in two sizes: (a) 2-3 1/2 inches in diameter and (b) over 3 1/2 inches in diameter. U.S. No. 2 quality is packed in one size, 2 inches and larger in diameter. All grades were assumed to be packed in 100-pound burlap sacks only. Culls and size B were assumed to be disposed of as unmarketable. Labor require-

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[1/] The two individuals most instrumental in the collection of the original data were Leonard Pawski, industrial engineer, and R. S. Claycomb, civil engineer, who later left USDA employment to accept positions in private industry. The University of Minnesota obtained the services of both men on a consulting basis to organize, modify, and update the basic data.

ments were converted to costs on the basis of a wage rate of $1.25 per hour, which was common during the 1963 packing season.

PACKING PLANT FACILITIES AND OPERATIONS PERFORMED

Storage

After potatoes are harvested, they are placed in storage at a temperature of 50-60° F. and relatively humidity for 10-14 days. Under these conditions, cuts and bruises heal rapidly and losses from shrinkage and decay are reduced. After the preliminary curing period, storage temperatures for tablestocks are reduced to 38-40° F.

The small, earth-covered, underground storage facility that predominated in the past is not suitable for packing the large volumes of potatoes required by present-day buyers. Although well adapted for the utilization of family labor, these facilities usually lack washing equipment--a necessity if the shipper intends to serve the tablestock market. Also, the control of humidity and temperature is difficult, usually resulting in potatoes unsuitable for processing.

Modern storage facilities are designed to take advantage of bulk handling. These large, above-ground structures typically have been built by rail sidings in the Valley. They are equipped with flume systems for moving potatoes from storage bins to high-capacity packing lines. As storage capacity has increased and processed potatoes have become more important as an alternative market outlet, automatic environmental control has become more important for firms who sell to processors.

Model storage and packing structures, on which costs in this study are based, have stress-grade, wood frames with steel sheathing; flat roof decks (diaphragm) with gravel-surfaced, hot-mopped roofs; concrete floors with necessary water flumes

and air ducts; 6-inch mineral wool or equivalent insulation; polyethylene vapor barriers; heating and ventilating systems with automatic controls designed for the Red River Valley climate; and adequate electrical systems.

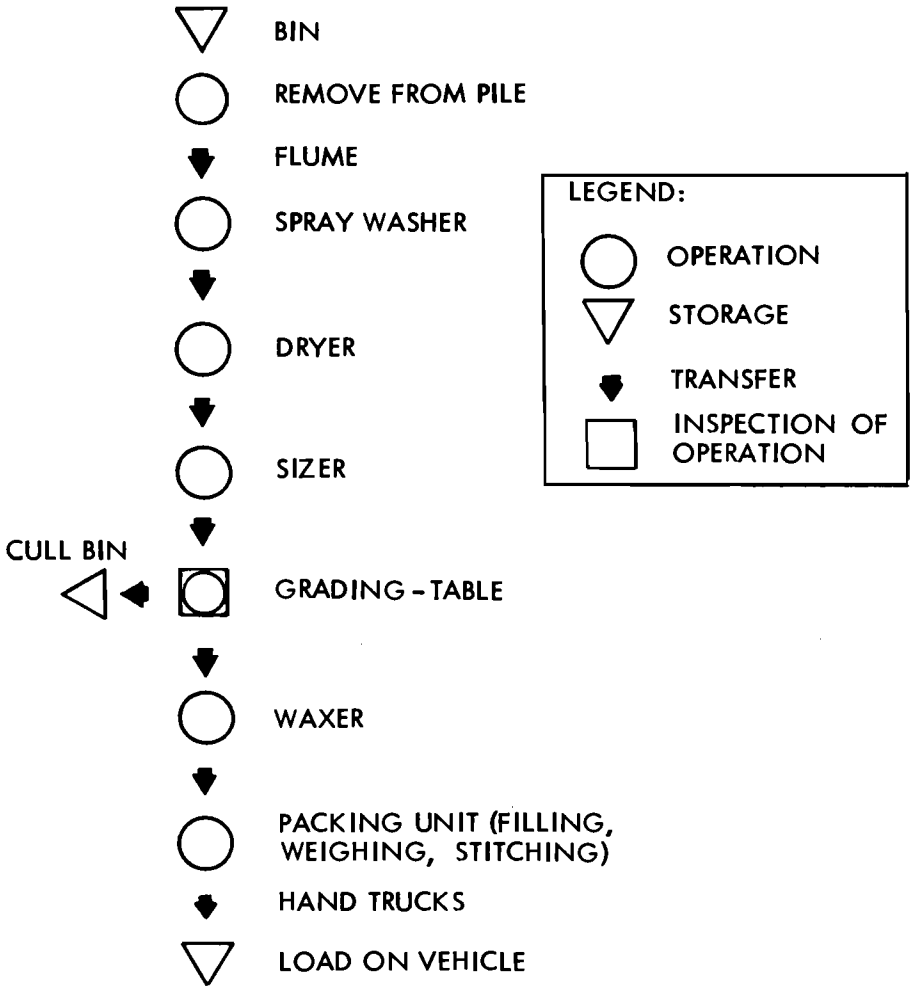
Packing

The market in which the potatoes are to be sold determines the grade pack, whether the potatoes are washed, and the size and type of container used. Most tablestock potatoes are packed in relatively large, flume-equipped, fixed line, packing plants. The overall operation may be broken down into a number of sub-operations or stages. Figure 1 is an illustration of such a breakdown.

