

March 19, 1973

To the Graduate Council:

I am submitting herewith a dissertation written by Ronald Emmett Jones entitled "Cost Analysis of Synthetic Model Lima Bean Freezing Plants." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.

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COST ANALYSIS OF SYNTHETIC MODEL
LIMA BEAN FREEZING PLANTS

A Dissertation
Presented to
the Graduate Council of
The University of Tennessee

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

by
Ronald Emmett Jones

June 1973

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ACKNOWLEDGMENT

The writer expresses his appreciation to many persons who aided him in various ways to complete this study. Appreciation is expressed to his committee--Drs. M. B. Badenhop, Luther Keller, Irving Dubov, and Hans Jensen; also to Dr. William E. Goble who rendered valuable assistance by offering suggestions and encouragement during the course of the study. Appreciation is expressed to the artists, clerks, typists, and other staff members who contributed time and effort.

Appreciation is expressed to The University of Tennessee Agricultural Experiment Station and the Department of Agricultural Economics and Rural Sociology for funds that supported this study.

A special expression of appreciation is extended to those who were patient with the writer as he sought their help and understanding. These include my wife, my children, those in leadership roles in the department, my fellow graduate students, my parents, and others that will go unnamed.

Failure to mention additional persons does not indicate a lack of appreciation,

ABSTRACT

The objectives of this study were: (1) to describe existing Tennessee vegetable freezing plants that processed lima beans, (2) to determine initial investment for synthetic model plants freezing lima beans in multiple-product operations, and (3) to compare cost per pound for processing lima beans in synthetic model freezing plants according to plant capacity, hours of operation, percent of capacity utilized, freezing method, and container.

Data concerning existing lima bean freezing plants were obtained from three West Tennessee processors via interviews with plant managers, observations of plant operations and plant accounting records. A composite or representative Tennessee multiple-product lima bean freezing plant was described on the basis of these data.

Sixteen synthetic model lima bean freezing plants were developed on the basis of data recorded from existing plants and from data collected by the technical research committee of the Southern Regional Cooperative Fruit and Vegetable Marketing Project SM 30. The model plants were multiple-product vegetable processing plants. Model plants were developed to plate freeze 10-ounce cartons, plate freeze 2-1/2-pound cartons, belt freeze 20-ounce polybags, and fluidized freeze 20-ounce polybags in 3,000, 6,000, 12,000, and 18,000 pound per hour capacity operations. The number of hours each model plant operated annually was considered the length of season. Seasonal lengths of 300,

500, 700, and 900 hours were used for each plant. Percent of capacity utilized was varied for each plant using rates of 90, 75, 60, and 45 percent of capacity.

Fixed and variable costs of model lima bean freezing plants according to plant capacity, hours of operation, percent of capacity utilized, method of freezing, and type of container used were tabulated to determine total cost of the various operations. These total cost computations were divided by appropriate output data to determine average cost for the plants under varying conditions of seasonal length and/or percent of capacity realized. Comparisons were also made among model plants on the basis of cost per pound of processing according to plant capacity, freezing method, hours of operation, percent of capacity utilized, and type of container used.

Cost analysis of model plants indicated that there were substantial economies of size in the lima bean freezing industry. The long run average cost curve (LRAC) fell rapidly as plant capacity was increased from 3,000 to 6,000 and to 12,000 pounds per hour. However, the cost analysis of model lima bean freezing plants also indicated that a longer processing season or the use of a higher percent of the plant's capacity may under some conditions be a more feasible alternative for lowering processing costs per pound than increasing plant size.

The ability of additional hours of processing to reduce the cost of processing per pound was found to diminish greatly after a 700 hour season was obtained. Processing operations using less than 75 percent of a plant's capacity may find considerable potential in reducing costs

by making more efficient use of the plant's capacity. It was determined that under many conditions, cost efficiency in lima bean freezing plants depended more upon the variable cost components than upon fixed cost components. Employing labor saving equipment in single-product processing plants has become an accepted means of obtaining cost efficiencies when total output justifies the purchase of such equipment,

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CHAPTER I

INTRODUCTION

Fruit and vegetables are an important source of income to many Tennessee farmers and are important to the state's agricultural economy. In 1969, Tennessee growers sold \$16.9 million worth of fruits and vegetables, which was about the same as the annual sales of \$17.0 million for the 1959-69 period. These sales were equal to about 2.9 percent of the value of farm products sold annually in the State. In 1969, growers in approximately two-thirds of the counties sold fruits and/or vegetables on the cash market and 58,000 acres were devoted to their production (Tennessee Agricultural Statistics, Annual Bulletins, 1960-1970).

The Problem

The need for major adjustments in the fruit and vegetable industry is continuous. Leaders in the vegetable processing industry in the southeastern states are currently appraising the possibilities of building new processing facilities, expanding existing facilities, and mechanizing more of the processing operation.

In the 1960's profits in the fruit and vegetable processing industry appeared low relative to other industrial sectors (Porter, 1970, p. 22). Despite the growing popularity of processed fruits and vegetables, the industry attracted few new firms. The number of firms

declined rather drastically in the 1960's as the smaller operators found it difficult to compete with larger firms.

Economies related to annual output in vegetable processing have become increasingly important and many surviving firms have expanded their plant's operations to supply the growing market demand. Most existing firms are operating multiple-product plants in an effort to meet new consumer demand while keeping unit operating cost as low as possible. Other interests are derived from the need for new or expanded rural enterprises to supplement farm income and to utilize underemployed rural resources.

The fresh market has been the primary outlet for fruits and vegetables in most of the southeastern states for many years. The processing market, however, has provided farmers a market for surplus production which could not be sold on the fresh market. Consequently, sales on the processing market continue to be of considerable economic importance,

Entrepreneurs in the vegetable processing industry, when planning new plants or expanding existing plants, have specific questions on the economics of processing. Answers to these questions are crucial to the industry, the firm, and society. This study was conducted specifically to answer the question--What size plant should be constructed for freezing lima beans in a multiple-product plant? Other important questions concerning methods of processing, hours of operation, percent of utilized plant capacity, and the source of raw materials have an influence on the long-run competitive position of processing firms.

According to a 1960 study of vegetable processing plants in the Southeast (Williams and Allen, p. 20), Tennessee led the southeastern states in the volume of vegetables purchased for processing. Two large processing plants that began their operations in Tennessee early in this century have grown rapidly. The annual value of green lima beans produced in Tennessee is estimated at approximately \$600,000 and the trend in national per capita consumption of lima beans is upward. Considering the effect of population growth and increasing incomes, the outlook appears favorable for substantial increases in total consumer demand for frozen lima beans.

Objectives

The primary objective of this study was to provide the lima bean freezing industry with cost estimates of processing in different size plants considering the variation in length of the processing season, percent of plant capacity utilized, size and type of containers, and the processing methods used. Results of this study should enable processors to make more intelligent decisions about the size of proposed plants and/or changes in existing plants.

Specific objectives were:

1. To describe existing Tennessee vegetable processing plants that freeze lima beans,
2. To determine the initial investment for synthetic model plants freezing lima beans in multiple-product operations, and

3. To compare the cost per pound for processing lima beans in synthetic model freezing plants according to varying plant capacities, hours of operation, percent of capacity utilized, freezing method, and type of container used.

Procedure

Input-output data were obtained from three West Tennessee processors of lima beans through interviews with plant managers, observations of plant operations, and plant accounting records. A composite or representative operational flow chart and equipment layout was developed for the existing plants. Timed production checks were used to estimate hourly output and percent of capacity utilized. This information served as the basis for a description of operations in the existing multiple-product lima bean freezing plants in Tennessee.

The major source of data utilized in the construction of synthetic model plants, particularly data concerning input costs and output capacities, was from research conducted by committee representatives of the Southern Regional Cooperative Fruit and Vegetable Marketing Project SM 30 (Pearson and Brooker, Bul. 150). Sixteen synthetic model lima bean freezing plants were developed for purposes of comparing initial investment and processing costs per pound. It appeared unrealistic to make cost estimates for processors using single-product model lima bean freezing plants. A plant designed to efficiently process only lima beans would include a much greater output of lima beans than any existing plant in the area processes at present. Most fixed and variable

factors required for processing lima beans in the synthetic model plants were the same as those used in processing other vegetables. The assumptions concerning model plants for this study were as follows:

1. Economies in plant operations and plant costs were independent of plant locations,
2. Sufficient quantities of lima beans were available to supply the processing plants,
3. Recovery percentage of freezing lima beans was assumed to be 100 percent. (Temporary storage in water prior to blanching may increase weight as much as 10 percent.)
4. Demand for the vegetables processed was adequate to warrant the scale of product processing employed in model plants.
5. Plants processing lima beans were multiple-product plants processing the same product mix of 20 percent lima beans, 30 percent Southern peas, 30 percent leafy greens, and 20 percent okra and other vegetables,
6. Only one size and type of container was employed in a given model plant,

Synthetic model plants were developed to plate freeze 10-ounce cartons, plate freeze 2-1/2-pound cartons, belt freeze 20-ounce polybags, and fluidized freeze 20 ounce polybags in 3,000, 6,000, 12,000, and 18,000 pounds per hour capacity operations. This capacity per hour was based on the processed product's net weight. Costs were classified as fixed and variable. Fixed costs included depreciation on buildings and facilities, depreciation on operating equipment, salaried management

and other personnel, property taxes, interest on investment, insurance, and repairs and maintenance. These costs are fixed on an annual basis over the planning period involved and are independent of plant output. Variable costs are those costs which vary as plant output varies. These costs include labor, cost of containers, fuel, power, raw materials, and office-brokerage costs.

For each of the synthetic model plants, fixed costs of equipment, buildings and salaried employees were tabulated. The cost allocated to lima beans made up the total use of the item. All cost data figures are for 1970.

Annual fixed overhead costs were expressed as a percentage of initial cost. Depreciation of buildings was considered a function of time and a useful life of 20 years was assumed. The straight line method of calculating depreciation was used; therefore, an annual charge of 5 percent of the initial cost of buildings represented depreciation. Processing equipment has a more rapid rate of depreciation than buildings. Equipment depreciation, therefore, was considered a function of time, use, and obsolescence over a life of 10 years with the annual cost being 10 percent of the initial cost.

Interest was computed at 4 percent of the initial cost of fixed assets, which is approximately 8 percent of the average value of these assets over their useful life.

Tax and insurance costs were each estimated at 1 percent of the initial cost of buildings.

It was assumed that annual maintenance and repair costs for buildings would average 2 percent of their initial cost. Tax and insurance costs for equipment used in processing were computed at an annual rate of 1.25 percent of initial cost. Annual maintenance and repair costs for equipment was computed at 2.5 percent of initial equipment cost. Table 1 summarizes the rates used for items specified.

Variable cost for each plant was tabulated by including the hourly costs of the raw product (shelled beans delivered at the plant), labor, brokerage fees, office expenditures, containers, power or fuel charges, and disposal fees. The number of hours each model plant operated annually was considered the length of season. Seasonal lengths of 300, 500, 700, and 900 hours were used for each plant. Percent of capacity utilized was varied for each plant using rates of 90, 75, 60, and 45 percent of capacity. Seasonal length and percent of capacity utilized both altered a plant's total variable costs which when added to the plant's annual fixed cost yielded annual total costs according to plant capacity, freezing method, hours of operation, percent of capacity utilized, and container.

The annual total costs were then divided by the plant's annual output to determine the cost per pound of processing by the different plants or by the same plant for different seasonal lengths and/or different rates of capacity utilized. Comparisons among model plant operations were on the basis of cost per pound of processing according to plant capacity, freezing method, hours of operation, percent of the plant's capacity utilized, and container.

Table 1. Rates used to calculate fixed costs in synthetic model plants

Cost items	Buildings	Processing equipment
	-----percent of initial cost ^a -----	
Depreciation	5	10
Interest	4	4
Taxes	1	1.25
Insurance	1	1.25
Repairs and maintenance	2	2.50

^aRepresents costs allocated to lima beans.

CHAPTER II

RELATED STUDIES

Numerous studies have been made to determine the most efficient methods of processing food. Most of these studies have been directed at measuring output in terms of input requirements in overall plant operations, measuring relative efficiencies of alternative methods of operation, and determining the importance of economies of scale.

Economies of Scale

Cost and efficiency studies in marketing are based on the economic theory of the firm (Boulding, 1948, and Stigler, 1952). In this theory, the production process is covered in two stages: (1) the input-output coefficients where the output is expressed as a function of the inputs--land, labor, buildings, and equipment, and (2) the use of price data of these production input determining the costs of producing the given output. The application of prices to output also provides a measure of gross revenue for the firm.

The basis for studies on economies of scale is production theory. The concept of scale is a technical instead of an economic relationship. Relative dimensions are changed without any change in the proportional relationship between the individual parts. That is, if the input factors used in production are all increased proportionately, this is the same as increasing the scale of the process. If the increase in output is

relatively greater than the increase in input, then economies of scale exist. In actual application, the assumptions of proportionality may be relaxed due to multiple inputs, discrete inputs, and technological changes.

Economies of scale may be illustrated with reference to plant size in terms of output capacity (Eidman, Dean and Carter, pp. 7-8). A series of short run average cost curves (SRAC) representing the operational costs of different size plants constitute the long run average cost (LRAC) curve as shown graphically in Figure 1. The lowest point of the short run cost curves represents the minimum average total cost of a particular plant size and serves as a point on the long run average cost curve. Plant size determines the short-run output capacity resulting from the fixed factors. The short run is too short a period of time to allow for alterations of fixed factors. The long run is a period of time sufficiently long to allow fixed factors that constitute plant size or capacity to vary. Graphic presentation of a series of short run curves for successively larger plant sizes may be used to derive the long run average cost curve.

For determining the economies of scale, the model-building approach is a traditional method and this method involves the development of physical input-output coefficients for each stage of the production process (Bressler, 1955, p. 270). These input-output coefficients provide the foundation, upon which individual model plants can be developed. When prices are applied to these factors, the optimum combination of factors for the least cost operation of a plant can be determined

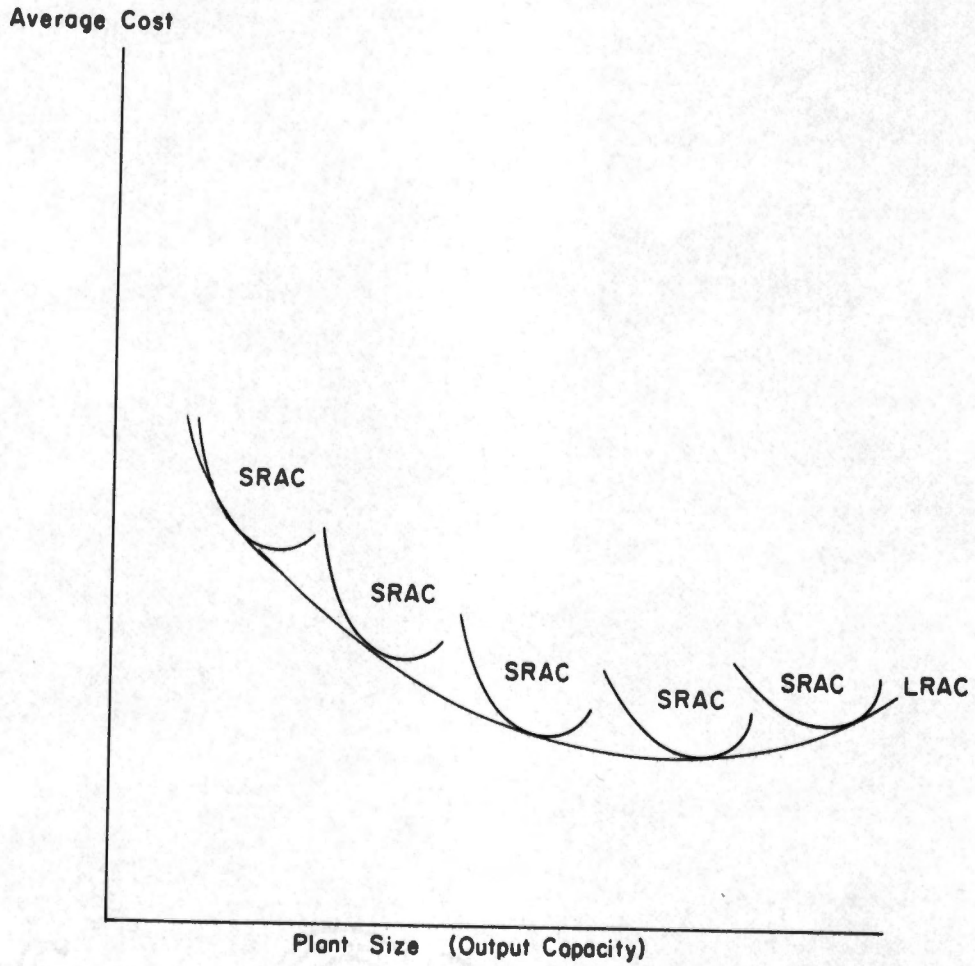


Figure 1. Plant size and the long run average cost curve

either by linear programming or budgeting. When several model plants are developed by this method, they indicate in theory, the optimum combination of resources or the best plant size.

