

AN ABSTRACT OF THE THESIS OF

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Title - Cost Analysis of Two Techniques of Grading, Sizing, and
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This study originated with industry recognition of inadequate flexibility in currently used procedures for grading, sizing, and packaging fresh apples in North Central Washington. Field-run apples are introduced into the process, and nearly all of the product must be placed in a marketing package in the process. Portions of the output products are stored for a 12-month marketing period. Frequently during this marketing period there are changes in the types of packaging demanded. In recognition of this problem, research has developed prototype equipment for performing a presorting and pre-sizing function. Presorted and presized apples could be returned to bulk bin storage for later selective market preparation. This study provides cost information on the application of this new procedure that should be useful to managers of packing plants.

The principal objective of the study is to determine how the application of the new procedure would affect the production-point marketing margins. An intermediate objective is to establish industry structure and trends that might relate to the application

of the new procedure. Cost analysis is limited to those operating input costs that would likely be affected by the application of the new procedure.

An economic-engineering method of analysis is used to measure the relative efficiency of the old and new techniques. A sample of four representative apple packing lines was analyzed for rate of output in standard operating periods (eight-hour shifts) and for average costs per unit of output in these periods. Cost per unit of output associated with integrating the presorting and presizing function into the process was estimated. Operating and cost models were developed for both the standard packing line and the new method. From analysis of standard packing line operation, it was concluded that presorting and presizing the 50 per cent of the total seasonal volume with the lowest quality would improve the rate of product output on standard packing lines. This is the basis for estimating operating and cost models of the new technique. Models are based on annual seasonal output volumes of 210,000, 280,000 and 350,000 boxes (42 pounds of apples per box). These volumes represent a majority of the larger packing plants in North Central Washington.

Average operating input costs per unit of output increase due to the application of presorting and presizing. The increase was approximately \$.025 per unit of output. This is one per cent of the average production-point marketing margin. Application of the new method would not increase the economic efficiency of this specific phase of grading, sizing, and packing fresh apples.

The application of presorting and presizing and integration with the current packing line procedures in apple packing plants in North Central Washington could result in total cost savings in individual plants through the more efficient use of storage facilities. Approximately 20 per cent more product can be stored in refrigerated storage or modified atmosphere refrigerated storage in bulk form in bins as compared to finished product storage. Presorting and presizing 50 per cent of the field-run product would also result in greatly improved flexibility in adapting to the market. The relatively small additional cost of application of this presorting and presizing function would improve the efficiency of many larger apple packing plants. The economic value would vary with each plant. Individual plant variables that should be analyzed are total seasonal volume and trends, storage capacity, current packing line efficiency, and marketing program.

COST ANALYSIS OF TWO TECHNIQUES OF
GRADING SIZING AND PACKING
RED DELICIOUS APPLES IN NORTH CENTRAL WASHINGTON

by

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TABLE OF CONTENTS

Chapter		Page
I	Introduction	1
	Industry Setting	4
	Definition of Terms	10
	The Problem	12
II	Methodological Framework	18
	Theoretical Framework and Past Research	18
	Description of Methodology Used in This Study	23
III	Empirical Results	29
	Costs Associated with the Standard Technology	29
	Costs Associated with the New Technology	34
	Cost Comparison of Two Technologies	40
IV	Summary and Market Orientation	44
	Bibliography	50
	Appendix 1	54
	Appendix 2	127
	Appendix 3	157

List of Tables

Table 1	Number and Storage Capacity of Apple Packing Plants in North Central Washington	10
Table 2	Washington Delicious Apples: Prices and Marketing Margins to Chicago and New York Markets per Carton by Seasons	13
Table 3	Operating and Cost Model - Fresh Apple Grading, Sizing, and Packaging	30
Table 4	Operating and Cost Model - Presorting and Presizing Line	35
Table 5	Coefficients of Determination and Significance Levels of Apple Quality and Rate of Output ...	37
Table 6	Comparative Costs of the Two Technologies	41