The grading table and other packing line components are designed to operate at a constant speed. The output rate is controlled by varying the dumping rate (input rate) rather than by varying the equipment operating speed. The basic quality of the potatoes and the grade standards to be packed are important determinants of crew organization and labor requirements. Thus, crew organization must be considered in terms of the quality of potatoes and the proposed input rate. The operator has no control over the quality but he can control the input rate and make adjustments in crew organization.

The operation begins when potatoes are moved from the pile to the flume by water pressure. Most of the field dirt is washed away in the flume, but upon reaching the packing line the potatoes are passed through a high-pressure water spray which completes the washing process. The potatoes are usually passed through a dryer after emerging from the washer. Hot air blowers and absorbent rollers remove surface moisture. Then, the potatoes go through the sizer, which separates out the very small (1 7/8 inches in diameter) and very large (3 1/2 inches in diameter) sizes for the

FIGURE 1 . Process-flow diagram for a typical potato packing plant.



tablestock market. The small or B size potatoes are usually sold to canners or other buyers who process and market precooked potatoes. The large or jumbo size potatoes are sold to starch or flour processors, or to institutional users.

Next, the remaining potatoes are conveyed across a roller-type grading table, where those that fail to meet grade requirements are removed. Although several varieties are produced in the Valley, most of those for the fresh market are red varieties that may be waxed. Waxing involves the application of a red vegetable wax dye to enhance the color.

The potatoes are then conveyed from the waxer to the pocking units. Small plants are usually equipped to pack only 100-pound bags, but in large plants there are usually two sets of packing equipment - 1 for filling 50- to 100-pound bags and another for filling 25-pound bags and small "consumer packages." The 50- and 100-pound bags are filled, weighed, and closed by hand, but the consumer packaging is usually done on a semiautomatic, "merry-go-round" type filling and weighing unit.

The packed potatoes are then conveyed to railroad cars and trucks for shipment to consumer centers. During the winter, the railroad cars and trucks are heated for several hours before loading to avoid frost damage to the products.

PACKING COSTS

Economies of size were analyzed by synthesizing model storage and packing plants in which various plant components were standardized. This was done to eliminate cost variations that could arise from factors other than plant size. As mentioned previously, model plants of five storage capacities (42, 60, 120, 240, and 380 thousand cwt.) and three packing rates (100, 200, and 300 cwt. per hr.) were consi-

dered. The actual pack-out volume is always less than the indicated storage capacity. In this regard it was assumed that the actual pack-out was 90 percent of the storage capacity, and this volume was used for the estimation of unit costs.[2/]

Costs were classified as variable and fixed. Variable costs, which vary with the level of output, include labor required for the fluming and packing operations; electricity; water for fluming and washing; maintenance; and such supplies as burlap sacks, twine, and floor coverings.

Fixed costs cover the major physical packing house facilities, such as storage and packing room structure, and fluming and packing equipment.

While the costs estimated in this study are thought to be applicable to small plants, they tend to underestimate typical investments in larger plants because prepackaging operations commonly performed in larger plants were specifically excluded from consideration in this study. In order to isolate economies of size, it was assumed that plants of all sizes were packing potatoes in 100-pound burlap sacks. As was indicated earlier, the larger plants usually have separate packing equipment and crew organization for packing potatoes in 25-pound and smaller packages. Initial investment for large plants will therefore be somewhat higher than the costs shown in this study.

Variable Costs

Labor Costs

Table 1 shows crew organization and man-hour labor requirements per plant hour for potato packing plants as related to the storage capacity and the packing rate. The

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2/ The five actual pack-out volumes are: 37,800, 54,000, 108,000, 216,000, and 347,432 cwt.

Table 1. Crew organization and labor requirements per plant hour for potato packing plants, Red River Valley, 1963.[A]

Storage capacity, 1,000 cwt.	Packing rate cwt.	Fluming	Packing							
			Grade[B]	Fill & Weigh No. 1's	Stitch No. 1's	Hand truck load No. 1's	Fill, stitch weigh No. 2's	Hand truck No. 2's	Total	
		man hrs./plant hr.								
42	100	1.09	2.00	1.00[B]	--	1.00	1.00[C]	--	5	00
	200	1.12	4.00	1.00	1.00	1.00	1.00[D]	--	8	00
60	100	1.10	2.00	1.00[B]	--	1.00	1.00[C]	--	5	0
	200	1.13	4.00	1.00	1.00	1.00	1.00[D]	--	8	0
120	100	1.12	2.00	1.00[B]	--	1.00	1.00[C]	--	5	0
	200	1.14	4.00	1.00	1.00	1.00	1.00[D]	--	8	0
	300	1.15	6.00	1.00[F]	2.00[E]	1.00	1.00	1.00	12.	0
240	100	1.09	2.00	1.00[B]	--	1.00	1.00[C]	--	5.	0
	200	1.14	4.00	1.00	1.00	1.00	1.00	--	8.	0
	300	1.15	6.00	1.00[F]	2.00[E]	1.00	1.00	1.00	12.	0
386	200	1.13	4.00	1.00	1.00	1.00	1.00[D]	--	8.	0
	300	1.16	6.00	1.00[F]	2.00[E]	1.00	1.00	1.00	12.	0

[A] Assumes 5 percent No. 3's removed by screen sizer; picked out equal to 25 percent No. 2's, 5 percent culls.

[B] Also stitch.
[C] Also hand truck loads.
[D] Also hand truck loads.