Other Economies

A processor may gain reductions in unit cost to some degree by extending the processing season. The processor is limited, however, to a season equal in length to the harvest season if the plant packs only a particular product that can not be stored. A multiproduct processor may be more successful if the harvesting seasons of its variety of products allows for early and late extensions of the processing season (Reed and Sammet, p. 167).

Economies may also result from more extensive use of fixed cost factors. Therefore, it is a matter of indifference as to the source of more extensive use of fixed factors. Increases in plant capacity and a longer season of operation can both quite logically be cited as comparable sources of cost reductions. Additional sources of economies stem from specialization in the use of labor, equipment, management, and in the use of by-products (McConnell, p. 457).

The labor and management requirements for larger capacities or longer lengths of the processing season are such that a greater annual output may be processed more efficiently. In plants with small capacities, or those with short seasonal operations, processors may find both labor and management being underutilized or used in a manner that does not allow specialization. An absence of specialization may lead

to inefficiency if proper skills are not developed when workers are shifted from one function to another. Excessive idle time for workers may result as workers function in several areas of skills in a small scale operation.

By-products do not exist in vegetable processing to the extent they did formerly. Recent developments in harvesting methods have eliminated some of the traditional by-products. In fact, many previous functions of a vegetable processing plant are now performed in the field by intricate, mobile harvesting equipment.

A relative large scale operation may have advantages other than those related to efficiency in terms of factor utilization and traditional cost theory related concepts. Both in the purchase of factors and in the sale of products, greater bargaining power is normally held by firms with large total outputs. Processors who operate the larger scale plants may enjoy a position that affords them lower factor costs and higher product prices than those of rivals who operate at lower levels of output. It should be stated, however, that an overzealous emphasis upon large scale operations may prove detrimental. If processors blindly seek larger outputs by increasing plant size, they may experience diseconomies which is a condition of higher unit cost resulting from an increase in plant size or annual output. Inefficiency of this nature is often the result of an operation becoming too large and complex in its arrangement for efficient managerial control (Leftwich, p. 34).

Vegetable Studies

In a report concerning an economic analysis of canning leafy greens, lima beans, and Southern peas (Mathia, Pearson, and Ela, p. 61), it was concluded that a low capacity, short season plant greatly reduced the probability of a profitable operation. A main factor cited was that of the difficulty in acquiring competent management for low output plant operations. An additional conclusion was that the seasonal aspect created additional problems in terms of financing.

Reed and Sammet (1963, p. 167) concluded that many California vegetable processors could achieve reductions in per unit cost by processing a combination of products maturing in different time periods. Their reasoning was that the costs of management and other fixed inputs could be spread over a greater annual quantity of output and thus yield economies. Simultaneous processing of products having the same harvest season was also seen as a means of increasing plant efficiency. Management, equipment, and other fixed costs are paid regardless of their rate of utilization in any given time period regardless of the scale of operation.

An additional conclusion of Reed and Sammet (1963, p. 21) was that there existed some joint costs in multiple-product processing requiring that an arbitrary procedure of cost allocation be used to compute cost for a particular product. The authors stated, however, that the majority of the variable factors and some of the equipment and other fixed factors can be specifically related to given products. Thus, the issue was

argued that only a small share of total cost would be subject to arbitrary allocation. They stated that undue concern pertaining to the allocative method used and the resulting margin of possible error is unwarranted.

In a study of lima bean processing in California, Reed (1959, p. 96) found that advantages of increased plant size are substantial in small capacity plants, but become less important in plants with a capacity above 20,000 pounds per hour. It was stated, however, that for any plant capacity, relatively large reductions in average cost are possible with a longer operating season. Economies associated with increased length of season become relatively less important as the season length approaches 750 hours.

Fairbanks and Polopolus (1965, p. 32 and pp. 60-61) found that the okra and okra-tomatoe canning plants the length of a plant's operating season is more critical in reducing unit processing costs than size of plant. Fixed labor and management costs are areas of potential cost saving if plant size is enlarged. A longer processing season has a similar and more critical effect in terms of per unit cost reductions.

Fairbanks and Polopolus concluded that the addition of a tomato line in an okra processing plant offered two potential favorable influences. The addition of the tomato line increases plant revenue by a percentage roughly three times that of the increase in plant cost. They added that the dual product operation afforded the plant flexibility in terms of easily adjusting to the processing of other vegetables. This would allow the plant to compete more favorably with larger single

product plants that had become established in the industry. The extended length of season and resulting larger output was cited as bringing about cost savings in okra-tomato processing plants.

Law and Beeson (1967, p. 2) concluded in a study of the profitability of sweet potato flaking plants that individual effects of variations in level of trim and peel loss, price of raw product, and price of the finished product, though important, were somewhat less important to profitability than the effects of either plant size or length of season. They found that the investment value of flaking plants to be highly sensitive to variation in plant size as well as in length of season. It was shown in their study that increases in either size of plant or length of season, based on the ranges studied, resulted in significantly more than proportionate increases in investment value.

Synthetic Model Building

French, Sammett, and Bressler (1961, pp. 544-549) developed a theoretical-analytical study designed to supply plant managers with more complete input-output data via synthetic model plant construction. Their study was intended to be of value in future research concerned with the economics of production and related studies. The dimension of time for output variation, plant segmentation with the use of many identical machines, discontinuous variation in rates of output, and multiple rather than single stage plants were their theoretical tools. These tools were designed as a means of analysis rather than for descriptive explanations.

Black's critique (1955, pp. 273-279) of the synthetic approach for the determination of costs states that a strong advantage of the synthetic approach is that it can be applied in an industry where data are not adequate for a statistical analysis. He cited the existence of insufficient numbers of plants at a given time and operating under comparable conditions as a prime factor that might limit the amount of existing data,

The synthetic technique, he added, can be used to obtain cost estimates other than those related to the envelope of least-cost curves at various levels of rate of output. He gave examples of other uses as being the development of average cost curves for plants producing with different factor costs, varying degrees of capacity utilization, and reducing accounting systems to one standard more subject to comparability.

Black summed up his report with a statement concerning limitations which exist with the use of a synthetic technique. Comments concerning limitations dealt with the development of arbitrary means of allocating joint costs, assumptions of management quality, considerations of external economies, and the fact that the economies-of-scale curve, in all studies, continues to decline asymptotically to some minimum level as plant output is increased.

CHAPTER III

DESCRIPTION OF EXISTING PLANTS

The lima beans processed in Tennessee constituted less than 5 percent of the total output of canning and freezing in 1968 (Table 2). Most of the equipment, labor, and management resources of the freezing plants were employed in the processing of other vegetables; thus they were multiple-product plants. There were three Tennessee freezing plants that were processing lima beans at the time of the study.

Products Processed

A vegetable freezing plant's operation normally starts in May or June with the processing of the early leafy greens, Southern peas, and squash. Lima beans, okra, and Southern peas are processed in mid-to-late summer. Near the end of the season, the fall and winter leafy green crop is processed. Most firms operate from 5 to 7 months each year.

One-fourth of the lima beans frozen were green limas and approximately three-fourths were speckled butter (lima) beans. The freezing plants processed lima beans without mechanical quality grading of the beans into whites and greens or into different size or quality class. Both the green lima and the speckled butter (lima) beans were frozen as "field run". Most of the frozen lima beans met the United States Department of Agriculture (USDA) standards required for top

Table 2. Total pounds of vegetables processed and percent of total, Tennessee, 1968

Product	Total pounds processed	Percent
Green beans	42,768,666	28.1
Southern peas	32,293,416	21.2
Leafy greens	30,904,554	20.3
Cabbage (sauerkraut)	16,008,841	10.5
Okra	15,128,472	9.9
Lima beans	6,904,554	4.5
Squash	4,258,921	2.8
White potatoes	1,561,065	1.0
Turnips	1,309,372	.9
Sweep potatoes	624,001	.4
Carrots	381,554	.2
Pepper	266,736	.2
Total	152,410,152	100.0

Source: Compiled from plant records of Tennessee vegetable processors, 1971.

grades. The objective, however, was to process the best quality field run beans obtainable from the raw product received.

The lima beans processed in the plants studied were grown within a 50 mile radius of the processing plant. Most, however, were grown within a radius of 20 miles. Processors also produced lima beans on farms they own and contracted additional supplies with individual farmers in the area. The contracts with the farmers stipulated that harvesting would be furnished by the buyer and the farmers would be paid on a per pound basis for the harvested beans.

Freezing Stages

Initial Preparation

The receiving and preparation operation in processing lima beans by freezing are illustrated in Figure 2 and the equipment layout for processing is shown in Figure 3. The operations include receiving and unloading pallet boxes (1,200 pound capacity) with a forklift from a truck bed. After pallet boxes are set aside in temporary storage, the forklift operator places empty boxes into the truck. The dumping stage of the process consists of lifting and then rotating the forks in a position that permits beans to flow from the box into the filler hopper. The beans then enter a series of cleaning stages. Beans flow from the feeder hopper through a vibrator conveyor onto a belt conveyor and pass through the shaker cleaner unit. The shaker cleaner unit consists of screens that separate from desirable beans, foreign material and defective beans. As the beans fall from the final shaker screen, they enter

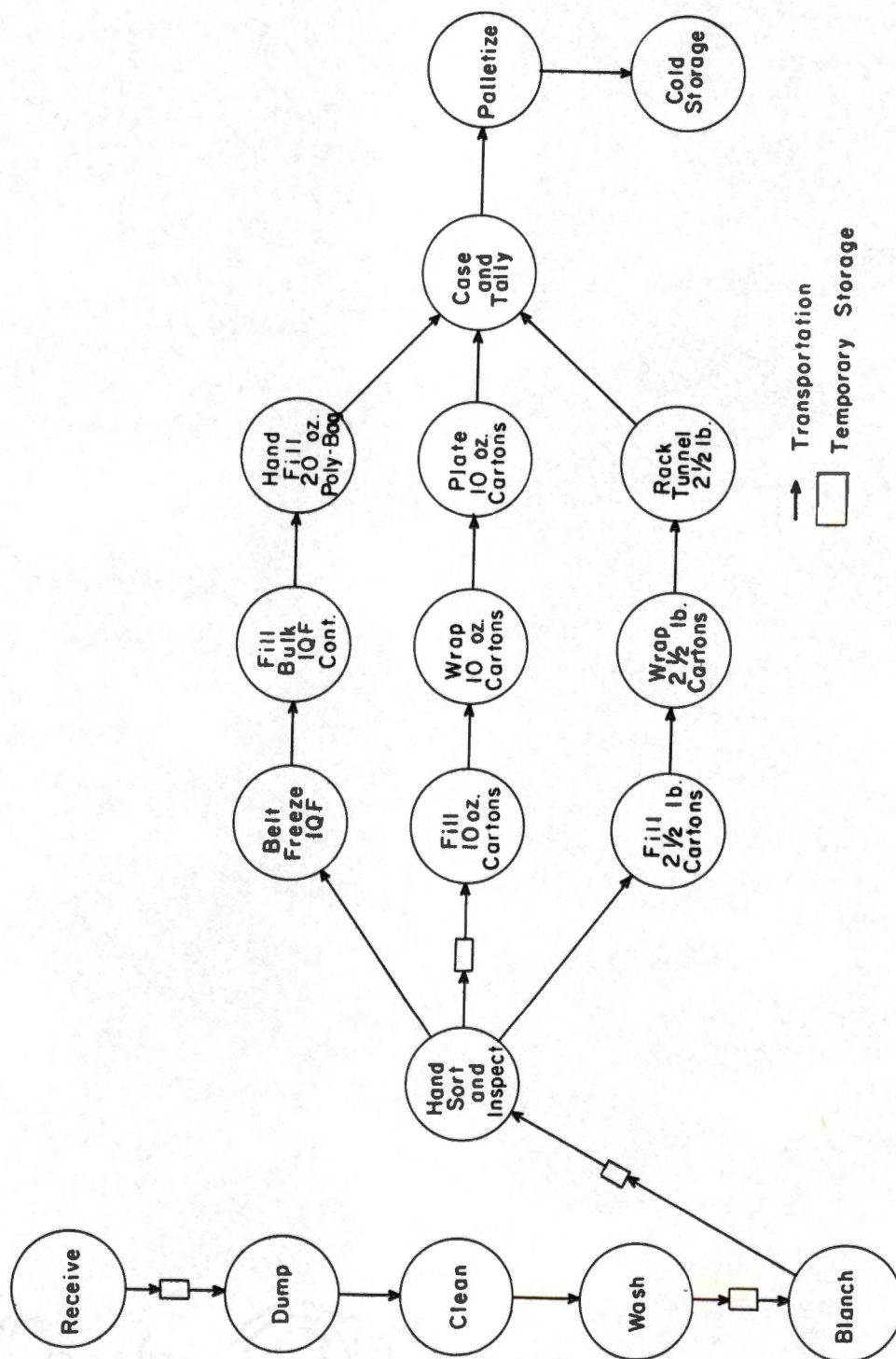
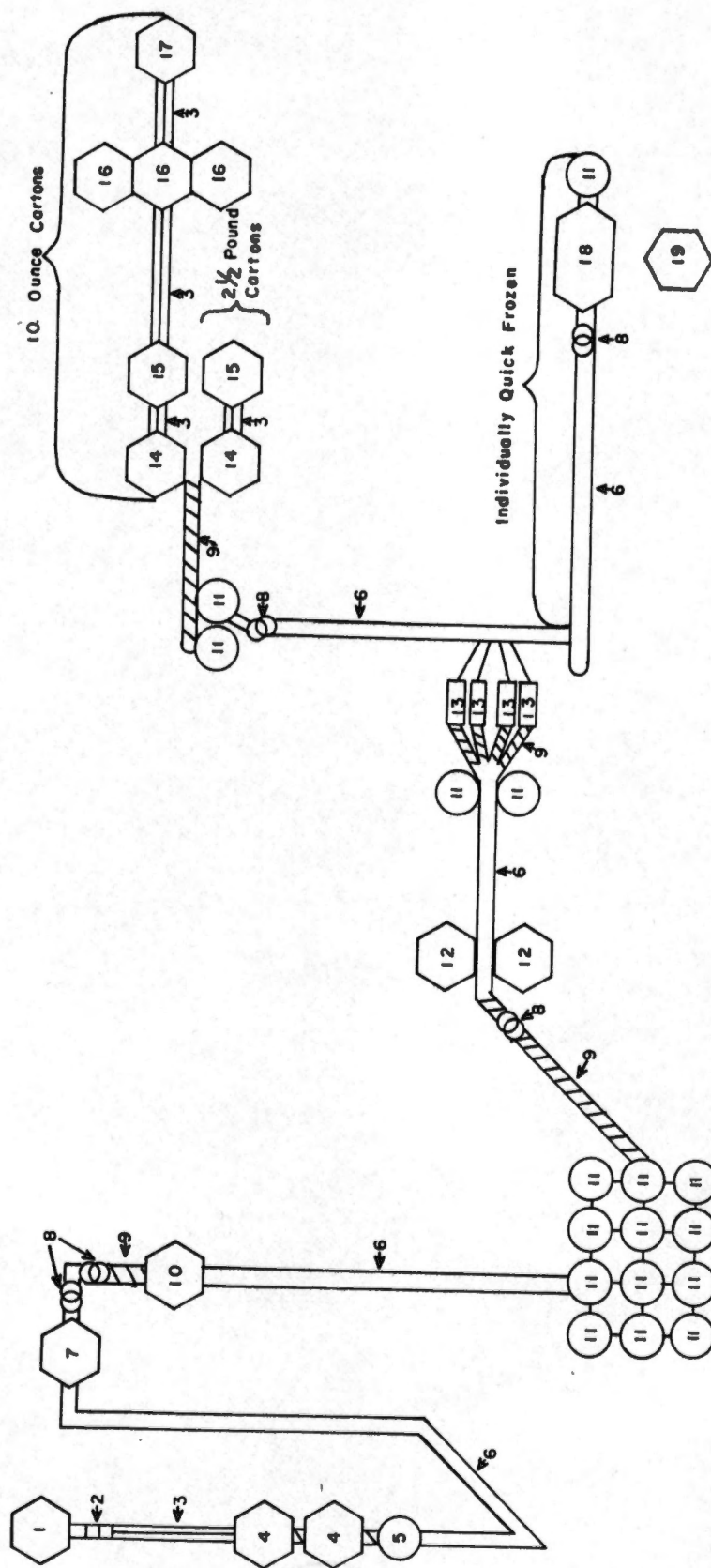


Figure 2. Operational flow chart of lima bean freezing plants in Tennessee, 1970



- | | | |
|-----------------------------|--------------------------|--------------------|
| 1. Dump Bin | 8. Dewater Reel | 15. Overwrapper |
| 2. Vibrator Shaker Conveyor | 9. Flume | 16. Plate Freezers |
| 3. Conveyor Belt | 10. Flotations Cleaner | 17. Case Sealer |
| 4. Shaker Cleaner | 11. Storage Vats | 18. Belt Freezer |
| 5. Pneumatic Cleaner | 12. Blancher | 19. Fork Lift |
| 6. Hydro Pump Conveyor | 13. Inspection Tables | |
| 7. Washer Cleaner | 14. Carton Former Filler | |

Figure 3. Equipment layout for a lima bean freezing plant in Tennessee, 1970

the pneumatic cleaner which consists of a forced air separation process that removes foreign material and defects which the shaker cleaner may fail to remove. Dry methods of cleaning are completed as the beans flow from the pneumatic cleaner into a hydraulic pump line that transports the beans to the washer cleaner. Dust, soil, and other impurities are washed from the beans as they flow over a screen under a spray of water and through a dewatering unit. The beans flow from the dewatering reels into the flotation cleaner where they are cleansed by an emulsion flotation process as the various defects and trash particles are separated and ejected. Beans flow directly, via hydro pump from the flotation cleaner to the blancher or they may be pumped to temporary storage vats to await blanching. Lima beans are usually collected and stored temporarily for 6 to 10 hours in clear water holding vats prior to blanching. Beans are slightly dehydrated prior to cleansing and temporary storage in fresh, clean water restores their original water content. The accumulation of a sizeable quantity of beans in the vats permits a more even flow of beans throughout the processing line. Continuity in the flow of beans is a critical factor in the overall processing operation.