List of Charts

	Page
Chart 1 Average Per Cent of Washington Fresh Apple Distribution by States 1960 Through 1964	8
Chart 2 Average Operating Input Cost per Unit of Output Related to Total Seasonal Volume, Standard Technology	33
Chart 3 Comparative Costs of the Two Technologies for Each Packing Line	42

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CHAPTER I

INTRODUCTION

To maintain or improve its competitive position in the national market, the apple industry of North Central Washington must improve its ability to meet market demand. During the past eight years the annual market period for apples has been extended from nine to twelve months. This increase in marketing period has been accomplished through the application of technological improvement in harvesting and storage methods. The volume of apples produced in this area increased by 30 per cent from 1960 to 1965 and is projected to increase an additional 25 per cent from 1965 to 1970. Apple packing and storage plant managers report an increasing trend toward mixed carload (refrigerated rail car or truck equivalents) demand and changing demand for varieties, grades, sizes, and containers of apples throughout the extended market period.

Packing and storage of apples is a marketing function performed for the purpose of meeting the demands of the market. The market for Washington apples is nationwide, with distribution in all major population centers. Packing plants receive the harvested fruit, provide refrigerated storage, grade, size, package, and load for shipping. The fruit is stored at the plants during the market period

and shipped on demand to terminal market receivers. Very little storage is provided in transit to markets or at market centers.

Present packing and storage plant operations do not provide the degree of flexibility necessary to adapt the raw product to changing market demands. Packing lines are completely integrated units that require finished product output for each given period of operation. Fifty to one hundred and twenty different finished products are produced by a single plant from a raw product input in a given operating period. These different finished products for each variety of apple consist of two or three grades and ten to twelve sizes placed in two to five different kinds of containers.

Only a portion of the various finished products are needed for current or planned sales. The market for the remaining finished products is not known at the time of packing line operation. Some degree of change in finished product is frequently desired by the market at a later time. For example, for a given period of packing line operation there may be a known demand for one size group, grade, and variety of apples. These apples are to be placed on trays in specified market containers. Later demand for other groups of sizes and grades of this variety may vary among two or three different forms of packaging.

In the currently used procedure on apple packing lines, field-run apples in varying combinations of sizes and grades are introduced into a continuous line process. The continuous process is made up

of a series of functions or functional stages. Each function may use varying quantities of inputs such as raw product, equipment, supplies, labor, and technologies to produce different outputs. In a continuous process made up of a combination of functions, the output rate (volume of packed apples per unit of time) is limited by the least efficient¹ function.

A new technology, recently introduced, allows for pregrading and presizing of field-run apples into certain specified groups of grades and sizes. Each of these groups can then be returned to bulk bin containers for further storage and for later processing by the packing line. This new technology provides an opportunity to process uniform batches of apples in predetermined grade and size groups for a given period of time.

The purpose of this study is to compare the costs of operating apple packing lines with and without the introduction of this new technology. Cost - output relationships for each function and a combination of these relationships into cost functions for the two technologies are developed for analysis.

¹Efficiency here is used in a physical sense, i.e., output per unit of input.

Industry Setting

The Washington apple industry is concentrated in the central part of the state. Apple production and handling extends north and south, joining similar industries at the Canadian and Oregon borders. Over the past 20-year period Washington has produced an average of 20 per cent of the total United States commercial apple crop. During the five-year period, 1959 through 1963, the average annual crop was 22,000,000 48-pound bushels. Since 1962 there has been an increase in annual crops, with state production reaching 25,000,000 bushels in 1964 and 1965 and 32,000,000 bushels in 1966. The projected production for 1970 is 38,000,000 bushels (26, Nov. 1966; 31, p.26). This would be a 73 per cent increase in production over the 1959-1963 average.

National apple production from 1951 through 1961 averaged approximately 112,000,000 bushels. The national production is expected to reach 135,000,000 to 155,000,000 bushels by 1970 (27, p.3). This represents a 20 to 38 per cent increase in production compared to Washington State's 73 per cent increase.