[E] Also fill, weigh, and stitch No. 1's, 3 1/2 inches and over.
[F] No. 1's, 2-3 1/2 inches only.

operation was broken down into a number of stages. Time study procedures were employed to estimate labor requirements. Labor requirements per plant hour were found to increase from 5 to 12 men as the packing rate increased from 100 to 300 cwt. per hour.

Season time requirements and total and per unit labor costs are indicated in table 2. The estimation of season time requirements is based on the man-hour requirements shown in table 1. For example, at a packing rate of 100 cwt. per hour it would take 52 8-hour plant days per season to pack out 37,800 cwt. (90 percent of the 42,000 cwt. storage capacity).

Per unit labor costs remain constant over the entire range of storage capacities but decrease 2.1 cents as the packing rate increases from 100 to 200 cwt., and 0.3 cents as the packing rate increases from 200 to 300 cwt. The economies associated with packing rate are the result of more efficient crew organization, made possible by higher packing rates.

Operating Costs

Table 3 shows annual and per cwt. operating costs of water, power, and maintenance for fluming and packing equipment. Per cwt. operating costs for fluming equipment do not appear to vary with respect to storage capacity but decrease slightly as the packing rate increases. Per cwt. operating costs for packing equipment decrease as the storage capacity and packing rate increase.

Storage costs, estimated at 2 cents per cwt., include power and maintenance for ventilation, humidity and heating units.

Supplies

Total supply costs were estimated at 18.1 cents per cwt. Supplies used in the

Table 2. Season time requirements and total and per cwt. labor costs for potato packing plants, Red River Valley, 1963.[1/]

Storage capacity, 1,000 cwt.	Packing rate, cwt./hr.	Season time requirements 8-hr. days	Total labor costs			Per cwt. labor costs		
			Fluming	Packing	Total	Fluming	Packing	Total
42	100	52	$ 574	$ 2,625	$ 3,199	$0.015	$0.069	.084
	200	26	295	2,100	2,395	0.008	0.055	.063
60	100	75	827	3,750	4,577	0.015	0.055	.084
	200	37	422	3,000	3,422	0.008	0.055	.063
120	100	150	1,674	7,500	9,254	0.015	0.069	.084
	200	75	855	6,000	6,855	0.008	0.055	.063
	300	50	575	6,000	6,575	0.005	0.055	.060
240	100	300	3,272	15,000	18,272	0.015	0.069	.084
	200	150	1,708	12,000	13,708	0.008	0.055	.063
	300	100	1,148	12,000	13,148	0.005	0.055	.060
386	200	241	2,725	19,326	22,051	0.008	0.055	.063
	300	161	1,871	19,302	21,173	0.005	0.055	.060

[1/] Wage rate assumed to be $1.25 per hour.

potato packing plant are sacks, twine, and floor coverings for trucks and railroad cars. The major cost items were the 100-pound burlap sacks--estimated at 17.0 cents each for this study. Twine, at 0.5 cents per sack, and floor covering, at 0.6 cents per sack, were added to the unit cost for supplies.

Table 3. Annual and per cwt. operating costs for fluming and packing equipment, Red River Valley, 1963.[A/]

Storage capacity, 1,000 cwt.	Packing rate, cwt.	Annual operating costs		Per cwt.[B/] unit costs	
		Fluming	Packing	Fluming	Packing
42	100	$ 92	$ 860	24¢	2.28¢
	200	64	797	17	2.11
60	100	134	1,163	25	2.15
	200	92	1,002	17	1.86
120	100	281	2,169	26	2.00
	200	211	1,793	20	1.66
	300	182	1,650	17	1.53
240	100	516	3,898	24	1.80
	200	424	3,375	20	1.56
	300	364	3,056	17	1.41
386	200	659	5,047	19	1.45
	300	651	4,691	19	1.35

[A/] Operating costs include power, water, and maintenance. See appendix table 1 for details on rates applied to these inputs and operating costs for individual equipment.

[B/] The actual packed-out volume is used for the computation of unit costs.

Fixed Costs

Storage and Packing Room Structure

Table 4 presents replacement, annual fixed, and per cwt. costs for storage and packing room structures, based on the type of construction specified previously.

Total cost for the structure includes site preparation, materials, labor, general construction, mechanical and electrical work, builder's risk insurance, bonding permits, costs for installation of sump, flume, heating and ventilation systems, builder's profits, and contingency. These costs are based on the prices for materials and wages prevailing in the 1958-63 period, adjusted to the 1963 price level. Costs of financing, purchase or lease, walks, rail sidings, fire protection systems, connections to utilities, and provisions for waste water disposal are not included in storage structure costs. Exclusion of these costs has a minor effect on the level of total costs but does not influence the shape of the cost curves.

Since the life of the structure extends over a number of years, costs per operating season must be computed on the basis of the structure's expected use-life. In this study it was estimated that the structure would last 33 years with no salvage value at the end of that time. This would lead to a depreciation rate of 3 percent of replacement costs. Other charges computed as a percent of replacement cost are as follows: repair, 2 percent; insurance, 1 1/2 percent; interest and taxes, 4 percent. These rates were adapted from information contained in similar studies.[3/]

[3/] R.V. Enochian, F. J. Smith, and L. L. Sammet, Cost and Efficiency in House Packing Western Head Lettuce (Berkeley: University of California, Division of Agricultural Science, Agr. Exp. Stn., Sept. 1957), p. 28. (Giannini Foundation Mimeo Rpt. No. 199). Processed. Also, U. S. Department of Treasury, Tables of Useful Lives of Depreciable Property, (Washington: Govt. Printing Office, 1948), p. 17 (U. S. Internal Revenue Service Publication 117, Bulletin F.).