Blanch and Inspect

Blanching of lima beans consists of pumping beans from either the flotation cleaner or storage vats through a dewatering unit and into the blancher prior to freezing. Blanching consists of heating the beans for 3 to 3-1/2 minutes, to prevent discoloration and undesirable flavors which result from enzyme activity (Reed, 1959, p. 25). After blanching,

beans are moved through a cooling vat and are pumped into holding tanks above the inspection belts. From the holding tanks, beans are allowed to flow onto slowly moving inspection belts where inspectors hand sort the beans to remove defects and foreign material. The quality of the beans being processed is determined to a large extent by the number of workers used per belt as well as the belt speed. If the quality of the beans is poor due to disease and insect damage or to improper maturity, the belt speed is either reduced or additional workers are employed at the belt. Beans are pumped from the inspection belts to different locations according to the type of freezing and packaging process desired.

Individual Quick Freezing

Beans that are to be individually quick frozen (IQF) are pumped from the inspection belt to a dewatering reel which deposits the beans via a vibrator conveyor on the IQF belt. The IQF belt passes through a tunnel that consists of freezer units which directs continuous blasts of extremely frigid air through the metal mesh IQF belt. As beans are conveyed through the IQF compartment, the continuous currents of cold air force individual beans into constant motion, thereby freezing each bean as a separate unit. Individually frozen beans flow as granules from the end of the mesh belt into palletized bulk crates. The crates are transported to storage if bulk packaging is the desired product pack. In the case of polybag packaging, bulk bins are transported by forklift to the manual polybag fill and case line. This line consists

of two bins for holding bulk beans and two conveyor belts situated so that filled polybags can be conveyed from the filling station to the sealing station. Small scales for checking the weight of bags, a sealer, and a coder are employed. Beans are dumped into the two bins at the start of the line. Workers dip beans from the bins with a small scoop and with the aid of a funnel and scales fill polybags to the desired weight. They are assisted by workers who hold the bags and place the filled bags onto the belt. As the bags are being conveyed to the sealer, bags are checked for proper weight periodically. The next stage is one of case forming, filling cases, and stenciling the palletized cases. Cases then are either transported to cold storage or shipped to market.

Plate Freezing

Beans that are to be packaged in 10-ounce retail cartons are transported via hydraulic pump from inspection tables to a dewatering unit above a holding tank from which beans flow into the hopper of the carton former, filler and closer machine. After cartons are formed, filled and closed, they pass through a wrapper which applies a waxed paper overwrap.

Cartons then move along a conveyor belt to the plate freezers. A worker attending the plate freezer activates a sweep bar that forces a row of cartons from the conveyor belt into the freezer unit. Entry of a row of cartons into the unit forces a row from the unit that has been frozen. As cartons are ejected from the plate freezer, they fall upon a conveyor belt which transports them to a table where cases are formed and cartons are placed into them by hand. Cases are then

transported via conveyor belt through the case sealer and are stacked onto pallets. The palletized cases are then transported by forklift to cold storage.

Storage Freezing

The process described above with respect to 10-ounce cartons is identical to that of 2-1/2 pound cartons up through the wrapping stage. As 2-1/2 pound cartons leave the wrapper, they are removed from the belt by hand and placed into wire baskets which are stacked upon pallets. Palletized baskets of cartons are then transported into the freezer storage area for both freezing and storage.

General Information

Multiple-Shift Operations

Additional workers were employed as raw products became available in quantities that would require multiple-shift processing. Relatively small capacity plants had, without a change in fixed factors, a two or three fold increase in daily output by employing additional shifts.

Processing Continuity

An even flow of vegetable raw materials was enhanced by specifically scheduled contractual production agreements with producers. Production from the processors' farms provided an additional way of controlling part of the total harvesting time table. The purchase of raw products produced out-of-state served as filler to help maintain continuity in the processing operation throughout the season.

Harvesting Season

Harvesting of lima beans normally begins in mid-July and ends during the first or second week of October. Therefore, three months or less per year are available for the processing of limas. Continuity of processing is broken by rains during the harvesting period because heavy equipment employed in harvesting requires relatively dry soil conditions to operate efficiently. Southern peas and lima beans are usually processed during the same time period because of a common harvesting season. Southern peas are less perishable than limas and this also aids in scheduling the processing. During rainy periods, plant output may be maintained by increasing the level of processing peas which are harvested manually or mechanically in whole pods and then stored in sufficient quantities for processing during slack time. Importing Southern peas from Alabama prior to the lima bean season and from Texas after the lima bean season extends the processing season for plants in the West Tennessee area. A processing season of approximately 9 months is possible with the processing of early and late leafy greens, Southern peas and lima beans.

Plant Capacity

Freezer plants in the Tennessee area have on the average the capacity to prepare through blanching, approximately 5,000 pounds of lima beans per hour. Inspection, filling, wrapping, and freezing are stages of processing that require more time than preparation and the rate of processing is thus normally reduced to approximately 4,000

pounds per hour. Holding vats are employed to store temporarily large quantities of beans because preparation stages are completed more rapidly than stages of packaging. These rates of output do not represent 100 percent of plant capacity because equipment and workers can prepare 6,000 pounds per hour and fill, wrap and freeze 5,000 pounds per hour under optimum conditions. Allowing for breakdowns, bottlenecks, cleanup, and other work stoppage, Tennessee area plants in general operate at about 80 percent capacity in terms of the time charged to processing lima beans.

During the middle of the lima bean season, large supplies of beans are received continuously for 5 to 6 weeks. Higher utilization of capacity during peak harvesting periods offsets the lower utilization of capacity that occur at the start and end of the harvesting season. Approximately 80 percent of the plant's capacity is used during the lima bean processing season each year.

CHAPTER IV

COST ESTIMATES FOR MODEL PLANTS

Processing cost per pound (average total cost) was computed in order to compare operations in the model processing plants. Average total cost indicates the relative efficiency of operations when raw product prices, labor charges, and other factor costs change. The cost data throughout the study have reference to 1970.

Total Output

Total output per season is the major determinant of plant efficiency relative to utilization of fixed factors. Total output is a function of the plant capacity, percent of the plant capacity used, and the number of hours the plant is operated. The largest model plant has a total output of 18,000 pounds per hour for processing lima beans when operating at 90 percent capacity and 900 hours during the processing season. The seasonal output from such a plant would exceed 14 million pounds which is approximately 10 percent of the national pack of frozen lima beans in 1968 (Frozen Food Pack Statistics, pp. 33-35).

Model freezing plants are designed to process beans that have been graded according to quality and size rather than for processing "field run" beans, the practice being used currently in the existing freezing plants. Additional holding tanks and size and quality grading equipment are required to pack and freeze limas according to maturity and size.

However, advantages exist when the beans are processed according to maturity and size. These advantages might justify the additional costs required for purchasing the relatively inexpensive equipment needed for size and quality grading. Labor required for processing is not subject to change with the size or quality of beans processed. Three grades and sizes, small, medium, and large, are possible with baby, green, and green plus mature beans.

Fixed Costs

Fixed costs are an important part of the processing cost of lima beans and per unit fixed cost depends primarily upon the total output of a plant. Total output depends primarily upon plant capacity and the length of the processing season. In the small capacity plants and particularly when the operating seasons are short, fixed costs are relatively high and they represent a large percentage of the unit cost of the product. However, in large capacity plants and particularly when the operating season is long, fixed cost per unit comprises a relatively small percentage of the per unit total cost of processing. The percentage of total output accounted for by various products processed in the model lima bean freezing plants is given in Table 3.

Equipment Cost

The cost of equipment for freezing lima beans in model freezing plants of different processing capacities is listed in summary form in Table 4. Equipment used in preparation, blanching and inspection stages

Table 3. Percentage of total output of various products processed measured in terms of total pounds of product in model lima bean freezing plants

	Percent
Lima beans	20
Southern peas	30
Leafy greens	30
Okra and other	<u>20</u>
Total	100

Table 4. Equipment costs for model lima bean freezing plants by plant capacity, freezing method, and container

Operation	Plant capacity Pounds per hour			
	3,000	6,000	12,000	18,000
	-----dollars-----			
Prepare, blanch, and inspect	24,760	27,160	38,020	39,800
Freezing (method)				
Plate	36,600	36,600	66,200	94,000
Belt	41,600	69,200	94,400	116,000
Fluidized	51,600	51,600	75,000	127,600
Packaging (container)				
10 oz. cartons	22,720	29,040	58,080	87,120
2-1/2 lb. carton	23,600	23,600	23,600	44,000
20 oz. polybag	9,170	12,820	19,670	32,490
Case, seal, code, and print	2,420	2,420	2,420	2,420
Miscellaneous ^a	<u>30,090</u>	<u>44,340</u>	<u>61,480</u>	<u>87,600</u>
Total				
Plate 10 oz.	116,590	139,560	226,200	310,940
Plate 2-1/2 lb.	117,470	134,120	191,720	267,820
IQF belt 20 oz.	108,040	155,940	215,990	278,310
IQF fluidized 20 oz.	118,040	138,340	196,590	289,910

^a Includes shop, laboratory, office and janitorial equipment.

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables, Southern Cooperative Series, Bulletin No. 150, December 1969. Data have been updated to reflect 1970 costs.

was assumed to be the same for all frozen lima bean plants of various capacities regardless of the freezing method or container used in packaging. The same is true for casing, sealing, printing and for miscellaneous operations. The cost of equipment for plants according to plant capacity, freezing method, and container used in packaging is shown by processing stages. Equipment cost is allocated to lima beans according to the percent lima beans are of the total volume of vegetable products processed by a particular item of equipment. (Appendix Table 15 lists the percentages used for each item of equipment.) The total equipment cost according to the method of freezing, containers used, and the plant capacity does not follow a general trend in terms of one method being more costly than another. With plant capacities varying, total equipment needed for the freezing method and the container size does not increase in the same proportion as does plant size. For example, when 10-ounce cartons are plate frozen in a plant with a 3,000 pound capacity, the investment in equipment is \$116,590, whereas the same method of processing in a plant of 6,000 pounds capacity requires a \$139,560 investment. This relatively small increase of \$22,970, or 17 percent in equipment cost, is because more complete utilization is made of the major items in the higher capacity plants. A plant with a capacity to plate freeze 12,000 pounds of lima beans per hour in 10-ounce cartons requires \$226,200 invested in equipment and an 18,000 pound capacity plant \$310,940. The reason for the large (\$84,740, or 37 percent) increase in equipment cost for the 18,000 pound capacity plant is because a plant with a capacity this large needs more than one unit of the major items

of processing equipment. When the capacity of model plants was increased from 6,000 to 12,000 pounds per hour, the increase in investments required for equipment among models employing all methods of freezing ranged from 39 to 62 percent. This relatively large increase in equipment cost results from the fact that many items of equipment required for lima bean freezing operates at a maximum hourly output of 6,000 pounds. The fact that many items of equipment used in lima bean freezing operations have hourly capacities of 6,000 pounds of output per hour, suggests that plants with an hourly capacity substantially below 6,000 pounds per hour is inefficient in terms of equipment use.

Building Cost

Building costs are a fixed cost allocated to lima beans by the same method as equipment cost. Costs of buildings prorated to lima beans for plants of different capacities are shown in Table 5.

The total cost of buildings for a 12,000 pound capacity plant is \$148,694, approximately twice that of a 6,000 capacity plant and three times the cost of a 3,000 pound capacity plant. The building cost required for a 3,000 pound capacity plant, \$48,575, is only one-sixth that of a plant with an 18,000 pound capacity. Small capacity plants are in general more inefficient in terms of utilizing equipment and buildings than are the larger size plants.

Fixed Salaries

Salaries paid during a processing season are a part of a plant's fixed cost. Table 6 lists the fixed salaries employees required for

Table 5. Building costs for model lima bean freezing plants by plant capacity

Use	Cost per square foot	Percent charge to lima beans	Cost allotted to lima beans	Plant capacity Pounds per hour			
				3,000	6,000	12,000	18,000
	dollars	percent		-----dollars-----			
Receiving	1.00	100	1.00	400	800	1,600	2,400
Preparation	8.50	50	4.25	5,100	8,500	16,150	21,250
Fill and case	9.00	20	1.80	1,800	2,160	4,320	6,840
Boiler room	8.00	20	1.60	640	816	1,024	1,280
Storage (dry)	9.00	20	1.80	720	1,440	2,880	4,320
Freezer storage	15.00	20	3.00	39,000	63,000	120,000	240,000
Office	10.00	20	2.00	200	400	800	1,600
Rest rooms	20.00	20	4.00	400	800	1,200	1,600
Shop	9.00	20	1.80	180	360	450	540
Laboratory	9.00	20	1.80	135	180	270	324
Total				48,575	78,456	148,694	280,154

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables, Southern Cooperative Series, Bulletin No. 150, December 1969, pp. 33-35. (Factor input prices were increased approximately 10 percent to allow for price increases from 1968 to 1970.)

Table 6. Fixed costs of management and other salaried personnel for model lima bean freezing plants by plant capacity

Job	Plant capacity Pounds per hour			
	3,000	6,000	12,000	18,000
	-----dollars-----			
Manager	4,000	4,000	4,000	4,000
Sales manager	3,000	3,000	3,000	3,000
Production manager	---	---	3,000	3,000
Plant manager	2,400	2,400	2,400	2,400
Field superintendent	2,400	2,400	2,400	2,400
Office manager	---	---	---	2,400
Secretary	900	900	1,800	1,800
Clerk	800	1,600	2,400	3,200
Typist	---	---	700	1,400
Plant engineer	---	---	1,700	1,700
Mechanic	1,500	1,500	1,500	1,500
Yield control	---	---	1,500	1,500
Quality control	1,500	1,500	1,500	1,500
Custodian	1,000	1,000	1,000	1,000
Night watchman	1,000	1,000	1,000	1,000
Warehouseman	1,500	1,500	1,500	1,500
Personnel manager	---	---	2,400	2,400
Total	20,000	20,800	31,800	35,700

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables, Southern Cooperative Series, Bulletin No. 150, December 1969. Data have been updated to reflect 1970 costs.

operating model plants according to plant capacities. The method of freezing used or type of container used in packaging does not affect the fixed salaried employee requirements.

A general manager, sales manager, plant manager, yield control person, quality control person and some general employees are required personnel for the operation of a given plant regardless of size. Production personnel, an office manager, a typist, plant engineer, and a yield control worker are required in plants with the larger capacities. The fixed salary charges to lima beans are 20 percent of the total fixed salary cost because lima beans comprise 20 percent of total plant output.

Total salaries vary only slightly between plants with capacities of 3,000 and 6,000 pounds per hour. However, the 12,000 pound per hour capacity plant requires 48 percent more cash outlays for salaries than a 6,000 pound capacity plant. An 18,000 pound capacity plant requires an increase of only 12 percent in salaries in order to operate over that of a 12,000 pound capacity plant. For the smallest model plant, salaries comprise 42 percent of the total fixed cost while in the larger plant, only 25 percent.

Total Fixed Cost

Total fixed costs are summarized in Table 7 for operating plants of different sizes according to methods of freezing and type of containers. For the four freezing methods: (1) plate frozen 10 ounce carton, (2) 2-1/2 pound carton, (3) belt frozen 20 ounce polybag, and (4) fluidized 20 ounce polybag, the 3,000 pounds per hour capacity plant had

Table 7. Annual fixed costs for model lima bean freezing plants by plant capacity, freezing method, and container

Method of freezing and type of container	Item of fixed cost	Plant capacity Pounds per hour			
		3,000	6,000	12,000	18,000
-----dollars-----					
<u>Plate Freezing</u>					
10 ounce carton	Salaries	20,000	20,800	31,800	35,700
	Equipment ^a	20,986	25,121	40,716	55,966
	Buildings ^a	6,291	10,197	19,331	36,424
	TOTAL	47,277	56,118	91,847	128,090
2-1/2 pound carton	Salaries	20,000	20,800	31,800	35,700
	Equipment ^a	21,145	24,140	34,508	48,206
	Buildings ^a	6,291	10,197	19,331	36,424
	TOTAL	47,436	55,137	85,639	120,330
<u>Belt Freezing</u>					
20 ounce polybag	Salaries	20,000	20,800	31,800	35,700
	Equipment ^a	19,444	28,066	38,879	50,095
	Buildings ^a	6,291	10,197	19,531	36,424
	TOTAL	45,735	59,063	90,010	122,219
<u>Fluidized Freezing</u>					
20 ounce polybag	Salaries	20,000	20,800	31,800	35,700
	Equipment ^a	21,244	24,898	35,387	52,038
	Buildings ^a	6,291	10,197	19,531	36,424
	TOTAL	47,535	55,895	86,518	124,162

^aEquipment and building costs were computed as depreciation, interest, tax, insurance and repairs.