The Washington apple industry can be divided into two major geographic production areas -- the South Central area and the North Central area. The South Central area is centered in Yakima County and includes Grant, Franklin, and Benton Counties. The North Central Washington area includes Chelan, Douglas, and Okanogan Counties, with marketing functions centered in the city of Wenatchee. The major

difference between the two production areas that likely affects production and marketing practices is the degree of diversification in fruit production. The South Central area, in addition to marketing nearly one-half of the state's commercial apple crop, is a major producer of Bartlett pears, peaches, black sweet cherries, apricots, and prunes. This diversification permits a more continuous use of marketing facilities. The North Central area produces and markets over one-half of the state's commercial apple crop. Apples account for about 90 per cent of the tree fruit production in this area. Only a few of the apple handling and marketing organizations have the opportunity to increase utilization of fixed plant and equipment by marketing other tree fruit crops. In addition, few other commodities that permit diversified use of facilities are produced in the area (33, Bulletin 2464).

The Washington apple industry is primarily based on a fresh market product. One-third of the commercial fresh apples sold in the United States are produced in and shipped from the state. Eighty per cent or more of the state's annual crop is marketed as a fresh product. Of the total apples produced in the United States, over 40 per cent are processed into products such as applesauce, apple juice, and dehydrated apples. In Washington only that portion of the apple crop which will not meet the state's grade standards for fresh market shipment are processed into other products. Over the past 10 years an average of 15 per cent of the state's crop has

been processed. There is little indication of change in this distribution between fresh and processed products in Washington (21, p.5).

Two major adjustments have been occurring in the Washington apple industry during the early 1960's. The first adjustment is the increasing production of two apple varieties -- Red Delicious and Golden Delicious. In the past, other varieties such as Winesap, Jonathan, and Rome Beauty were major varieties. However, they have lost their predominant position and may decline as a proportion of the total major crop. The Red Delicious variety increased from an annual average of 8,000,000 bushels in the 1950's to 12,000,000 bushels in 1966, and it is projected to reach 18,000,000 bushels in 1970 (32, p.26). The Golden Delicious variety's average annual production in the 1950's was approximately 1,500,000 bushels. It increased to 6,000,000 bushels in 1966 and is projected to reach 10,000,000 bushels in 1970 (32, p.26). The North Central Washington area's volume of total apple production is projected to increase. The predominant increase is in the Red Delicious variety with slightly over 10,000,000 bushels projected for 1970 (32, p.26, 57, 66 and 77).

The second adjustment affecting the Washington apple industry is the extension of the market period. Technological developments in harvesting and storing of the two primary apple varieties have permitted the extension of the market to a 12-month period. The introduction of modified atmosphere (C.A.) refrigerated storage has made

a major contribution to this extension of the market season. There are currently 40,000,000 bushels of refrigerated storage capacity located in the apple producing areas of Washington. A large number of cold storage units has been constructed since 1959, with an addition of over 10,000,000 bushels in refrigerated storage capacity since that year (29, p. 1-8). During the same period the new technology of modified atmosphere (C.A.) refrigerated storage has been added. Washington had only 120,000 boxes of fresh apples in C.A. storage in 1959. In 1966, seven years later, 5,000,000 boxes of apples, or about 12 per cent of the state's apple crop, were in C.A. storage (31, p.185).

The prospective increase in total U.S. apple production is more than sufficient to match expected population growth. Per capita consumption of apples has been fairly constant since the early 1950's. Even with a small increase in per capita consumption over the next few years, the prospective increase in apple production will be large enough to intensify the problem of finding adequate market outlets for the fruit, especially in years of large crops. For Washington apples the problem may be more serious than in most other states because of the likelihood of sharper relative increases in production (27, p.3).