Table 4. Replacement, annual fixed and per cwt, costs for storage and packing room, Red River Valley, 1963.

Storage capacity 1,000 cwt.	Packing rate, cwt.	Replacement costs			Annual fixed costs			Unit costs[A/]		
		Storage	Packing room	Total structure	Storage	Packing room	Total structure	Storage	Packing room	Total structure
42	100	$50,400	$10,660	$61,060	$ 4,800	$1,015	$ 5,815	12.70¢	2.68¢	15.38¢
	200	50,400	12,310	62,710	4,800	1,172	5,872	12.70	3.10	15.80
60	100	66,400	10,660	77,060	6,324	1,015	7,339	11.71	1.88	13.58
	200	66,400	12,310	78,710	6,324	1,172	7,496	11.71	2.17	13.88
120	100	102,600	10,660	113,260	9,771	1,015	10,786	9.05	0.94	9.99
	200	102,600	12,310	114,910	9,771	1,172	10,944	9.05	1.09	10.14
	300	102,600	13,820	116,420	9,771	1,316	11,087	9.05	1.22	10.27
240	100	181,100	10,660	191,760	17,248	1,015	18,263	7.98	0.47	8.45
	200	181,100	12,310	193,410	17,248	1,172	18,420	7.98	0.54	8.52
	300	181,100	13,820	194,920	17,248	1,316	18,564	7.98	0.61	8.59
386	200	291,200	12,310	303,510	27,733	1,172	28,905	7.98	0.34	8.32
	300	291,200	13,820	305,020	27,733	1,316	29,049	7.98	0.38	8.36

[A/] The actual packed-out volume is used for the computation of unit costs.

Annual fixed costs were obtained by applying these various rates to the replacement costs, and then adding up all the cost components.

Table 4 also shows unit fixed costs for the storage and packing room structure as related to the three packing rates and the five storage capacities. It is clear that economies associated with large storage capacity are almost exhausted as the storage size reaches 240,000 cwt., and further increases in the storage size do not substantially reduce per unit costs.

Price advantages in carload purchases of lumber, steel sheathing, plywood, and other materials probably contribute to the reduced unit costs for the larger facilities. Other cost-cutting techniques, such as prefabrication, tilt-up, assembly line methods, and indoor construction, also reduce costs.

Differences in mechanical costs stem largely from the fact that doubling or quadrupling the output of such items as fans, heaters, dampers, damper motors, thermostats, and ducts does not double or quadruple the installation costs of such items. When increasing the size of the facility the planner has ample opportunity to design into the facility some cost-cutting in the mechanical department. Unit costs for electrical work, however, do not change appreciably. More bins mean more outlets, larger service entrances, and more elaborate requirements established by the code.

It is also clear from table 4 that the per unit costs increase slightly as the packing rate increases from 100 to 300 cwt. per hr. This is because a larger packing room is required to handle higher packing rates while total packed-out volume per season remains the same.

Equipment Costs

Estimated annual fixed costs include allowances for depreciation, insurance,

interest, and taxes. The annual depreciation charges are estimated by dividing the replacement costs by their respective use-life.[4/] Other charges are: interest, 5 percent of one-half of the replacement costs; taxes and insurance, 2 1/2 percent of the replacement costs. Annual and per cwt. fixed costs estimated for fluming and packing are shown in table 5. Per unit packing equipment fixed costs are considerably greater than those of fluming equipment but both show similar cost-size relationships. Per unit equipment fixed costs decrease sharply as the storage capacity increases; however, they increase as the packing rate increases. When total pack-out volume is held constant, higher equipment costs that are associated with higher packing rates mean greater costs per unit.

Total Costs

The material in the preceding sections provides a set of "building blocks" for constructing an estimate of per cwt. cost schedules as related to the five storage capacities and the three packing rates.

Individual cost components and their totals are shown in table 6. Cost-size relationships that exist in the Red River Valley potato packing plants are illustrated in figure 2. The larger storage facilities offer substantial cost reductions. Total per unit costs range from 50.66 cents (42,000 cwt., 100 cwt./hr.) to 36.82 cents (386,000 cwt., 300 cwt./hr.) or a differential of 13.84 cents. Unit costs decrease sharply as the storage size increases from 42,000 to 120,000 cwt. and decrease at a slower rate as the storage size approaches 240,000 cwt. Then per unit costs level off at storage capacities of 240,000 cwt.

[4/] See appendix tables for equipment specifications, expected use-life, replacement costs, and annual fixed costs for fluming and packing equipment.

The larger packing rates offer only slight cost reductions, most of which are realized between 100 and 200 cwt./hr. packing rates. These cost reductions are due in large part to the reduced labor costs associated with higher packing rates.

Table 5. Annual and per cwt. fixed costs for fluming and packing equipment, Red River Valley, 1963.

Storage capacity, 1,000 cwt.	Packing rate, cwt.	Annual costs		Per cwt. costs[A]	
		Fluming equipment	Packing equipment	Fluming equipment	Packing equipment
42	100	$237	$1,371	0.63¢	3.63¢
	200	288	1,758	0.76	4.65
60	100	263	1,371	0.49	2.54
	200	317	1,758	0.59	3.25
120	100	326	1,371	0.30	1.27
	200	387	1,758	0.36	1.63
	300	432	2,205	0.40	2.04
240	100	431	1,371	0.20	0.63
	200	492	1,758	0.23	0.81
	300	536	2,205	0.25	1.02
386	200	636	1,758	0.18	0.51
	300	685	2,205	0.20	0.64

[A] The actual packed-out volume is used for the computation of unit costs.