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969. Data have been updated to reflect 1970 costs.

19, 16, 29 and 18 percent, respectively, lower total fixed costs according to the freezing methods than the 6,000 pound per capacity plant. Increasing capacity from 6,000 to 12,000 pounds per hour required an increased investment in fixed costs of 60, 55, 52, and 55 percent, respectively, for the four freezing methods.

Variable Cost

Cost factors that vary according to their use as product output changes are the cost charged to labor, containers, fuel or power, and the raw product. These comprise the plants variable cost. Unlike costs attributed to fixed factors, there is no need for allocating these costs since they relate directly to only the lima bean processing operation.

Labor Cost

A variable factor not related as directly to output as other variable cost factors is labor. Bottlenecks, breakdowns, and temporary delays in a plant's operation may reduce total output and when these occur, the payment for labor must continue. Variable costs such as costs for containers, the raw products, and utilities, however, vary proportionately with output. The characteristics of labor cost are somewhat different. A plant operating at 90 percent of capacity has the same labor cost as when it is operating at 75, 60, or 45 percent of capacity. While operating at 75, 60, or 45 percent of capacity the plant would have reduced costs for containers and the raw product proportionately to the loss of capacity from the 90 percent level.

Operations that are most dependent upon hand labor and the least adoptive to mechanization incur costs more directly by the operation of a plant at various rates of capacity. Inspection, filling cases, and cleanup operations are examples of processing stages requiring considerable hand labor and these costs vary according to the percent of capacity at which the plant operates. Supervision and machine operation labor requirements are more likely to remain unchanged as plant operating capacities vary. The hourly labor costs for the model plants are listed in Table 8. Labor cost for model freezing plants shows a rather steady increase as the plant was increased from 3,000 to 6,000 pounds per hour. For example, when packing in 10 ounce, 2-1/2 pound cartons, and 20 ounce polybags, there are additional labor costs of \$29.60, \$23.70, and \$25.30 per hour, respectively, according to the type of container used. An increase of hourly capacity from 6,000 to 12,000 pounds results in an increase in labor cost of \$47.05, \$40.65, and \$43.70, respectively, for 10 ounce cartons, 2-1/2 pound cartons and 20 ounce polybags.

Miscellaneous Inputs

Miscellaneous factor requirements and their unit cost are shown in Table 9 for a 100 percent plant capacity operation. Appendix tables contain the miscellaneous factor requirements for 90, 75, 60 and 45 percent plant capacity operations. Containers, electricity, fuel, oil, and water requirements tend to vary directly with the percent of the plant's capacity used in the processing operation.

Table 8. Labor cost per hour for model lima bean freezing plants by plant capacity and container

Operation	Plant capacity Pounds per hour			
	3,000	6,000	12,000	18,000
	-----dollars-----			
Prepare, inspect, and freeze—all methods and containers	34.50	52.75	58.40	117.10
Packaging:				
10 ounce cartons	6.40	9.60	16.00	19.20
2-1/2 pound cartons	6.40	6.40	6.40	12.80
20 ounce polybags ^a	7.05	8.65	15.70	24.35
Casing and transportation— all methods and containers	11.85	14.10	17.30	27.55
Miscellaneous—all methods and containers	13.50	16.70	21.50	26.95
Total:				
10 ounce cartons	66.25	93.15	140.20	190.80
2-1/2 pound cartons	66.25	89.95	130.60	184.40
20 ounce polybags ^a	66.90	92.20	139.90	195.95

^a Belt frozen and fluidized frozen methods have identical labor cost requirements.

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Research Bulletin No. 150, December 1969. Data have been updated to reflect 1970 costs.

Table 9. Miscellaneous costs per hour for model lima bean freezing plants by plant capacity, freezing method, and container operating at 100 percent capacity

Item	Unit	Plant capacity Pounds per hour				Cost per unit	Plant capacity Pounds per hour			
		3,000	6,000	12,000	18,000		3,000	6,000	12,000	18,000
Containers		-----units-----				-----dollars-----				
10 ounce cartons	1,000	4.848	9.696	19.392	29.088	\$ 10.50	50.90	101.81	203.62	305.42
Overwraps	"	5.040	10.080	20.160	30.240	6.50	32.76	65.52	131.04	196.56
Cases 24/	"	202	.404	.808	1.212	110.00	22.22	44.44	88.88	133.32
2-1/2 pound cartons	"	1.212	2.424	4.848	7.272	25.00	30.30	60.60	121.20	181.80
Overwraps	"	1.260	2.520	5.040	7.560	8.50	10.71	21.42	38.10	64.26
Cases 12/	"	.102	.202	.404	.606	140.00	14.28	28.28	56.56	84.84
Polybags	"	2.448	4.896	9.792	14.688	27.00	66.10	132.19	264.38	396.58
Cases 12/20	"	.202	.404	.808	1.212	96.00	19.39	38.78	77.57	116.35
Electricity										
Prepare and light	KWH	24	51	85	108	.01	.24	.51	.85	1.08
Fill and case:										
10 ounce cartons	"	24	19	37	56	.01	.24	.19	.37	.56
2-1/2 pound cartons	"	24	14	14	27	.01	.24	.14	.14	.27
20 ounce polybags	"	16	11	11	30	.01	.16	.11	.11	.30
Freezing										
Plate	KWH	230	460	920	1380	.01	2.30	4.60	9.20	13.80
Belt	"	238	475	949	1424	.01	2.38	4.75	9.49	14.24
Fluidize	"	218	434	869	1303	.01	2.18	4.34	8.69	13.03
Freezer storage	"									
Fuel oil	1,000 gal.	10	19	37	54	.16	1.60	3.04	5.92	8.64
Water and disposal	"	5.2	10.5	21.0	31.6	.60	3.12	6.20	12.60	18.96

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969, p. 36. Factor input prices were increased approximately 10 percent to allow for price increases from 1968 to 1970.

Factor and Product Price Estimates

Shelled lima beans received at the plant were assumed to cost \$.11 per pound. The finished or frozen product when sold was priced at \$.22 per pound. Estimates of the raw product cost and especially the finished products price represents an over-simplification relative to the other factors. Since cost estimates are for the purpose of comparing methods, plant capacities and outputs, these estimates are adequate.

Raw product requirements represent about half of the variable costs of a lima bean freezing plant operation. Other variable factors include the USDA inspection, brokerage fees, and office expenses. These and the other hourly variable cost figures are indicated in Tables 10 and 11 according to plant size, method of freezing, type of container used, and the percent of capacity at which the plants are operated. Raw product costs, brokerage fees, office expenses, and container costs are directly related to the plant output while other variable costs depend upon the hours of operation of the plant.

The variable cost per hour for plate frozen 10 ounce cartons in a model plant operating at 90 percent of capacity is \$503.93, \$959.98, \$1,855.16 and \$2,774.88, respectively, for the 3,000, 6,000, 12,000 and 18,000 pounds per hour capacity plants. The same model plants operating at 75 percent of capacity have variable costs per hour of \$433.57, \$819.33, \$1,583.87 and \$2,345.00, respectively, for the 3,000, 6,000, 12,000, and 18,000 pounds per hour capacity plants. The same general relationship exists between plant size and variable cost in model plants operating other capacities. For all models, doubling plant capacity increases variable cost by slightly over 90 percent.

Table 10. Variable cost per hour for model lima bean freezing plants, operating at 75 and 90 percent capacity by freezing method and container

Item	Plant capacity—pounds per hour					
	3,000		6,000		12,000	
	75	90	75	90	75	90
	Percent of capacity					
	75	90	75	90	75	90
Raw Products^a	248.00	297.00	496.00	594.00	1188.00	1782.00
Labor						
10 ounce cartons	66.25	66.25	93.15	93.15	140.20	190.80
2-1/2 pound cartons	66.25	66.25	89.95	89.95	130.60	184.40
20 ounce polybags	66.90	66.90	92.20	92.20	139.90	195.95
USDA inspection	8.00	8.00	8.00	8.00	8.00	8.00
Brokerage and Office ^b	25.00	29.70	50.00	59.40	108.80	178.20
Containers						
10 ounce cartons	38.18	45.81	76.36	91.62	183.26	274.88
Overwraps	24.57	29.48	49.14	58.96	117.94	176.90
Cases	16.67	20.00	33.33	40.00	79.99	119.99
2-1/2 pound cartons	22.73	27.27	45.45	54.54	109.08	163.62
Overwraps	8.03	9.64	16.07	19.28	34.29	57.83
Cases	10.71	.92	21.21	25.45	50.90	76.36
Polybags	49.58	59.49	99.14	118.97	237.94	356.92
Cases	14.54	17.45	29.09	34.90	87.26	104.72
Electricity						
Prepare and light	.18	.22	.38	.46	.77	.97
Fill and case:						
10 ounce cartons	.18	.22	.14	.17	.33	.50
2-1/2 pound cartons	.18	.22	.11	.13	.13	.24
20 ounce polybags	.12	.14	.08	.10	.10	.27

Table 10 (continued)

Item	Plant capacity—pounds per hour							
	3,000		6,000		12,000		18,000	
	75	90	75	90	75	90	75	90
	Percent of capacity							
	dollars							
Plate freezing	2.30	2.30	4.60	4.60	9.20	9.20	13.80	13.80
Belt freezing	1.79	2.14	3.56	4.28	7.12	8.54	10.68	12.82
Fluidized freezing	1.64	1.96	3.26	3.91	6.52	7.82	9.77	11.73
Freezer storage	.70	.70	1.30	1.30	2.00	2.00	4.00	4.00
Fuel oil	1.20	1.44	2.28	2.74	4.44	5.33	6.48	7.78
Water and disposal	2.34	2.81	4.65	5.58	9.45	11.34	14.22	17.06
Total								
Plate 10 ounce	433.57	503.93	819.33	959.98	1583.87	1855.16	2345.00	2774.88
Plate 2-1/2 pound	395.62	438.47	740.00	865.43	1418.34	1658.44	2253.00	2494.26
Belt frozen								
20 ounce polybags	418.35	485.99	786.68	921.93	1520.10	1780.53	2263.06	2668.69
Fluidized frozen								
20 ounce polybags	418.20	485.81	786.38	921.56	1519.50	1779.81	2262.15	2667.60

^aRaw product cost of \$0.11 per pound received at plant.

^bBased on 5 percent of gross sales at \$0.22 per pound.

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969. Data have been updated to reflect 1970 costs.

Table 11 (continued)

Item	Plant capacity—pounds per hour					
	3,000		6,000		12,000	
	Percent of capacity					
	45	60	45	60	45	60
-----dollars-----						
Plate freezing	1.04	1.38	2.07	2.76	4.14	5.52
Belt freezing	1.07	1.43	2.14	2.85	4.27	5.69
Fluidized freezing	.98	1.31	1.95	2.60	3.91	5.21
Freezer storage						
Fuel oil	.72	.96	1.37	1.82	2.66	3.55
Water and disposal	1.40	1.87	2.79	3.72	5.67	7.56
Total						
Plate 10 ounce	288.63	360.07	529.69	672.53	1003.22	1290.88
Plate 2-1/2 pound	265.87	329.72	480.81	608.45	902.16	1156.68
Belt frozen						
20 ounce polybags	280.10	348.35	510.42	647.15	968.22	1241.15
Fluidized frozen						
20 ounce polybags	280.01	348.37	510.23	646.90	967.85	1241.17

^aRaw product cost of \$0.11 per pound received at plant.

^bBased on 5 percent of gross sales at \$0.22 per pound.

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969. Data have been updated to reflect 1970 costs.

For a given plant operating at different capacity rates, the major cause for changes in variable costs per hour are attributed to container requirements. The 10 ounce cartons are the most expensive followed by the 2-1/2 pound cartons and the polybags. Costs per hour using 2-1/2 pound cartons plus cases and overwraps are only one-half that of those when using 10 ounce cartons. The costs requirements of bags and cases for polybags IQF containers are only one-fourth that of 10 ounce cartons and one-half of the 2-1/2 pound cartons.

Labor costs account for as much as 25 percent of the variable cost of operating a 3,000 pound per hour capacity plant operating at 45 percent of capacity for plate freezing 10 ounce cartons to only 7 percent operating an 18,000 pound capacity plant at 90 percent capacity. The remaining variable cost factors, utilities, fuel, and USDA inspection contribute less than 1 percent to total variable costs. The influence of the plant's capacity utilized upon total output thus logically affects the efficiency values of all the fixed factors.

Total Cost

The total cost of processing lima beans in model plants according to the size of the plant, the percent of the plant's capacity used, the method of processing, the type of containers used and the length of the processing season is given in Appendix Tables 25 through 28. For the small size plant, 3,000 pound per hour capacity, freezing 10 ounce cartons of lima beans operating for 300 hours a season at 90 percent of capacity, the fixed costs represented 24 percent of the total cost of

processing. For the large size plant, 18,000 pounds per hour capacity, freezing 10 ounce cartons and operating at 90 percent of capacity for a 300 hour season, the fixed costs amounted to 14 percent of the total costs. If this large size plant operated 900 hours during the processing season, fixed costs would amount to only 4 percent of the plant's total cost. Increases in plant output by being able to operate longer during the processing season would result in a smaller percentage of the total cost being fixed and a larger percentage of total cost charged to the variable factors.

Cost Per Pound

The average cost per pound for processing lima beans in model freezer plants according to different size plants, type of containers used, methods of freezing, hours of operation per season, and the percent of a plant's capacity used during the processing season is shown in Tables 12 and 13. Plate frozen 10 ounce cartons processed in the 3,000 pound per hour capacity plant operating for 300 hours during the processing season, and at 45 percent of capacity, was the most costly operation for processing beans at 33.05 cents per pound. The most efficient or cheapest freezing cost per pound was in 2-1/2 pound cartons, plate frozen. These costs were 16.22 cents per pound when the processing was done in an 18,000 pound capacity plant that operated at 90 percent of its capacity and for 900 hours during the processing season. The typical lima bean freezing plants in the Tennessee area, processed about 300 hours per season with the plate freezing method and at a capacity of approximately 5,000 to 6,000 pounds per hour.

Table 12. Total cost per pound for processing lima beans in model freezing plants by plant capacity, freezing method, container, and hours of operation at 90 and 75 percent capacity

Type of container	Hours of operation	90 percent capacity				75 percent capacity			
		Plant capacity				Plant capacity			
		Pounds per hour				Pounds per hour			
		3,000	6,000	12,000	18,000	3,000	6,000	12,000	18,000
----- cents per pound -----									
Plate Frozen 10 ounce cartons	300	24.50	21.24	20.01	19.76	26.23	22.36	21.00	20.44
	500	22.16	19.85	18.87	18.71	28.47	20.70	19.68	19.28
	700	21.16	19.26	18.39	18.25	22.27	19.98	19.29	18.74
	900	20.60	18.98	18.12	18.00	21.60	19.59	18.78	18.42
Plate Frozen 2-1/2 pound cartons	300	22.09	19.48	17.99	17.87	24.61	20.52	18.93	18.66
	500	19.75	18.06	16.94	16.88	21.79	18.89	17.66	17.44
	700	18.74	17.48	16.48	16.45	20.59	18.19	17.11	16.96
	900	18.19	17.16	16.23	16.22	19.92	17.80	16.81	16.74
Belt Frozen 20 ounce polybags	300	23.68	20.71	19.26	18.91	25.36	21.85	20.22	19.78
	500	21.51	19.26	18.15	17.98	22.65	20.10	18.89	18.57
	700	20.50	18.63	17.67	17.55	21.49	19.35	18.31	18.05
	900	19.94	18.28	17.41	17.31	20.85	18.94	18.00	17.76
Fluidized Frozen 20 ounce polybags	300	23.68	20.51	19.51	19.02	25.62	21.61	20.08	19.82
	500	21.51	19.13	18.08	17.99	22.81	19.95	18.80	18.59
	700	20.50	18.54	17.62	17.56	21.60	19.24	18.25	18.07
	900	19.94	18.21	17.36	17.31	20.93	18.85	17.95	17.77

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969. Data have been updated to reflect 1970 costs.