Fresh apples from Washington are marketed in most states of the nation, and nearly five per cent of the state's crop is marketed in foreign countries. Chart 1 shows the distribution of the Washington fresh apple crop during the 1960-1964 period (30, p. 1-19). Most

AVERAGE PER CENT OF WASHINGTON FRESH APPLE DISTRIBUTION BY STATES^a

1960 Through 1964

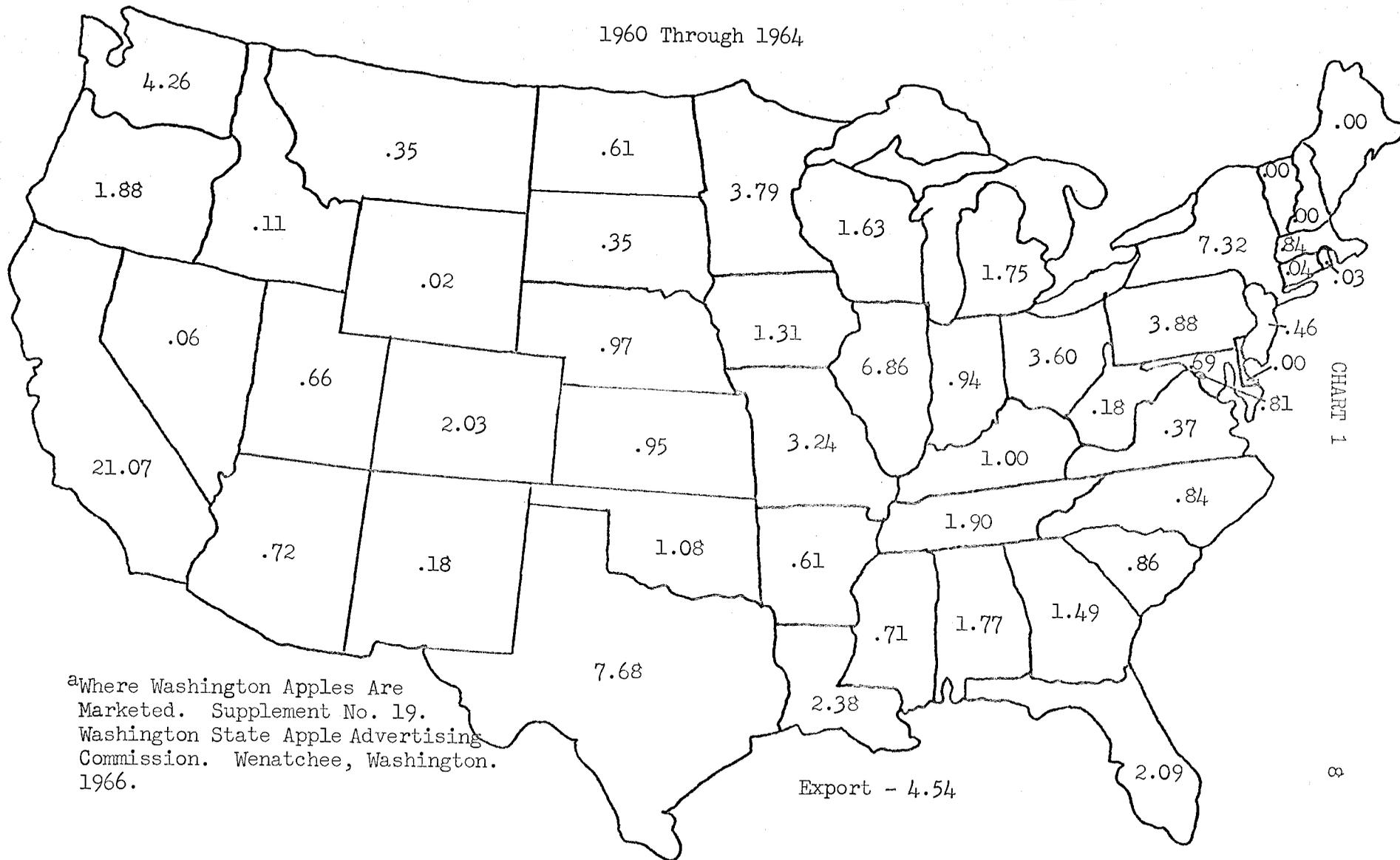


CHART 1

^aWhere Washington Apples Are Marketed. Supplement No. 19. Washington State Apple Advertising Commission. Wenatchee, Washington. 1966.