FIGURE 2. Total per cwt. costs for potato packing plants, Red River Valley, 1963

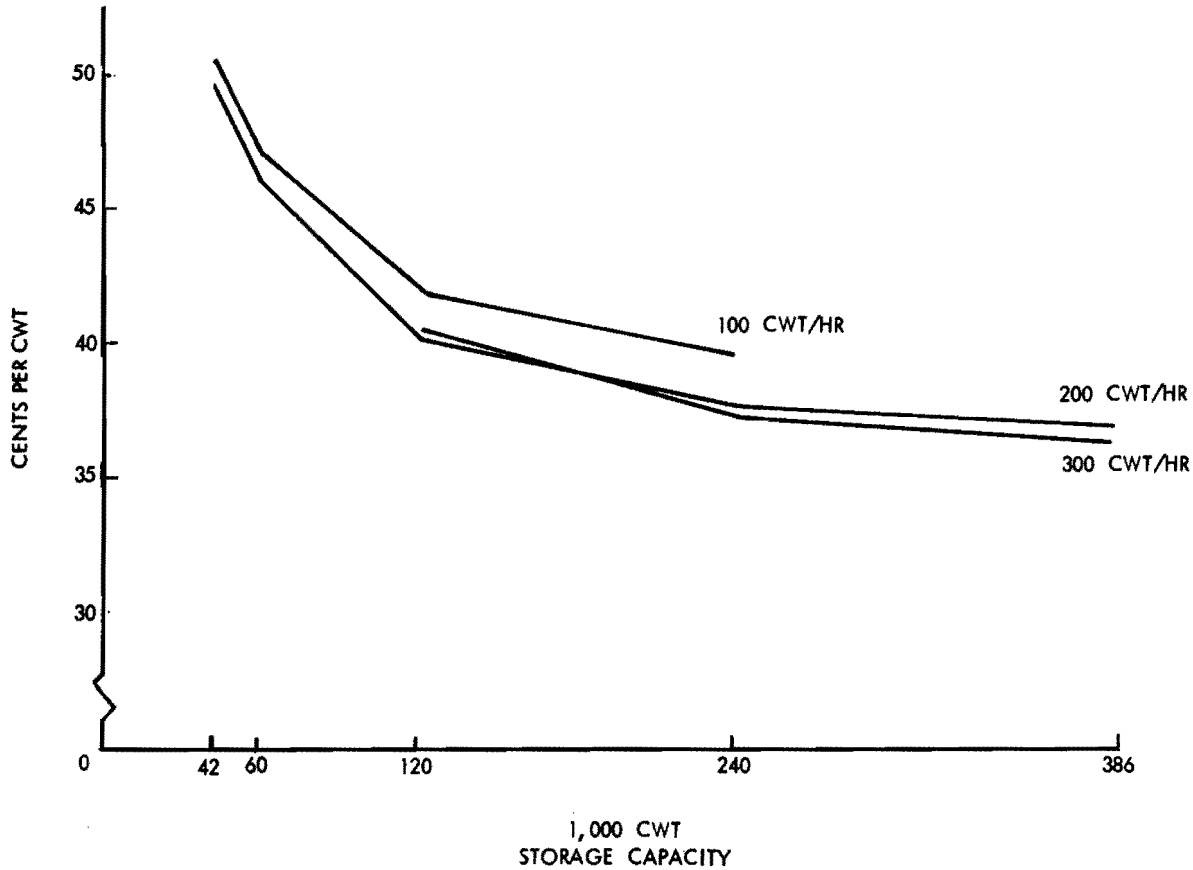

Table 6. Total per cwt. costs for potato packing plants as related to the five storage capacities and the three packing rates, Red River Valley, 1963.[A/]

Storage capacity, 1,000 cwt.	Packing rate, cwt.	Unit costs, cents/cwt.									
		Variable costs					Fixed costs				
		Labor	Storage	Fluming	Packing	Supplies	Storage	Packing room	Fluming equipt.	Packing equipt.	Total
42	100	8.40	2.00	0.24	2.28	18.10	12.70	2.68	0.63	3.63	50.66
	200	6.30	2.00	0.17	2.11	18.10	12.70	3.10	0.76	4.65	49.89
60	100	8.40	2.00	0.25	2.15	18.10	11.71	1.88	0.49	2.54	47.52
	200	6.30	2.00	0.17	1.86	18.10	11.71	2.17	0.59	3.25	46.15
120	100	8.40	2.00	0.26	2.00	18.10	9.05	0.94	0.30	1.27	42.32
	200	6.30	2.00	0.20	1.66	18.10	9.05	1.09	0.36	1.63	40.38
	300	6.00	2.00	0.17	1.53	18.10	9.05	1.22	0.40	2.04	40.51
240	100	8.40	2.00	0.24	1.80	18.10	7.98	0.47	0.20	0.63	39.83
	200	6.30	2.00	0.20	1.56	18.10	7.98	0.54	0.23	0.81	37.73
	300	6.00	2.00	0.17	1.41	18.10	7.98	0.61	0.25	1.02	37.34
386	200	6.30	2.00	0.19	1.45	18.10	7.98	0.34	0.18	0.51	37.05
	300	6.00	2.00	0.19	1.35	18.10	7.98	0.38	0.20	0.64	36.82

[A/] The actual packed-out volume is used for the computation of unit costs.