Table 13. Total cost per pound for processing lima beans in model freezing plants by plant capacity, freezing method, container, and hours of operation at 60 and 45 percent capacity

Type of container	Hours of operation	60 percent capacity				45 percent capacity			
		Plant capacity				Plant capacity			
		Pounds per hour				Pounds per hour			
		3,000	6,000	12,000	18,000	3,000	6,000	12,000	18,000
-----cents per pound-----									
Plate Frozen 10 ounce cartons	300	28.75	23.87	22.18	21.66	33.05	26.54	24.24	23.59
	500	25.25	21.79	20.48	20.08	28.38	23.77	21.97	21.48
	700	23.75	20.90	19.75	19.40	26.38	22.58	21.00	20.58
	900	22.92	20.41	19.34	19.02	25.27	21.92	20.46	20.07
Plate Frozen 2-1/2 pound cartons	300	27.10	22.00	20.02	19.73	31.40	24.61	21.99	21.50
	500	23.58	19.96	18.44	18.24	26.72	21.89	19.87	19.52
	700	22.08	19.08	17.76	17.60	24.71	20.72	18.97	18.67
	900	21.24	18.60	17.38	17.25	23.59	20.07	18.46	18.20
Belt Frozen 20 ounce polybags	300	27.82	22.34	21.40	20.85	32.04	26.19	23.48	22.73
	500	24.43	21.25	19.73	19.34	27.52	23.27	21.26	20.72
	700	22.98	20.32	19.02	18.69	25.58	22.02	20.31	19.86
	900	22.17	19.79	18.62	18.33	24.51	21.33	19.78	19.38
Fluidized Frozen 20 ounce polybags	300	28.15	23.14	21.24	20.90	32.47	25.79	23.26	22.80
	500	24.63	21.07	19.64	19.37	27.78	23.03	21.12	20.75
	700	23.12	20.18	18.95	18.71	25.77	21.85	20.21	19.88
	900	22.28	19.69	18.57	18.34	24.65	21.19	19.70	19.39

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969. Data have been updated to reflect 1970 costs.

Plant Capacity

The highest cost of processing was in a plant in which the plant capacity and percent of the capacity used was considerably below the level which would justify an efficient operation as illustrated by the small plant of 3,000 pounds capacity. The cheapest processing operation while realistic with respect to the plant's capacity or percent of the capacity used, was unrealistic from the standpoint of the amount of lima beans that could be processed.

A reasonable situation according to the standards of plant operating in the Southeast is a plant that has a capacity of processing 6,000 pounds per hour operating for 300 hours during the season and at 75 percent of capacity. Plants with capacities and seasonal processing periods of this magnitude would process 1.35 million pounds of lima beans and 6.75 million pounds of all vegetables processed per season. Plate frozen 10 ounce cartons resulting from such an operation produces a total cost of approximately 22.36 cents per pound. Model plants of the same size processing plate frozen 2-1/2 pound cartons and belt or fluidized frozen 20 ounce polybags have processing costs of 20.52, 21.85, and 21.61 cents per pound, respectively. An additional 200 hours of operation, or 500 hours per season, would result in a cost reduction of approximately 1.5 cents per pound in the same model plants.

Use of Capacity

The model plant plate freezing 10 ounce cartons, 6,000 pounds per hour capacity operating for 300 hours during the processing season and

at 90 percent of capacity would have costs of 21.24 cents per pound. An identical plant operating 300 hours at 75 percent of capacity would have costs per pound of 22.36 cents. The same capacity model plant operating at 90 percent and freezing 2-1/2 pound cartons by the plate method cartons, 20 ounce polybags by the belt method and 20 ounce polybags by the fluidized method results in costs per pound of 19.48, 20.71, and 20.51 cents, respectively. These same plants operating at only 75 percent of capacity would have costs per pound of 22.36, 20.52, 21.85, and 21.61 cents for 10 ounce plate frozen cartons, 2-1/2 pound plate frozen cartons, 20 ounce belt frozen polybags, and 20 ounce fluidized frozen polybags. This represents an approximate reduction of 1.0 to 1.5 cents per pound in average processing costs resulting from operating at 90 percent of capacity rather than at only 75 percent of capacity. Model plants operating at 75 percent of capacity but with a capacity of 12,000 pounds per hour have costs per pound very similar to these of model plants operating at 90 percent of a 6,000 pound per hour capacity.

If a plant's capacity is increased to gain cost efficiency the success of such an increase depends primarily upon the ability of the plant to maintain the use of a given percent of capacity used. A loss in the percent of capacity used may occur if raw product procurement becomes difficult. The cost per unit for 12,000 pound capacity plants which operate for 300 hours during the processing season, and at 60 percent of capacity are 22.18, 20.02, 21.40, and 21.24 cents, respectively, for plate frozen 10 ounce cartons, 2-1/2 pound plate frozen cartons, 20 ounce belt frozen polybags, and 20 ounce fluidized frozen polybags.

Unit costs increase considerably as the percent of plant capacity used declines. Plants which have increases in potential capacity to a level where procurement of the raw product becomes a problem and results in discontinuity will likely lose most, if not all, the potential savings derived from economies of scale due to the inefficiencies resulting from low levels of capacity utilization.

Total Output

Based upon current trends in demand for, and supply of lima beans in the Tennessee area, total output per plant of frozen lima beans in the next decade would most likely range from 1-1/2 to 3-1/2 million pounds annually. Table 14 lists the total annual output for model plants according to plant capacity, the percent of capacity used, and the hours of operation. Model plants with a capacity of 3,000 pounds per hour would be required to process lima beans for at least 700 hours per season to produce 1.5 million pounds of frozen lima beans annually. Multishift operations would most likely be required if 700 hours of lima bean freezing operations are undertaken. It is unlikely however that any plant will operate for more than 500 hours a processing season and utilize more than 75 percent of its potential capacity for the processing season. Thus, it can be assumed for 3,000 pound capacity plants that the restraints imposed by seasonal procurement conditions and hours of efficient operation would allow for a maximum output of 1.125 million pounds. This volume could be obtained from a 500 hour processing season if the plant operated at 75 percent of capacity. A freezing operation

Table 14. Total annual output for model lima bean freezing plants by plant capacity, hours of operation, and percent of capacity used

Plant capacity Pounds per hour	Percent capacity used	Hours of plant operations			
		300	500	700	900
		total output -----millions of pounds-----			
3,000	90	.810	1.350	1.890	2.430
	75	.675	1.125	1.575	2.025
	60	.540	.900	1.260	1.620
	45	.405	.675	.945	1.215
6,000	90	1.620	2.700	3.780	4.860
	75	1.350	2.250	3.150	4.050
	60	1.080	1.800	2.520	3.240
	45	.810	1.350	1.890	2.430
12,000	90	3.240	5.400	7.560	9.720
	75	2.700	4.500	6.300	8.100
	60	2.160	3.600	5.040	6.480
	45	1.620	2.700	3.750	4.860
18,000	90	4.860	8.100	11.340	14.580
	75	4.050	6.750	9.450	12.150
	60	3,240	5.400	7.560	9.720
	45	2.430	4.050	5.670	7.290

of this type yields a cost per pound of 28.47 cents for plate frozen 10 ounce cartons, 21.79 cents for plate frozen 2-1/2 pound cartons, and 22.65 and 22.81 cents, respectively, for 20 ounce polybags belt frozen and 20 ounce polybags fluidized frozen. These relatively high costs per pound would most likely lead to low levels of profits.

A model plant with a potential capacity of processing 6,000 pounds per hour operating for 500 hours during the processing season and at 75 percent of capacity could freeze 2.25 million pounds of lima beans annually. This model depicts a plant that might logically and efficiently operate in the Southeast. The cost per pound for processing with this model would be 20.70, 18.89, 20.10 and 19.95 cents, respectively, for plate frozen 10 ounce cartons, plate frozen 2-1/2 pound cartons, and 20 ounce belt frozen polybags and 20 ounce fluidized frozen polybags.

A 6,000 pound capacity plant operating for more than 500 hours per season would most likely experience raw product procurement problems, labor problems due to double shift requirements, and thus have to reduce its operating capacity. Output resulting from 300 or less hours of operation per season by a plant with a 6,000 pound per hour processing capacity would be insufficient to yield efficient factor utilization. Such a plant operating for 300 hours per season would have a cost per pound of 22.36, 20.52, 21.85, and 21.61 cents, respectively, for plate frozen 10 ounce cartons, plate frozen 2-1/2 pound cartons, 20 ounce belt frozen polybags, and 20 ounce fluidized frozen polybags.

Hours of Operation

Figure 4 depicts per unit costs for a 3,000, 6,000, 12,000 and 18,000 pound capacity per hour model plants operating at 75 percent of capacity. The four short run average cost curves labeled $SRAC_1$, $SRAC_2$, $SRAC_3$, and $SRAC_4$, indicate these plants in the order listed, and show output and costs per pound resulting from 300, 500, 700 and 900 hours of operation per season. The long run average cost curve (LRAC) connecting the lowest points of the SRAC curves is called the planning curve and indicates the most efficient output for each plant size. Increases in plant capacity, which lowers the per unit cost, are shown by the downward slope of the LRAC and signifies the economies of scale. The 3,000 pound capacity plant has a potential low cost per pound for lima beans of 21.6 cents, whereas the 18,000 pound capacity plant has a potential low cost of 18.5 cents per pound. An annual output of approximately 4 million pounds could be processed most efficiently (19.6 cents per pound) by a 6,000 pound capacity plant. Underutilization of factors in the 12,000 and 18,000 pound capacity plants processing 4 million pounds of annual output would result in per unit costs of 19.9 and 20.6 cents per pound, respectively, which is higher than the costs of processing in the 6,000 pound capacity plant. Annual outputs of 2 million pounds could also be processed in the 6,000 pound capacity plants more efficiently (20.7 cents per pound) than in either the 12,000 or 18,000 pound capacity plant. A 3,000 pound capacity plant using a longer season to process 2 million pounds would have the highest average cost per pound of any processing plant, 21.6 cents per pound.

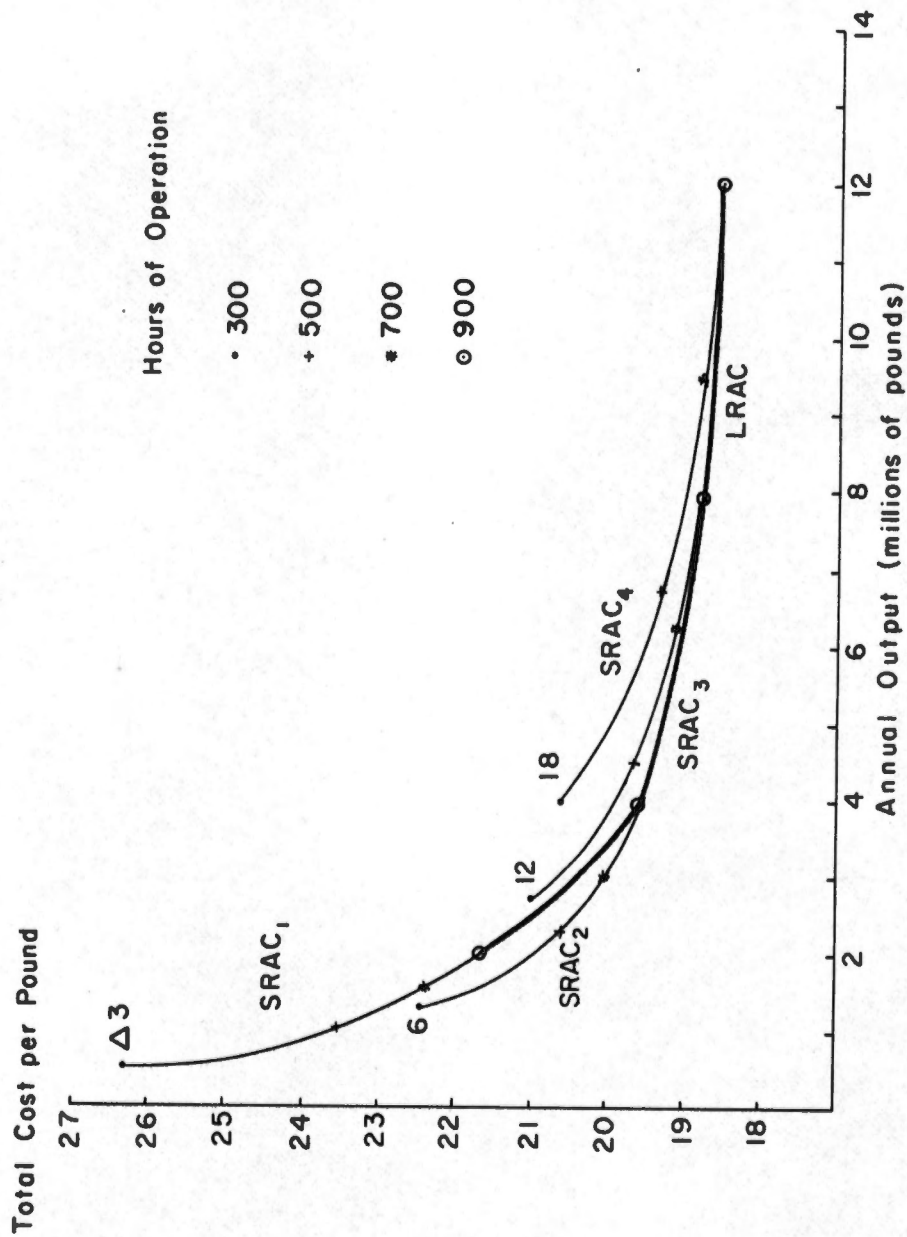


Figure 4. Average cost curves for four model lima bean freezing plants, plate freezing 10 ounce cartons at 75 percent capacity for 300, 500, 700, and 900 hours of operation

Comparisons of model plants of different capacity operating at different capacity rates according to different methods of freezing and containers used yielded economies similar to those shown in Figure 4. Freezing plants that anticipate total output ranging from 2 to 4 million pounds of lima beans annually that have processing capacities greater than 6,000 pounds per hour offer no economies of scale. Therefore, over a wide range of output, cost efficiencies depend primarily upon the percent of a plant's capacity used and the length of the processing season.

The relationship between the percent of a plant's capacity used and the cost per pound of processing is shown in Figure 5. Indicated are the unit cost per pound of lima beans processed in four model plants with 3,6,12, and 18 thousand pound per hour capacity and operating for 500 hours with belt freezing and packaging in 20 ounce polybags in plants operating at 90, 75, 60 and 45 percent of capacity. A 3,000 pounds per hour capacity plant operating at 45 percent of capacity has an average cost of processing limas of 27.52 cents per pound; whereas, the same plant operated at 90 percent of capacity for the same number of hours has a cost of 21.51 cents per pound. The cost per pound for processing lima beans does not vary as greatly for large capacity plants operating at different rates of capacity as plants with capacities that are relatively small. For the smaller size plants, 3,000 pounds per hour, a cost reduction of slightly over 6 cents per pound was obtained, whereas for a plant with an 18,000 pound per hour capacity operating from 45 percent to 90 percent of capacity had a reduction ranging from

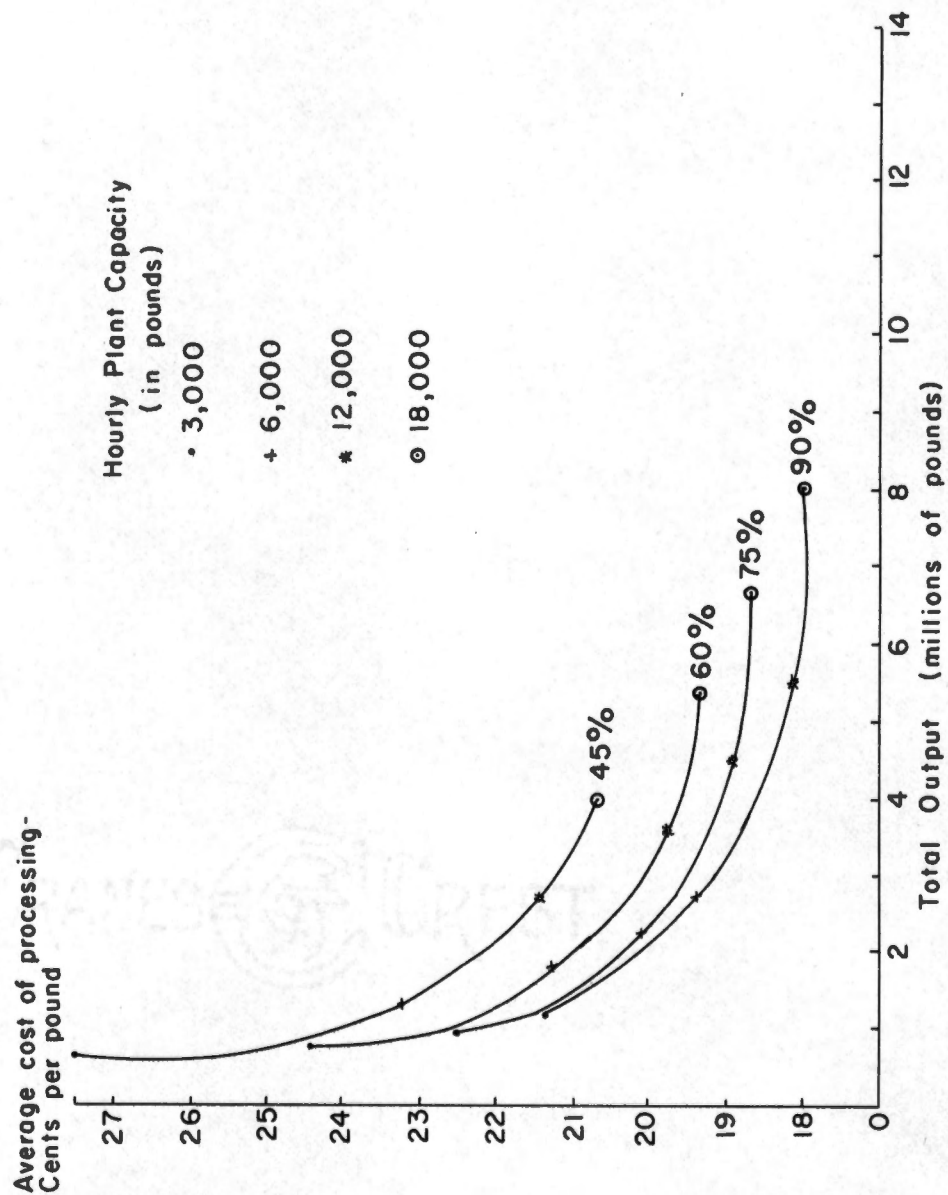


Figure 5. Average cost for four model lima bean freezing plants, belt freezing 20 ounce polybags for 500 hours of annual operation at 90, 75, 60, and 45 percent capacity

20.7 to 17.9 cents per pound. The larger capacity plant had received about a 3 cents per pound reduction in cost or approximately one-half the cost reduction received by the smaller plant as its rate of capacity increased from 45 to 90 percent. Analysis of other size plants freezing limas in different types of containers and at varying rates of capacity use indicate efficiencies are gained when the higher rates of plant capacities are used, but these efficiencies diminish as plant capacity or size increases.