SUMMARY AND CONCLUSIONS

The potato packing industry in the Red River Valley has experienced a rapid decrease in the number of firms and an increase in the size of operating units. These developments have paralleled changes in bulk handling and environment control of potato storage to meet present-day market requirements.

Total unit packing and storage costs estimated in this study decreased from 49.89 cents (42,000 cwt. storage) to 37.05 cents (386,000 cwt. storage) at a packing rate of 200 cwt./hr. On the other hand, a cost reduction of only 2.49 cents was realized as the packing rate increased from 100 to 300 cwt./hr. at a storage capacity of 240,000 cwt. Most of the savings were attributable to economies associated with larger storage facilities. A sharp initial cost reduction was followed by a gradual decline. The cost saving was almost exhausted as the storage capacity approached 240,000 cwt. Higher packing rates, on the other hand, offered only a modest cost saving.

During the 1962-63 season, the total volume of potatoes packed by the 704 packing plants in the Red River Valley was roughly 18 million cwt. Applying the costs estimated in this report to the existing plant size distribution, the total costs of packing 18 million cwt. would have been approximately $8.6 million. The same volume could have been packed in only 52 plants having the 386,000 cwt., 300 cwt./hr. capacity at an estimated cost of $7.3 million - a cost saving of $1.3 million.

The fact that the report shows that costs decline as the size of operation increases should not be interpreted to mean that the largest firms have decided cost advantages. For example, labor costs reflect the cost of hired labor at the existing wage rate. It should be recognized that many of the small operations utilize owner and family

labor, these workers may have few alternative employment opportunities during the winter months when potatoes are being packed and marketed. Furthermore, existing buildings and packing equipment, although likely to have little or no salvage value, are typically usable. Such operations can be expected to have lower actual cash outlays than those shown in this analysis. But over the long run, equipment and buildings will need to be replaced and alternative labor opportunities will arise. In this sense the advantages of lower short run cash outlays may be illusory. This is especially true of small shippers who must sell at lower prices than large operators.

The costs included in this report only reflect in-plant efficiency and do not take into consideration potential savings that could arise from improvements in distribution efficiency. For example, no effort has been made to measure the advantages of having sufficient volume to maintain a stable labor force; or of the improvements in management efficiency that result from delegation of responsibility, with one person devoting full time to supervision of processing and another devoting full time to selling other market activities. Another important consideration for a packer is the ability to supply large buyers with any grade, variety, and size of potatoes and thus enable him to maintain a bargaining position relative to other packers. There are indications of significant economies in assembly and distribution at much larger sizes. Additional work in this area is needed before definite conclusions can be reached.

APPENDIX

Table

Exhibit

Appendix Exhibit A. Water rates in the Red River Valley, 1963

WATER RATES (W-57)

First	2,000 gal., 75 cents per M
Next	8,000 gal., 60 cents per M
Next	20,000 gal., 50 cents per M
Next	170,000 gal., 35 cents per M
Over	200,000 gal., 28 cents per M

MINIMUM - $1.50 per month

Sprinkling rate (in season) . . . . . 30 cents per M

Appendix Table 1. Operating costs for individual fluming and packing equipment, Red River Valley, 1963[A/]

Storage capacity 1,000 cwt.	Packing rate, cwts./hr.	Motor pump	Draper chain elevator	Total	Packing															
					Screen sizer	Washer absorber	Roller grading table	Roller grading table for no. 2's	Waxer	Expanding roll sizer	Sacking table	Belt conveyor for no. 2's	Cull conveyor	Cull chute	Cull conveyor	Bucket elevator	Cull conveyor	Cull hopper	Platform scale	Hand truck	Total
42	100	$60.47	$31.43	$91.90	$24.55	$542.18	$23.24	$16.31	$38.40	$50.74	$39.73	$20.23	$---	$---	$34.23	$35.72	$24.51	$5.60	$4.72	$6.48	$860.16
	200	45.53	18.97	64.50	19.25	471.79	53.33	12.00	31.58	42.01	60.58	---	18.02	---	34.23	22.91	17.10	3.98	4.72	5.04	796.54
60	100	88.47	45.92	134.39	31.26	751.91	29.90	20.95	48.84	64.28	50.51	25.86	---	---	43.36	45.76	31.21	7.00	4.96	7.68	1163.48
	200	64.05	27.70	91.75	23.64	627.14	65.06	14.75	38.62	51.13	73.42	---	21.98	---	21.98	20.87	20.87	4.97	4.96	6.00	1002.43
120	100	185.13	95.88	281.01	53.58	1467.80	52.07	36.40	83.64	109.37	86.42	44.58	---	---	73.75	79.75	53.50	11.66	5.71	11.76	2169.49
	200	153.92	57.83	211.76	37.15	1214.28	100.96	23.25	60.16	78.93	112.36	---	34.09	---	34.09	44.55	32.43	7.00	5.71	8.16	1793.12
	300	132.65	49.44	182.09	31.54	1140.75	93.48	19.36	49.55	68.87	112.86	---	26.01	---	26.01	33.66	26.51	5.44	7.32	8.96	1650.33
240	100	324.26	191.76	516.02	98.23	2616.02	96.41	67.31	153.24	199.55	158.24	82.03	---	---	134.54	146.24	98.09	20.99	7.22	19.92	3898.03
	200	307.86	115.66	423.52	64.07	2370.14	172.75	40.23	103.25	134.53	190.25	---	58.30	---	58.30	76.23	55.53	11.66	7.22	44.32	3375.18
	300	265.30	98.88	364.18	51.48	2237.69	150.73	31.71	80.42	110.78	179.91	---	42.16	---	42.16	55.45	43.10	8.55	8.37	13.12	3055.63
386	200	464.15	194.53	658.68	96.66	3573.62	259.10	60.69	155.12	201.41	283.88	---	87.44	---	87.44	116.60	83.33	17.32	6.34	18.24	5047.19
	300	486.00	164.86	650.86	75.71	3498.84	220.30	46.71	117.95	161.72	261.40	---	61.78	---	61.78	81.95	63.13	12.32	9.34	18.24	4691.40

[A/] Operating costs include: power, $0.02/kw.-hr; water (see exhibit A in Appendix), and maintenance (all items except the cull hopper, 1.5 percent of replacement costs plus 0.5 percent of replacement costs per 100 hr. of use; for cull hopper, 0.75 percent of replacement costs plus 0.25 percent of replacement costs per 100 hr. of use).

Appendix Table 2. Fluming equipment specification and use-life, Red River Valley, 1963.

Storage capacity, 1,000 cwt.	Packing rate, cwt/hr.	Pump with motor, in. x hp.	Gal. steel plumb., sump thru pump, each	Gal. valves, in. x in.	Grating around intake & over-flow pipe, each	Flume cover, bd. ft.	Al. pipe fitting elbow, in. x ft.	Rubber covered coil irrig. hose, in. x ft.	Sand bags, each	Draper chain elevator, hp. x in. x ft.
42	100	3 x 2	1	3 x 3	1	1,528	4 x 149	4 x 30	2	3/4 x 18 x 13
	200	4 x 3	1	3 x 4	1	1,528	5 x 149	5 x 30	2	1 x 24 x 13
60	100	3 x 2	1	3 x 3	1	2,177	4 x 197	4 x 30	2	3/4 x 18 x 13
	200	4 x 3	1	3 x 4	1	2,177	5 x 197	5 x 30	2	1 x 24 x 13
120	100	3 x 2	1	3 x 3	1	3,949	4 x 263	4 x 30	2	3/4 x 18 x 14
	200	4 x 3	1	3 x 4	1	3,949	5 x 263	5 x 30	2	1 x 24 x 14
	300	4 x 5	1	3 x 6	1	3,949	6 x 263	6 x 30	2	2 x 32 x 14
240	100	3 x 2	1	3 x 3	1	7,437	4 x 263	4 x 30	2	3/4 x 18 x 14
	200	4 x 3	1	3 x 4	1	7,437	5 x 263	5 x 30	2	1 x 24 x 14
	300	4 x 5	1	3 x 6	1	7,437	6 x 263	6 x 30	2	2 x 32 x 14
386	200	4 x 3	1	3 x 4	1	11,633	5 x 359	5 x 30	2	1 x 24 x 15
	300	4 x 5	1	3 x 6	1	11,633	6 x 359	6 x 30	2	2 x 32 x 15
Expected use-life, yr.		15	25	15	25	7	25	10	3	15

Appendix Table 3. Replacement costs for fluming equipment, Red River Valley, 1963.

Storage capacity, 1,000 cwt.	Packing rate cwt./hr.	Pump with motor	Gal. steel plumb., sump thru pump	Gal. valves	Grating around intake & over-flow pipe	Flume cover	Al. pipe fitting elbow	Rubber-covered coil irrig. hose	Sand bags	Draper chain	Total
42	100	$478.00	$148.41	$59.84	$34.00	$220.03	$226.31	$100.20	$10.00	$435.50	$1,712.29
	200	637.00	178.38	110.72	34.00	220.03	297.08	121.50	10.00	516.00	2,124.71
60	100	478.00	148.41	59.84	34.00	313.49	281.48	100.20	10.00	435.50	1,860.92
	200	687.00	178.38	110.72	34.00	313.49	379.54	121.50	10.00	516.00	2,341.63
120	100	478.00	148.41	59.84	34.00	568.66	356.22	100.20	10.00	458.00	2,213.33
	200	662.00	178.38	110.72	34.00	568.66	471.76	121.50	10.00	543.00	2,700.02
	300	735.00	204.25	143.79	34.00	568.66	575.48	159.00	10.00	625.00	3,055.18
240	100	478.00	148.41	59.84	34.00	1,070.93	356.22	100.20	10.00	458.00	2,715.60
	200	662.00	178.38	110.72	34.00	1,070.93	471.76	121.50	10.00	543.00	3,202.29
	300	735.00	204.25	143.79	34.00	1,070.93	575.48	159.00	10.00	625.00	3,557.45
386	200	662.00	178.38	110.72	34.00	1,675.18	620.08	121.50	10.00	570.00	3,981.86
	300	735.00	204.25	143.79	34.00	1,675.18	755.24	159.00	10.00	655.00	4,371.46

Appendix Table 4. Packing equipment specification and use-life, Red River Valley, 1963