Containers

The relationship between total processing cost per pound for lima beans by freezing method and container used in the model plants is shown in Figure 6. The data indicate cost per pound when the model plants are operated at 90 and 60 percent capacity for 500 hours by freezing method, and container. The plant's capacity and percent of capacity used does not change the relative positions of the costs per pound according to freezing methods and container. Plate freezing 10 ounce cartons is the most costly freezing method and plate freezing 2-1/2 pound cartons is the least costly.

The cost per pound for plate freezing 10 ounce cartons of lima beans in the 3,000, 6,000, 12,000, and 18,000 pound per hour capacity model plants operating for 500 hours at 90 percent of capacity was 22.16, 19.85, 18.87, and 18.71 cents per pound, respectively. Model plants which freeze lima beans in 2-1/2 pound cartons using the same method, capacities, hours of operation, and percent of capacity utilized

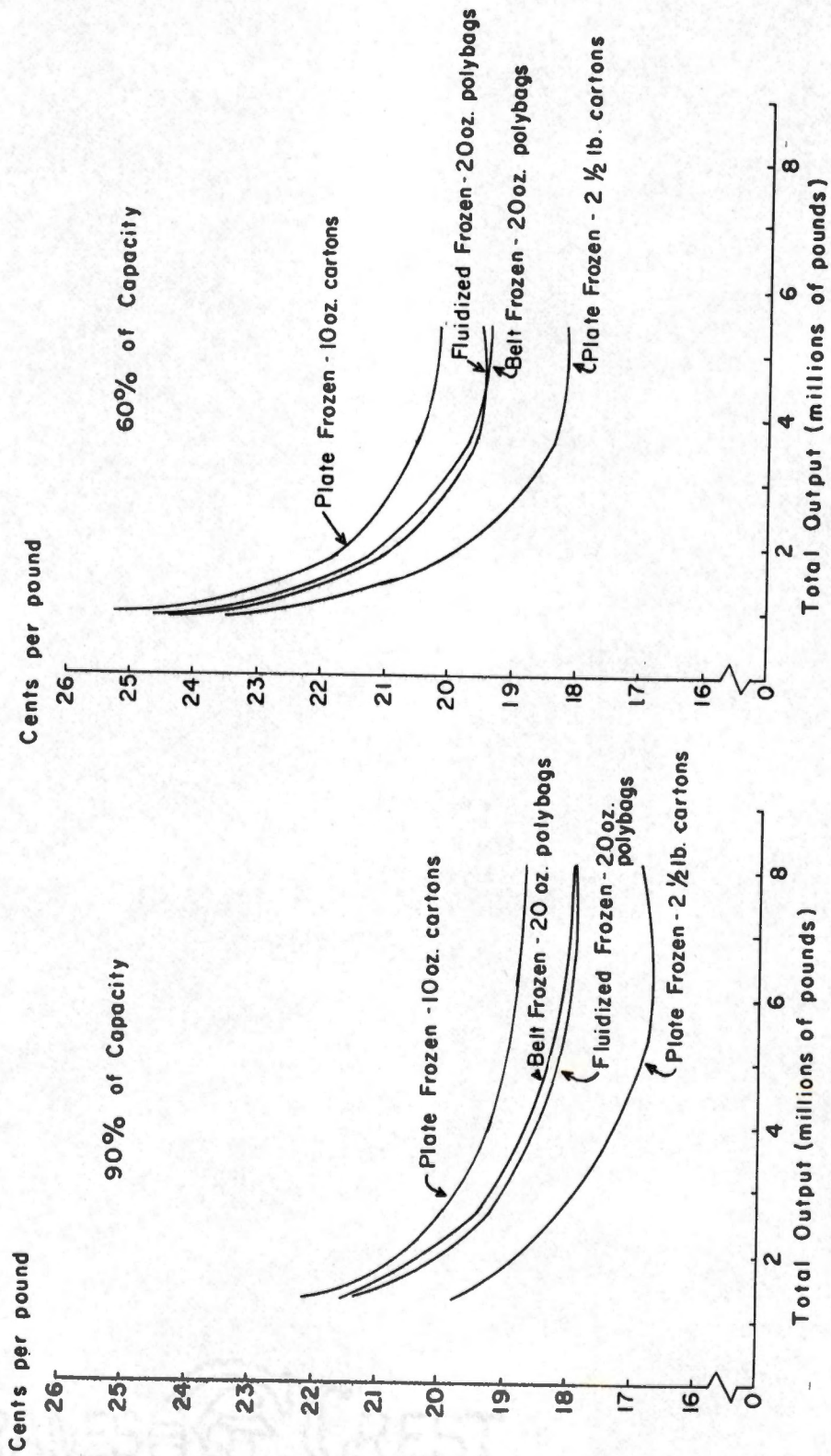


Figure 6. Average cost for four model lima bean freezing plants operating 500 hours at 90 and 60 percent of capacity, according to container

as previously mentioned for the plate freezing models had costs of 21.51, 19.26, 18.15, and 17.98 for belt freezing; and 21.51, 19.13, 18.08, and 17.99 cents per pound, respectively, for the fluidized method.

When cost comparisons were made according to hours of operation and the percent of the plant's capacity used, the belt and fluidized frozen 20 ounce polybags resulted in costs averaging less than a cent per pound more than when beans were processed by the plate freezing method and packaged in 2-1/2 pound cartons. The plate frozen 10 ounce cartons for all hours of operation and rates of plant capacity utilized averaged a little less than 2 cents per pound more than the polybag operations.

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CHAPTER V

SUMMARY

Economies

Cost analysis of model plants indicated that there were substantial economies of size in the lima bean freezing industry. The long run average cost curve (LRAC) fell rapidly as plant capacity was increased from 3,000 to 6,000 and to 12,000 pounds per hour. For capacities greater than 12,000 pounds per hour, costs per pound continued to fall but at a decreasing rate. Therefore, it was concluded that large capacity plants offer considerable cost savings. However, the cost analysis of model lima bean freezing plants also indicated that a longer processing season or the use of a higher percent of the plant's capacity was under some conditions, a more feasible alternative for lowering processing costs per pound than increasing plant size.

Plant Capacity

Economies gained from operating the larger capacity plants were rather substantial. This is particularly true in terms of labor cost per unit of product processed. However, plant capacities of 12,000 and 18,000 pounds per hour would likely require raw product supplies in greater quantities than could be obtained to assure processing continuity and efficient operation.

Processing lima beans in plants with capacities as small as 3,000 pounds per hour results in small seasonal outputs which leads to cost inefficiency. On the other hand, a plant with a capacity as large as 12,000 or 18,000 pounds per hour would most likely be utilized and thus also operate inefficiently due to raw product procurement and labor problems. A 6,000 pound capacity plant however has a capacity sufficiently large to allow for reasonable efficiency of operation under the existing conditions. Increases in demand for lima beans for processing in the future may reach a level enabling the 12,000 and 18,000 pound capacity plants to operate efficiently in the Southeast. However, under existing conditions, the 6,000 pound capacity plants are more efficient.

Hours of Operation

A model plant that was considered realistic in terms of existing plants in the Tennessee area was a 6,000 pounds per hour capacity model plant operating at 75 percent of its capacity for 300 hours annually and processing 10 ounce plate frozen cartons. Doubling the plant's capacity to 12,000 pounds per hour yielded a 1.36 per pound reduction in cost. However, by adding 200 hours of total processing a 1.66 cent per pound in cost reduction could be realized. This same concept is applicable to other model plants operating with similar capacities, hours of operating and outputs. The ability of additional hours of processing to reduce cost of processing per pound was found to diminish greatly after a 700 hour season was obtained.

Use of Capacity

An increase in the percent of the plant's capacity utilized in its lima bean freezing operation led to reduced processing costs per pound. In a 6,000 pound per hour capacity plant operating for 700 hours during the processing season and plate freezing 10 ounce cartons with the plant operating at 75 percent of capacity was less efficient from the standpoint of cost per pound than if the same plant was operating at 90 percent of capacity. Cost per pound was decreased by 1.12 cents by increasing the capacity to this extent. When the same plant was operated for 500 hours instead of 300, costs were further reduced by .85 cent per pound when operated at 90 percent of capacity rather than 75 percent. Processing operations using less than 75 percent of a plant's capacity were found to have great potential for reducing costs by making more efficient use of the plant's capacity.

Variable Factors

It was determined that under many conditions, cost efficiency in lima bean freezing plants depended more upon the variable cost components than fixed cost components. The payments for labor wages, container supplies, and the raw vegetable product constituted the major items of variable costs.

Labor

Labor cost greatly influenced total cost. Factors that influenced labor cost were potential keys to efficiency in operating costs.

Employing labor saving equipment in single-product plants has become an accepted means of obtaining cost efficiency when total output justifies the purchase of such equipment. In this study it was seen that multiple-product processing plants could gain the same type of cost savings plus that of sharing fixed costs among several products.

Containers

Container supplies constituted a significant share of the variable cost of model lima bean processing plants. Paper cartons, waxed paper overwraps, and cardboard cases were major variable cost components of plate freezing. The plastic, printed polybag used for IQF of lima beans replaced the paper cartons and overwraps used when limas were plate frozen. The lower cost of the plastic bag containers was a factor contributing to the relatively low cost per pound for freezing in polybags. Equipment and labor cost for plants that freeze limas by the belt and fluidized methods exceeded that of plate freezing plants; however, the lower cost of packaging in polybag containers yielded an average cost per pound that was less except for the smallest capacity operations.

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APPENDIX

Table 15. Equipment required for model lima bean freezing plants by plant capacity, freezing method, and container

Operation and equipment	Hourly capacity pounds	Charge to limas percent	Cost per unit dollars	Cost to lima beans per unit dollars	Plant capacity Pounds per hour			Plant capacity Pounds per hour		
					units-----			dollars-----		
					3,000	6,000	12,000	18,000	3,000	6,000
<u>Receive and Unload</u>										
Fork lift--gasoline 2500 capacity	20,000	50	7,000	3,500	1	1	1	1	3,500	3,500
<u>Dumping</u>										
Dumping bin (custom built) with continuous feed	18,000	100	1,500	1,500	1	1	1	1	1,500	1,500
<u>Convey</u>										
Conveyor belt, 30" x 10'	30,000	100	1,100	1,100	1	1	1	1	1,100	1,100
<u>Cleaning</u>										
Pea and lima bean cleaner	4,000	40	1,300	520					520	
Pea and lima bean cleaner	18,000	40	7,300	2,920	1	1	1	1	2,920	2,920
<u>Elevating</u>										
Gooseneck elevator 16" x 18'	12,000	40	1,800	720	1	1	1	1	720	720
<u>Washing</u>										
Rotary washer	9,000	40	1,700	680	1	1	2	2	680	1,360
<u>Grading</u>										
Dewater shaker	12,000	40	1,600	640	1	1	2	2	640	1,280
Quality grader (automatic)	9,000	40	5,800	2,320	1	1	2	2	2,320	4,640
Brine maker	20,000	40	700	280	1	1	1	1	280	280
Cross conveyor 18" x 10"	30,000	40	1,000	400	1	1	1	1	400	400
Hydropump with scavenger screen and tank	18,000	40	3,450	1,380	1	1	1	1	1,380	1,380
Dewater reel	20,000	40	1,650	660	1	1	1	1	660	660
Vibrating conveyor 30" x 25'	18,000	40	2,500	1,000	1	1	1	1	1,000	1,000
Pea grader	6,000	40	2,100	840	1	1	2	2	840	1,680

Table 15. (continued)

Operation and equipment	Hourly capacity pounds	Charge to limas percent	Cost per unit dollars	Cost to lima beans per unit dollars	Plant capacity Pounds per hour			Plant capacity Pounds per hour					
					units			dollars					
					3,000	6,000	12,000	18,000	3,000	6,000	12,000	18,000	

Storage (temporary)													
Flume-shop built 25' length set	---	100	500	500	3	3	3	3	1,500	1,500	1,500	1,500	
Holding tank	---	40	1,200	480	2	2	3	4	960	960	1,440	1,920	
Blanching													
Rotary blancher	9,000	20	9,000	1,800	1	1	2	2	1,800	1,800	3,600	3,600	
Cooling flume shop built	30,000	20	800	160	1	1	1	1	160	160	160	160	
Dewatering reel	6,000	20	1,300	260	1	1	2	3	260	260	520	780	
Vibrating conveyor 30" x 35'	18,000	20	3,500	700	1	1	1	1	700	700	700	700	
Inspect and Sort													
Picking table 24" x 25'	6,000	20	2,700	540	1	1	2	3	540	540	1,080	1,620	
Belt conveyor as top	6,000	20	2,500	500	1	1	2	3	500	500	1,000	1,500	
Elevator gooseneck with overhead water spray									24,760	27,160	38,020	39,800	
Plate Freezing													
Refrigeration and housing for freezer (freight, insulation, wiring, engineering and erection)	6,000 12,000 18,000	20 20 20	183,000 331,000 470,000	36,600 66,200 94,000	1	1	1	1	36,600 66,200 94,000	36,600 66,200 94,000	66,200 94,000 116,000	94,000	
Belt Freezing													
Refrigeration and housing for freezer (freight insulation, wiring, engineering and erection)	4,000 9,000 14,000 18,000	20 20 20 20	208,000 346,000 472,000 580,000	41,600 69,200 94,400 116,000	1	1	1	1	41,600 69,200 94,400 116,000	41,600 69,200 94,400 116,000	94,400 116,000	116,000	
Fluidized Freezing													
Refrigeration and housing for freezer (freight insulation, wiring, engineering and erection)	6,000 12,000 18,000	20 20 20	258,000 375,000 638,000	51,600 75,000 127,600	1	1	1	1	51,600 75,000 127,600	51,600 75,000 127,600	75,000 127,600	127,600	

Table 15 (continued)

Operation and equipment	Hourly capacity pounds	Charge to limas percent	Cost per unit dollars	Cost to lima beans per unit dollars	Plant capacity Pounds per hour				Plant capacity Pounds per hour			
					3,000	6,000	12,000	18,000	3,000	6,000	12,000	18,000
-----dollars-----												
<u>Packaging 10 Ounce Cartons</u>												
<u>Convey to filler</u>												
Hydraulic bin dumper with 16" x 18' conveyor	8,000	40	5,000	2,000	1	1	2	3	2,000	2,000	4,000	6,000
Filler, automatic	8,000	40	28,000	11,200	1	1	2	3	11,200	11,200	22,400	33,600
Carton conveyor	3,000	40	800	320	1	2	4	6	320	640	1,280	1,920
Overwrapper	3,000	40	15,000	6,000	1	2	4	6	6,000	12,000	24,000	36,000
Caser (semiautomatic)	7,000	40	8,000	3,200	1	1	2	3	3,200	3,200	6,400	9,600
									22,720	29,040	58,080	87,120
<u>Packaging 2-1/2 Pound Cartons</u>												
<u>Hydraulic dump bin and conveyor</u>												
Automatic filler	15,000	40	5,000	2,000	1	1	1	2	2,000	2,000	2,000	4,000
Conveyor belt 12" x 12'	15,000	40	30,000	12,000	1	1	1	2	12,000	12,000	12,000	24,000
Overwrapper	15,000	40	1,000	400	1	1	1	2	400	400	400	800
Caser (semiautomatic)	12,000	40	15,000	6,000	1	1	1	2	6,000	6,000	6,000	12,000
	20,000	40	8,000	3,200	1	1	1	1	3,200	3,200	3,200	3,200
									23,600	23,600	23,600	44,000
<u>Packaging 20 Ounce Polybags</u>												
<u>Hydraulic dump bin and conveyor</u>												
Automatic polybag filler	15,000	40	5,000	2,000	1	1	1	2	2,000	2,000	2,000	4,000
Single tube	4,000	40	17,000	6,800	1		1	1	6,800		6,800	6,800
Double tube	8,000	40	26,000	10,400		1	1	2		10,400	10,400	20,800
Bag conveyor 8" x 10'	6,000	40	800	320	1	1	2	3	320	320	320	640
Casing table (manual casing)	4,000	40	200	50	1	2	3	5	50	100	150	250
									9,170	12,820	19,670	32,490
<u>Case, Seal, Code, and Print</u>												
<u>(All Sizes and Methods)</u>												
Conveyor (power) 12" x 16'	20,000	20	1,000	500	1	1	1	1	500	500	500	500
Case sealer (18' compression)	20,000	20	6,000	1,200	1	1	1	1	1,200	1,200	1,200	1,200
Coder-printer	20,000	20	3,500	700	1	1	1	1	700	700	700	700
Conveyor (gravity)	20,000	20	400	20	1	1	1	1	20	20	20	20
									2,420	2,420	2,420	2,420

Table 15 (continued)

Operation and equipment	Hourly capacity pounds	Charge to limas percent	Cost per unit dollars	Cost to lima beans per unit dollars	Plant capacity Pounds per hour			Plant capacity Pounds per hour				
					units			dollars				
					3,000	6,000	12,000	18,000	3,000	6,000	12,000	18,000
Miscellaneous (All)												
Truck scales (60' pit)	--	20	12,000	2,400	1	1	1	1	2,400	2,400	2,400	2,400
Boiler (complete) I	--	20	14,000	2,800	1	1			2,800	2,800		
II	--	20	24,000	4,800								
Refrigeration (-25° storage)	--	20	1,800	360	25	40	54	105	8,640	14,400	4,800	4,800
Pallets 40" x 48"	--	20	5	1	750	1,000	1,500	2,000	750	1,000	1,500	2,000
Bulk bins 40" x 48" x 36"	--	20	20	4	100	200	400	600	400	800	1,600	2,400
Fork lift (electric)	--	20	16,000	3,200	2	3	4	4	6,400	9,600	12,800	12,800
Pallet frames--iron	--	20	40	8	500	900	1,200	1,800	4,000	7,100	9,600	14,400
Sewage disposal I	--	20	12,000	2,400	1	1			2,400	2,400		
II	--	20	18,000	3,600			1	1			3,600	3,600
One-half ton pick-up truck	--				1	1	2	2	560	560	1,120	1,120
One and one-half ton truck	--											
Air compressor	--	20	4,200	840		1	1	1		840	840	840
Janitorial	--	20	2,000	400	1	1	1	1	400	400	400	400
Office furnished and equipped	--	20	300	60	1	2	3	4	60	120	180	240
Shop	--	20	1,600	640	1	3	4	5	320	960	1,280	1,600
Laboratory furnished	--	20	3,200	640	1	1	2	3	640	640	1,280	1,920
	--	20	1,600	320	1	1	2	3	320	320	640	1,280
									30,090	44,340	61,480	87,600

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969. Factor input prices were increased approximately 10 percent to allow for price increases from 1968 to 1970.

Table 16. Building space required for model lima bean freezing plants by plant capacity

Use	Description	Plant capacity Pounds per hour			
		3,000	6,000	12,000	18,000
-----square feet-----					
Receive	Concrete slab 4"	400	800	1,600	2,400
Preparation	Fully enclosed with 14' ceiling	1,200	2,000	3,800	5,000
Fill-case	Fully enclosed with 14' ceiling	1,000	1,200	2,400	3,600
Boiler room	Enclosed 14' ceiling	400	510	640	800
Storage	Enclosed and dry	400	800	1,600	2,400
Freezer storage	25' ceiling and 12' aisles	13,000	21,000	40,000	80,000
Office	Furnished	100	200	400	800
Rest rooms	Furnished	100	200	300	400
Shop	Enclosed with utilities	100	200	250	300
Laboratory	Enclosed with utilities	75	100	150	180

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Research Bulletin No. 150, December 1969.

Table 17. Managerial and other fixed salary requirements for model lima bean freezing plants by plant capacity

Job	Annual salary	Charge to lima beans ^a	Plant capacity Pounds per hour			
			3,000	6,000	12,000	18,000
	---dollars---		-----number required-----			
Manager	20,000	4,000	1	1	1	1
Sales manager	15,000	3,000	1	1	1	1
Production manager	15,000	3,000			1	1
Plant manager	12,000	2,400	1	1	1	1
Field superintendent	12,000	2,400	1	1	1	1
Personnel management	12,000	2,400			1	1
Office manager	12,000	2,400				1
Secretary	4,500	900	1	1	2	2
Clerk	4,000	800	1	2	3	4
Typist	3,500	700			1	2
Plant engineer	8,500	1,700			1	1
Mechanic	7,500	1,500	1	1	1	1
Yield control	7,500	1,500			1	1
Quality control	7,500	1,500	1	1	1	1
Custodian	5,000	1,000	1	1	1	1
Night watchman	5,000	1,000	1	1	1	1
Warehouseman	7,500	1,500	1	1	1	1

^aTwenty percent of the cost is charged to lima beans.

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Research Bulletin No. 150, December 1969. Data have been updated to reflect 1970 costs.

Table 18. Annual fixed costs for model lima bean freezing plants by plant capacity, freezing method, and container

Method of freezing and type of container	Item of fixed cost	Plant capacity Pounds per hour			
		3,000	6,000	12,000	18,000
-----dollars-----					
<u>All</u>	Salaries	20,000	20,800	31,800	35,700
<u>Plate Freezing</u>	<u>Equipment</u>				
10 ounce carton	Depreciation	11,659	13,956	22,620	31,094
	Interest	4,664	5,582	9,048	12,436
	Taxes	1,166	1,396	2,262	3,109
	Insurance	1,166	1,396	2,262	3,109
	Repairs	2,331	2,791	4,524	6,218
	TOTAL	20,986	25,121	40,716	55,966
2-1/2 pound carton	Depreciation	11,747	13,412	19,172	26,782
	Interest	4,699	5,364	7,668	10,712
	Taxes	1,175	1,341	1,917	2,678
	Insurance	1,175	1,341	1,917	2,678
	Repairs	2,349	2,682	3,834	5,356
	TOTAL	21,145	24,140	34,508	48,206
<u>Belt Freezing</u>					
20 ounce carton	Depreciation	10,804	15,594	21,599	27,831
	Interest	4,320	6,236	8,640	11,132
	Taxes	1,080	1,559	2,150	2,783
	Insurance	1,080	1,559	2,150	2,783
	Repairs	2,160	3,118	4,320	5,566
	TOTAL	19,444	28,066	38,879	50,095
<u>Fluidized Freezing</u>					
20 ounce carton	Depreciation	11,804	13,834	19,659	28,910
	Interest	4,720	5,532	7,864	11,564
	Taxes	1,180	1,383	1,966	2,891
	Insurance	1,180	1,383	1,966	2,891
	Repairs	2,360	2,766	3,932	5,782
	TOTAL	21,244	24,898	35,387	52,038
<u>All</u>	<u>Buildings</u>				
	Depreciation	2,419	3,923	7,435	14,008
	Interest	1,936	3,138	5,948	11,208
	Taxes	484	784	1,487	2,802

Table 18 (continued)

Method of freezing and type of container	Item of fixed cost	Plant capacity Pounds per hour			
		3,000	6,000	12,000	18,000
		-----dollars-----			
	Insurance	484	784	1,487	2,802
	Repairs	968	1,568	2,974	5,604
	TOTAL	6,291	10,197	19,331	36,424
Total					
Plate, 10 ounce		47,277	56,118	91,847	128,090
2-1/2 pound		47,436	55,137	85,639	120,330
Belt, 20 ounce		45,735	59,063	90,010	122,219
Fluidized, 20 ounce		47,535	55,895	86,518	124,162

Table 19. Labor requirements for model lima bean freezing plants by plant capacity, freezing method, and container

Job	Plant capacity Pounds per hour			
	3,000	6,000	12,000	18,000
	<u>Number of Workers</u>			
Unload	1	1	1	2
Dump	1	1	1	2
Air clean	1	1	1	1
Wash	1	1	2	2
Quality grade	1	1	2	2
Size grade		1	1	1
Mix brine		1	1	1
Storage	1	1	1	1
Blanch	1	1	2	2
Inspect	8	16	32	48
Supervise	1	1	1	1
Cleanup	1	1	1	1
Freeze (all methods)	2	3	4	5
	<u>Packaging 10 Ounce Cartons</u>			
Operate bin dump	1	1	2	3
Supply cartons	1	2	3	3
Operate filler	1	2	3	3
Operate overwrapper	1	1	2	3
	<u>Packaging 2-1/2 Pound Cartons</u>			
Operate bin dump	1	1	1	2
Supply cartons	1	1	1	2
Operate filler	1	1	1	2
Operate overwrapper	1	1	1	2
	<u>Packaging 20 Ounce Polybags</u>			
Operate bin dump	1	1	2	3
Operate filler	1	1	2	3
Fill cases (by hand)	2	3	5	8
	<u>All Containers and Methods</u>			
Supply and form cases	2	2	3	5
Operate caser	1	1	1	1
Operate sealer	1	1	1	2
Operate coder-printer	1	1	1	2
Set cases on pallet	1	1	2	3
Operate fork lift	1	2	2	3

Table 19 (continued)

Job	Plant capacity ^a Pounds per hour			
	3,000	6,000	12,000	18,000
Electrician	1	1	1	2
Tool room clerk		1	1	1
Maintenance	1	1	2	2
Quality control	1	1	1	1
Cleanup	1	2	3	4
Warehouseman	1	1	2	3
Boiler attendant	1	1	1	1
Refrigeration mechanic	1	1	1	1

Table 20. Labor costs per hour for model lima bean freezing plants by plant capacity, freezing method, and container

Operation	Wage Rate Used	Plant capacity Pounds per hour			
		3,000	6,000	12,000	18,000
<u>Dollar Cost Per Hour</u>					
Unload	2.25	2.25	2.25	2.25	4.50
Dump	1.60	1.60	1.60	1.60	3.20
Air clean	1.60	1.60	1.60	1.60	1.60
Wash	1.60	1.60	1.60	3.20	3.20
Quality grade	1.60	1.60	1.60	3.20	3.20
Size grade	1.60		1.60	1.60	1.60
Mix brine	1.60		1.60	1.60	1.60
Storage	1.60	1.60	1.60	1.60	1.60
Blanch	1.60	1.60	1.60	3.20	3.20
Inspect	1.60	12.80	25.60	51.20	76.80
Supervise	3.75	3.75	3.75	3.75	3.75
Cleanup	1.60	1.60	1.60	1.60	1.60
Freeze	2.25	4.50	6.75	9.00	11.25
<u>Packaging 10 Ounce Cartons</u>					
Operate bin dump	1.60	1.60	1.60	3.20	4.80
Supply cartons	1.60	1.60	3.20	4.80	4.80
Operate filler	1.60	1.60	3.20	4.80	4.80
Operate overwrapper	1.60	1.60	1.60	3.20	4.80
<u>Packaging 2-1/2 Pound Cartons</u>					
Operate bin dump	1.60	1.60	1.60	1.60	3.20
Supply cartons	1.60	1.60	1.60	1.60	3.20
Operate filler	1.60	1.60	1.60	1.60	3.20
Operate overwrapper	1.60	1.60	1.60	1.60	3.20
<u>Packaging 20 Ounce Polybags</u>					
Operate bin dump	1.60	1.60	1.60	3.20	4.80
Operate filler	2.25	2.25	2.25	4.50	6.75
Fill cases	1.60	3.20	4.80	8.00	12.80
<u>All Containers and Methods</u>					
Supply and form cases	1.60	3.20	3.20	4.80	8.00
Operate caser	1.60	1.60	1.60	1.60	1.60
Operate sealer	1.60	1.60	1.60	1.60	3.20
Operate coder-printer	1.60	1.60	1.60	1.60	3.20
Set cases on pallet	1.60	1.60	1.60	3.20	4.80
Operate fork lift	2.25	2.25	2.25	4.50	6.75

Table 20 (continued)

Operation	Wage Rate Used	Plant capacity Pounds per hour			
		3,000	6,000	12,000	18,000
Electrician	2.25	2.25	2.25	2.25	4.50
Tool room clerk	1.60		1.60	1.60	1.60
Maintenance	1.60	1.60	1.60	3.20	3.20
Quality control	1.60	1.60	1.60	1.60	1.60
Cleanup	1.60	1.60	3.20	4.80	6.40
Warehouseman	1.60	1.60	1.60	3.20	4.80
Boiler attendant	1.60	1.60	1.60	1.60	1.60
Refrigeration mechanic	3.25	3.25	3.25	3.25	3.25

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Research Bulletin No. 150, December 1969. Data have been updated to reflect 1970 costs.

Table 21. Miscellaneous variable factor requirements for model lima bean freezing plants by plant capacity, freezing method, and container operating at 90 percent capacity

Item	Unit	90 percent plant capacity—pounds per hour							
		3,000		6,000		12,000		18,000	
		number	dollars	number	dollars	number	dollars	number	dollars
Containers									
10 ounce cartons	1,000	4.363	45.81	8.726	91.62	17.392	183.26	26.179	274.88
Overwraps	"	4.536	29.48	9.072	58.96	18.144	117.94	27.216	176.90
Cases 24/	"	.182	20.00	.364	40.00	.727	79.99	1.091	119.99
2-1/2 pound cartons									
Overwraps	"	1.091	27.27	2.182	54.54	4.363	109.08	6.545	163.62
Cases 12/	"	1.134	9.64	2.268	19.28	4.536	34.29	6.804	57.83
	"	.092	.92	.182	25.45	.364	50.90	.545	76.36
Polybags									
Cases 12/20	"	2.203	59.49	4.406	118.97	8.813	237.94	13.219	356.92
	"	.182	17.45	.364	34.90	.727	69.81	1.091	104.72
Electricity									
Prepare and light	KWH	21.60	.22	45.90	.46	76.50	.77	97.2	.97
Fill and case:									
10 ounce cartons	"	21.60	.22	17.10	.17	33.30	.33	50.4	.50
2-1/2 pound cartons	"	21.60	.22	12.60	.13	12.60	.13	24.3	.24
20 ounce polybags	"	14.40	.14	9.90	.10	9.90	.10	27	.27
Freezing									
Plate	"	230	2.30	460	4.60	920	9.20	1380	13.80
Belt	"	214.20	2.14	427.50	4.28	854.10	8.54	12.82	12.82
Fluidize	"	196.20	1.96	390.60	3.91	782.10	7.82	11.73	11.73
Fuel Oil									
Gallons	9	1.44	17.10	2.74	33.30	5.33	48.6	7.78	
Water and Disposal									
1,000 gals.	4.68	2.81	9.45	5.58	18.90	11.34	28.44	17.06	

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969, p. 36. Data have been updated to reflect 1970 costs.

Table 22. Miscellaneous variable factor requirements per hour for model lima bean freezing plants by plant capacity, freezing method, and container operating at 75 percent capacity

Item	Unit	75 percent plant capacity--pounds per hour					
		3,000		6,000		12,000	
		number	dollars	number	dollars	number	dollars
<u>Containers</u>							
10 ounce cartons	1,000	3.636	38.18	7.272	76.36	14.544	152.72
Overwraps	"	3.780	24.57	7.560	49.14	15.120	98.28
Cases 24/	"	.152	16.67	.303	33.33	.606	66.66
2-1/2 pound cartons	"	.909	22.73	1.818	45.45	3.636	90.90
Overwraps	"	.945	8.03	1.890	16.07	3.780	28.58
Cases 12/	"	.077	10.71	.152	21.21	.303	42.42
Polybags	"	1.836	49.58	3.672	99.14	7.344	198.29
Cases 12/20	"	.152	14.54	.303	29.09	.606	58.18
<u>Electricity</u>							
Prepare and light	KWH	18	.18	38.25	.38	63.75	.64
Fill and case:							
10 ounce cartons	"	18	.18	14.25	.14	27.75	.28
2-1/2 pound cartons	"	18	.18	10.50	.11	10.50	.11
20 ounce polybags	"	12	.12	8.25	.08	8.25	.08
<u>Freezing</u>							
Plate	"	230	2.30	460	4.60	920	9.20
Belt	"	178.5	1.79	356.25	3.56	711.75	7.12
Fluidize	"	163.5	1.64	325.50	3.26	651.75	6.52
<u>Fuel Oil</u>							
	Gallons	7.5	1.20	14.25	2.28	27.75	4.44
<u>Water and Disposal</u>							
	1,000 gals.	3.9	2.34	7.88	4.65	15.75	9.45
						23.7	14.22

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969, p. 36. Data have been updated to reflect 1970 costs.