Packing rate, cwt./hr.	Washer absorber in. x ft., units, hp.	Screen sizer	Roller grading table	Roller grading table No. 2's	Waxer	Expanding roll sizer	Sacking table	Belt conveyor for No. 2's	Cull conveyor	Cull chute each	Cull conveyor	Bucket elevator	Cull conveyor	Cull hopper ft. x ft. x ft.	Platform scale each	Hand truck each
	in. x ft., hp										in. x ft., hp					
100	24 x 9, 2,3/4	24 x 4, 1/2	21 x 9, 3/4	14 x 4, 1/2	24 x 4, 3/4	24 x 5, 3/4	36 x 11, 3/4	9 x 8, 1/2	--------	1	9 x 23, 1/2	9 x 18, 1	9 x 15, 1/2	8 x 8 x 9	2	6
200	36 x 9, 2, 1	36 x 4, 3/4	36 x 9, 1 1/2	18 x 5, 1/2	36 x 4 1	36 x 5 1	36 x 12, 1	-----	9 x 16, 1/2	1	9 x 23, 1/2	9 x 18, 1	9 x 16, 1/2	8 x 8 x 9	2	6
300	48 x 9, 2, 1	48 x 4, 3/4	48 x 12, 1 1/2	21 x 6, 1/2	48 x 4, 1	48 x 5, 1	36 x 15, 1	-----	9 x 16, 1/2	1	9 x 23, 1/2	9 x 18, 1	9 x 18, 1/2	8 x 8 x 9	2	8
Expected use-life, yr.	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

Appendix Table 5. Replacement costs for packing equipment, Red River Valley, 1963

Packing rate, cwt./hr.	Washer absorber	Screen sizer	Roller grading table	Roller grading table for No. 2's	Waxer	Expanding roll sizer	Sacking table	Belt conveyor for No. 2's	Cull conveyor	Cull chute	Cull conveyor	Bucket elevator	Cull conveyor	Cull hopper	Platform scale	Hand truck	Total
100	$2,151.00	$595.00	$515.00	$366.00	$936.00	$1,279.00	$973.00	$475.00	-----	$40.00	$864.00	$791.00	$594.00	$311.00	$280.00	$240.00	$10,410.00
200	2,562.00	676.00	1,945.00	417.00	1,138.00	1,555.00	2,298.00	-----	658.00	40.00	864.00	791.00	621.00	311.00	280.00	240.00	14,396.00
300	2,920.00	773.00	2,415.00	468.00	1,245.00	1,797.00	3,054.00	-----	658.00	40.00	864.00	791.00	675.00	311.00	420.00	320.00	16,751.00

Appendix Table 6. Annual fixed costs for fluming equipment, Red River Valley, 1963 [A/]

Storage capacity, 1,000 cwt.	Packing rate, cwt./hr.	Pump with motor	Gal. steel plumb., sump. through pump	Gal. valves	Grating around intake & overflow pipe	Flume cover	Al. pipe fitting elbow	Rubber-covered coil irrigation hose	Sand bags	Draper chain elev.	Total
42	100	$62.94	$15.59	$ 7.88	$3.57	$ 45.44	$23.76	$16.54	$3.98	$57.34	$237.04
	200	83.88	18.74	14.58	3.57	45.44	31.19	20.05	3.98	67.94	288.37
60	100	62.94	15.59	7.88	3.57	65.15	29.57	16.54	3.98	57.34	262.56
	200	83.88	18.74	14.58	3.57	54.15	28.91	20.05	3.98	67.94	316.68
120	100	62.94	15.59	7.88	3.57	118.21	37.41	16.54	3.98	60.30	326.42
	200	87.16	18.74	14.58	3.57	118.21	49.53	20.05	3.98	71.50	387.32
	300	96.78	21.45	18.93	3.57	118.21	60.43	26.24	3.98	82.30	431.89
240	100	62.94	15.59	7.88	3.57	222.60	37.41	16.54	3.98	60.30	430.81
	200	87.16	18.74	14.58	3.57	222.60	49.53	20.05	3.98	71.50	491.71
	300	96.78	21.45	18.93	3.57	222.60	60.43	26.24	3.98	82.30	536.28
386	200	87.16	18.74	14.58	3.57	348.20	65.10	20.05	3.98	75.05	636.43
	300	96.78	21.45	18.93	3.57	348.20	79.30	26.24	3.98	86.25	684.70

[A/] The annual charges for each cost component as a percent of replacement costs are as follows: depreciation, replacement costs/use-life; interest, 1/2 @ 5 percent; insurance and taxes, 2.5 percent.

Appendix Table 7. Annual fixed costs for packing equipment, Red River Valley, 1963. [A/]

Packing rate, cwt./hr.	Screen sizer	Washer absorber	Roller grading table	Roller grading table for No. 2's	Waxer	Expanding roll sizer	Sacking table	Belt conveyor for No. 2's	Cull conveyor	Cull chute	Cull conveyor	Bucket elevator	Cull conveyor	Cull hopper	Platform scale	Hand truck	Total
100	$ 78.35	$283.22	$ 67.81	$48.19	$123.24	$168.41	$128.12	$62.55	$ ---	$5.27	$113.76	$104.15	$78.21	$40.95	$36.87	$31.60	$1370.70
200	89.01	387.33	256.10	54.91	149.84	204.75	164.69	---	86.64	5.27	113.76	104.15	81.77	40.95	36.87	31.60	1757.64
300	101.78	384.47	317.98	61.12	163.93	236.61	402.11	---	86.64	5.27	113.76	104.15	88.88	40.95	55.29	42.14	2205.00

[A/] The annual charges for each cost component as a percent of replacement costs are as follows: depreciation, replacement costs/use-life; interest, one-half replacement costs @ 5 percent; insurance and taxes, 2.5 percent.