Table 23. Miscellaneous variable factor requirements per hour for model lima bean freezing plants by plant capacity, freezing method, and container operating at 60 percent capacity

Item	Unit	60 percent plant capacity—pounds per hour					
		3,000		6,000		12,000	
		number	dollars	number	dollars	number	dollars
Containers							
10 ounce cartons	1,000	2.909	30.54	5.817	61.08	11.635	122.17
Overwraps	"	3.024	19.66	6.048	39.31	12.096	78.62
Cases 24/	"	.121	13.31	.242	26.62	.485	53.35
2-1/2 pound cartons	"	.727	18.18	1.109	2.73	2.909	72.73
Overwraps	"	.756	6.43	1.512	12.85	3.024	25.70
Cases 12/	"	.061	8.54	.121	16.94	.242	33.88
Polybags	"	1.469	39.66	2.938	79.33	5.875	158.63
Cases 12/20	"	.121	11.62	.242	23.23	.485	46.56
Electricity							
Prepare and light	KWH	14.40	.14	30.60	.31	51	.51
Fill and case:							
10 ounce cartons	"	14.40	.14	11.40	.11	22.20	.22
2-1/2 pound cartons	"	14.40	.14	8.40	.08	8.40	.08
20 ounce polybags	"	9.60	.10	6.40	.07	6.60	.07
Freezing							
Plate	"	138	1.38	276	2.76	552	5.52
Belt	"	142.80	1.43	285	2.85	569.40	5.69
Fluidize	"	130.80	1.31	260.40	2.60	521.40	5.21
Fuel Oil							
	Gallons	6	1.96	11.40	1.82	22.20	3.55
Water and Disposal							
	1,000 gals.	3.12	1.87	6.30	3.78	12.60	7.56
						18.96	11.38

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969, p. 36. Data have been updated to reflect 1970 costs.

Table 24. Miscellaneous variable factor requirements per hour for model lima bean freezing plants by plant capacity, freezing method, and container operating at 45 percent capacity

Item	Unit	45 percent plant capacity—pounds per hour					
		3,000		6,000		12,000	
		number	dollars	number	dollars	number	dollars
<u>Containers</u>							
10 ounce cartons	1,000	2.182	22.91	4.363	45.81	8.726	91.62
Overwraps	"	2.268	14.74	4.536	29.48	9.072	58.97
Cases 24/	"	.091	10.01	.182	20.02	.364	40.04
2-1/2 pound cartons	"	.545	13.63	1.090	27.25	2.182	54.55
Overwraps	"	.567	4.82	1.134	9.64	2.268	19.28
Cases 12/	"	.046	6.44	.091	12.74	.182	25.48
Polybags	"	1.102	29.75	2.203	59.48	4.406	118.96
Cases 12/20	"	.091	8.74	.182	17.47	.364	34.94
<u>Electricity</u>							
Prepare and light	KWH	10.80	.11	22.95	.23	38.25	.38
Fill and case:							
10 ounce cartons	"	10.80	.11	8.55	.09	16.65	.17
2-1/2 pound cartons	"	10.80	.11	6.30	.06	6.30	.06
20 ounce polybags	"	7.20	.07	4.95	.05	4.95	.05
<u>Freezing</u>							
Plate	"	103.50	1.04	207.00	2.07	414.00	4.14
Belt	"	107.10	1.07	213.75	2.14	427.05	4.27
Fluidize	"	98.10	.98	195.30	1.95	391.05	3.91
<u>Fuel Oil</u>							
	Gallons	4.50	.72	8.55	1.37	16.65	2.66
<u>Water and Disposal</u>							
	1,000 gals.	2.34	1.40	4.73	2.84	9.45	5.67

Source: James L. Pearson and John R. Brooker, eds., Planning Data for Marketing Selected Fruits and Vegetables in the South, Southern Cooperative Series, Bulletin No. 150, December 1969, p. 36. Data have been updated to reflect 1970 costs.

Table 25. Fixed, variable, and total costs for model lima bean freezing plants by plant capacity, freezing method, container, and hours of operation at 90 percent capacity

Type of container	Plant capacity 3,000					Plant capacity 6,000					Plant capacity 12,000					Plant capacity 18,000				
	Hours					Hours					Hours					Hours				
	300	500	700	900	1,000	300	500	700	900	1,000	300	500	700	900	1,000	300	500	700	900	1,000
Plate Frozen																				
Fixed	47,277	47,277	47,277	47,277	47,277	56,118	56,118	56,118	56,118	56,118	91,847	91,847	91,847	91,847	91,847	128,090	128,090	128,090	128,090	128,090
Variable	151,179	251,965	352,751	453,537	453,537	287,994	479,990	671,986	863,982	863,982	927,580	1,298,612	1,669,644	1,669,644	1,669,644	832,464	1,387,440	1,942,416	2,497,392	2,497,392
Total	198,456	299,242	400,028	500,814	500,814	344,112	536,108	728,104	920,100	920,100	1,019,427	1,390,459	1,761,491	1,761,491	1,761,491	832,464	1,387,440	1,942,416	2,497,392	2,497,392
Plate Frozen																				
Fixed	47,436	47,436	47,436	47,436	47,436	55,137	55,137	55,137	55,137	55,137	85,639	85,639	85,639	85,639	85,639	120,330	120,330	120,330	120,330	120,330
Variable	131,541	219,235	306,929	394,623	394,623	259,629	432,715	605,801	778,887	778,887	829,220	1,160,908	1,492,586	1,492,586	1,492,586	748,278	1,247,130	1,745,982	2,244,834	2,244,834
Total	178,977	266,671	354,365	442,059	442,059	314,766	487,852	660,938	834,024	834,024	914,859	1,246,547	1,578,235	1,578,235	1,578,235	868,608	1,367,460	1,866,312	2,365,164	2,365,164
Belt Frozen																				
Fixed	45,735	45,735	45,735	45,735	45,735	59,063	59,063	59,063	59,063	59,063	90,010	90,010	90,010	90,010	90,010	122,219	122,219	122,219	122,219	122,219
Variable	145,797	242,995	340,193	437,391	437,391	276,579	460,965	645,351	829,737	829,737	890,265	1,246,371	1,602,477	1,602,477	1,602,477	800,607	1,334,345	1,868,083	2,401,821	2,401,821
Total	191,532	288,730	385,928	483,126	483,126	335,642	520,028	704,414	888,800	888,800	980,275	1,336,381	1,692,487	1,692,487	1,692,487	922,836	1,456,564	1,990,302	2,524,040	2,524,040
Fluidized Frozen																				
Fixed	47,535	47,535	47,535	47,535	47,535	55,895	55,895	55,895	55,895	55,895	86,518	86,518	86,518	86,518	86,518	124,162	124,162	124,162	124,162	124,162
Variable	145,743	242,905	340,067	437,229	437,229	276,486	460,780	645,092	829,440	829,440	889,905	1,245,867	1,601,829	1,601,829	1,601,829	800,280	1,333,800	1,867,320	2,400,840	2,400,840
Total	193,278	290,440	387,602	484,764	484,764	332,381	516,675	700,987	885,335	885,335	976,423	1,332,385	1,688,347	1,688,347	1,688,347	924,442	1,457,962	1,991,482	2,525,002	2,525,002

Table 26. Fixed, variable, and total costs for model lima bean freezing plants by plant capacity, freezing method, container, and hours of operation at 75 percent capacity

Type of container	Plant capacity 3,000					Plant capacity 6,000					Plant capacity 12,000					Plant capacity 18,000				
	Hours					Hours					Hours					Hours				
	300	500	700	900	1,000	300	500	700	900	1,000	300	500	700	900	1,000	300	500	700	900	1,000
Plate Frozen																				
Fixed	47,222	47,277	47,277	47,277	47,277	56,118	56,118	56,118	56,118	56,118	91,847	91,847	91,847	91,847	91,847	128,090	128,090	128,090	128,090	128,090
Variable	130,071	216,785	303,499	390,213	390,213	245,799	409,665	573,531	737,397	737,397	791,935	1,108,709	1,425,483	1,425,483	1,425,483	703,500	1,172,500	1,641,500	2,110,500	2,110,500
Total	177,293	264,062	350,776	437,490	437,490	301,917	465,783	629,649	795,515	795,515	883,782	1,200,556	1,517,330	1,517,330	1,517,330	831,590	1,300,590	1,769,590	2,238,590	2,238,590
Plate Frozen																				
Fixed	47,436	47,436	47,436	47,436	47,436	55,137	55,137	55,137	55,137	55,137	85,639	85,639	85,639	85,639	85,639	120,330	120,330	120,330	120,330	120,330
Variable	118,686	197,810	276,934	356,058	356,058	222,000	370,000	518,000	666,000	666,000	709,170	992,838	1,276,506	1,276,506	1,276,506	635,427	1,059,045	1,482,663	1,906,281	1,906,281
Total	166,122	245,246	324,370	403,494	403,494	277,137	425,137	573,137	721,137	721,137	794,809	1,078,477	1,362,145	1,362,145	1,362,145	755,757	1,179,375	1,602,993	2,026,611	2,026,611
Belt Frozen																				
Fixed	45,735	45,735	45,735	45,735	45,735	59,063	59,063	59,063	59,063	59,063	90,010	90,010	90,010	90,010	90,010	122,219	122,219	122,219	122,219	122,219
Variable	125,505	209,175	292,845	376,515	376,515	236,004	393,340	550,676	708,012	708,012	760,050	1,064,070	1,368,090	1,368,090	1,368,090	678,919	1,131,530	1,584,142	2,036,754	2,036,754
Total	171,240	254,910	338,580	422,250	422,250	295,067	452,403	609,739	766,075	766,075	850,060	1,154,080	1,458,100	1,458,100	1,458,100	801,137	1,253,749	1,706,361	2,158,973	2,158,973
Fluidized Frozen																				
Fixed	47,535	47,535	47,535	47,535	47,535	55,895	55,895	55,895	55,895	55,895	86,158	86,158	86,158	86,158	86,158	124,162	124,162	124,162	124,162	124,162
Variable	125,460	209,100	292,740	376,380	376,380	235,914	393,190	550,466	703,742	703,742	759,750	1,063,650	1,367,550	1,367,550	1,367,550	677,645	1,131,075	1,583,505	2,032,935	2,032,935
Total	172,995	256,635	340,275	423,915	423,915	291,809	449,085	606,361	767,637	767,637	845,908	1,149,808	1,454,068	1,454,068	1,454,068	801,807	1,255,237	1,707,667	2,157,097	2,157,097

Table 27. Fixed, variable, and total costs for model lima bean freezing plants by plant capacity, freezing method, container, and hours of operation at 60 percent capacity

Type of container	Plant capacity 3,000					Plant capacity 6,000					Plant capacity 12,000					Plant capacity 18,000				
	Hours					Hours					Hours					Hours				
	300	500	700	900	1,000	300	500	700	900	1,000	300	500	700	900	1,000	300	500	700	900	1,000
Plate Frozen	47,277	47,277	47,277	47,277	47,277	56,118	56,118	56,118	56,118	56,118	91,847	91,847	91,847	91,847	91,847	128,090	128,090	128,090	128,090	128,090
Variable	108,021	180,035	252,049	324,063	324,063	201,759	336,265	470,771	605,277	605,277	387,264	645,440	903,616	1,161,792	1,161,792	573,753	956,255	1,338,757	1,721,259	1,721,259
Total	155,298	227,312	299,326	371,340	371,340	257,877	392,383	526,889	661,395	661,395	479,111	737,287	995,616	1,253,639	1,253,639	701,843	1,084,345	1,466,847	1,849,349	1,849,349
Plate Frozen	47,436	47,436	47,436	47,436	47,436	55,137	55,137	55,137	55,137	55,137	85,639	85,639	85,639	85,639	85,639	120,330	120,330	120,330	120,330	120,330
Variable	98,916	164,860	230,804	296,748	296,748	182,535	304,225	425,915	547,605	547,605	347,004	578,340	809,676	1,041,012	1,041,012	518,991	864,985	1,210,979	1,556,973	1,556,973
Total	146,352	212,296	278,240	344,184	344,184	237,672	359,362	481,052	602,742	602,742	432,643	663,979	895,315	1,126,651	1,126,651	639,321	985,315	1,331,309	1,677,303	1,677,303
Belt Frozen	45,735	45,735	45,735	45,735	45,735	59,063	59,063	59,063	59,063	59,063	90,010	90,010	90,010	90,010	90,010	122,219	122,219	122,219	122,219	122,219
Variable	104,505	174,175	243,845	313,515	313,515	194,145	323,575	453,005	582,435	582,435	372,345	620,575	868,805	1,117,035	1,117,035	553,326	922,210	1,291,094	1,659,978	1,659,978
Total	150,240	219,910	289,580	359,250	359,250	253,208	382,638	512,068	641,498	641,498	462,355	710,585	958,815	1,207,045	1,207,045	675,546	1,044,429	1,413,313	1,782,197	1,782,197
Fluidized Frozen	47,535	47,535	47,535	47,535	47,535	55,895	55,895	55,895	55,895	55,895	86,518	86,518	86,518	86,518	86,518	124,162	124,162	124,162	124,162	124,162
Variable	104,511	174,185	243,859	313,533	313,533	194,070	323,450	452,830	582,210	582,210	372,351	620,585	868,819	1,117,053	1,117,053	553,116	921,860	1,290,604	1,659,348	1,659,348
Total	152,046	221,720	291,394	361,068	361,068	249,965	379,345	508,725	638,105	638,105	458,869	707,103	955,337	1,203,571	1,203,571	677,276	1,046,022	1,414,766	1,783,510	1,783,510

Table 28. Fixed, variable, and total costs for model lima bean freezing plants by plant capacity, freezing method, container, and hours of operation at 45 percent capacity

Type of container	Plant capacity 3,000					Plant capacity 6,000					Plant capacity 12,000					Plant capacity 18,000				
	Hours					Hours					Hours					Hours				
	300	500	700	900	1,000	300	500	700	900	1,000	300	500	700	900	1,000	300	500	700	900	1,000
Plate Frozen	47,277	47,277	47,277	47,277	47,277	56,118	56,118	56,118	56,118	56,118	91,847	91,847	91,847	91,847	91,847	128,090	128,090	128,090	128,090	128,090
Variable	86,589	144,351	202,041	259,767	259,767	158,907	264,845	370,783	476,721	476,721	300,966	501,610	702,254	902,898	902,898	445,221	742,035	1,038,849	1,463,753	1,463,753
Total	133,866	191,592	249,318	307,044	307,044	215,025	320,963	426,901	532,839	532,839	392,813	593,457	794,101	994,745	994,745	573,311	870,125	1,166,939	1,463,753	1,463,753
Plate Frozen	47,436	47,436	47,436	47,436	47,436	55,137	55,137	55,137	55,137	55,137	85,639	85,639	85,639	85,639	85,639	120,330	120,330	120,330	120,330	120,330
Variable	79,761	132,935	186,109	239,283	239,283	144,243	240,405	336,567	432,729	432,729	270,648	451,080	631,512	811,944	811,944	402,210	670,350	938,490	1,206,630	1,206,630
Total	127,197	180,371	233,545	286,719	286,719	199,380	295,542	391,704	490,866	490,866	356,287	536,719	717,151	897,583	897,583	522,540	790,680	1,058,820	1,326,960	1,326,960
Belt Frozen	45,735	45,735	45,735	45,735	45,735	59,063	59,063	59,063	59,063	59,063	90,010	90,010	90,010	90,010	90,010	122,219	122,219	122,219	122,219	122,219
Variable	84,030	140,050	196,070	252,090	252,090	153,126	255,210	357,294	459,378	459,378	290,466	484,110	677,754	871,398	871,398	430,275	717,125	1,003,975	1,290,825	1,290,825
Total	129,765	185,785	241,805	297,825	297,825	212,189	314,273	416,357	518,441	518,441	380,476	574,120	767,764	961,608	961,608	552,494	839,344	1,126,194	1,413,044	1,413,044
Fluidized Frozen	47,535	47,535	47,535	47,535	47,535	55,895	55,895	55,895	55,895	55,895	86,518	86,518	86,518	86,518	86,518	124,162	124,162	124,162	124,162	124,162
Variable	84,003	140,005	196,007	252,009	252,009	153,069	255,115	357,161	459,207	459,207	290,355	483,925	677,495	871,065	871,065	429,960	716,000	1,003,240	1,289,880	1,289,880
Total	131,538	187,540	243,542	299,544	299,544	208,964	311,010	413,056	515,102	515,102	376,873	570,443	764,013	957,583	957,583	554,122	840,762	1,127,402	1,414,042	1,414,042

VITA

Ronald Emmett Jones was born in Clayton, Alabama, on November 1, 1939, the son of Emmett Hill and Grace Oberon Chance Jones. He attended Clayton Elementary School and was graduated from Clayton High School in 1958. The following September he entered Auburn University, and in December, 1961, he received a Bachelor of Science degree in Agricultural Education. The following January he accepted a research assistantship at Auburn University and began study toward a Master's degree in Agricultural Economics. He received that degree in December, 1963.

He entered the Graduate School at The University of Tennessee in January, 1964, after accepting a research assistantship in the Department of Agricultural Economics and Rural Sociology. He completed course work and other requirements for a Doctor of Philosophy degree in Agricultural Economics prior to accepting, in 1967, a teaching position on the faculty of Abraham Baldwin Agricultural College in Tifton, Georgia. After teaching 5 years in Tifton, he completed the requirements for his doctorate in June, 1973.

He is married to the former Marcia Hudson of Louisville, Alabama. They have two children--a son, Ronnie, age 9, and a daughter, Suzanne, age 6.