Washington apples are shipped to market in a standard container consisting of a fiber box with either fiber or plastic trays and containing 42 pounds of fruit. During the 1965 shipping season an industry sampling of 12,000 carloads (840 boxes with 42 pounds of apples per box in an average carload) of apples shipped from North Central Washington showed 90 per cent of the shipments were made in the standard fiber cartons. The remaining 10 per cent was made up of several miscellaneous packages including cell dividers in fiber cartons, bagged apples in fiber cartons, and smaller packages.

In the North Central Washington area, where apples are the predominant crop to be marketed, there are 117 packing and storage plants. The 43 largest plants handle approximately 80 per cent of all the apples produced in this area (see Table 1). Many packing plants have increased their storage capacity in the past five years. The two larger groups account for most of this increase. Twenty-six of the 43 larger packing plants are cooperative units. These cooperative associations handle approximately 60 per cent of all the apples in North Central Washington (29, p. 1-8).

Including the recent additions to apple packing plants in North Central Washington, the total capacity is currently just adequate to handle the crops produced in 1965 and 1966. With increasing crop potentials, any alternative which provides opportunity to use packing plant facilities at larger volumes with greater efficiency should be analyzed. The new technology of presorting and presizing offers the possibility of improving the efficiency of plant handling of apples in the grading, sizing, packaging, and storage functions.

TABLE 1

NUMBER AND STORAGE CAPACITY^a OF APPLE PACKING
PLANTS IN NORTH CENTRAL WASHINGTON^b

Storage Capacity (thousand boxes)	Number of Plants	Total Storage Capacity (thousand boxes)
49 or less	34	666
50 to 99	23	1,711
100 to 199	17	2,347
200 to 299	19	4,300
300 or more	24	11,795
Total	117	20,819

^aCapacity measured in packed boxes of 42 pounds of apples.

^bJune 1966, records of the Washington Growers' Clearing House Association, Inc., Wenatchee, Washington.

Definition of Terms

In an effort to avoid repetition and provide for common understanding between the reader and author, some frequently used terms are defined. It will become evident that the meanings of some of these terms are somewhat unique to the apple industry.

Apple packing and storage plants are multiphased business units in the sense that each plant usually performs several operations. The more common operations include receiving field-run apples from orchards and placing them in storage, packing for market by processing over an apple packing line, market season storage, selling, loading for shipment to market, and general administrative functions (14, p. 6-9). Many plants perform other functions such as orchard

supply handling, and professional advisory services. The term "plant" is used in referring to this general business unit.

An apple packing line is a continuous process involving several functions. Generally these functions include bringing apples from storage, dumping from field containers for introduction onto the line, trash and small apple elimination, washing, treating, polishing, sorting into two or three grades, exact sizing, placing in shipping containers, marking and weighing filled containers, lidding, and returning to storage (12, p.5 for complete diagram). In the process cull apples are eliminated from the line and returned to storage for shipping to by-product plants. The term "packing line" is used in referring to this process or plant phase.

Two technologies or groupings of techniques for performing the normal functions of the packing line are to be compared. The first grouping of techniques will be referred to as the "standard technology". This is represented by a sample of packing lines as these lines presently perform this marketing function. The second or alternative technology, referred to as the "new technology", includes presorting (grading) and presizing field-run apples before they are introduced into the packing line. The basic difference in the two technologies is the nature of the product (apples) introduced into the process. In the standard technology only field-run apples are introduced into the packing line. In the new technology a new process is introduced. The 50 per cent of the field-run apples with the lowest market quality of grades and sizes are presorted with

five per cent error and presized into four size groups. Presorted and presized apples are returned to bulk bin containers and then to storage. Apples introduced into the packing line in an operating season consist of the 50 per cent of the field-run apples of the highest quality and the 50 per cent presorted and presized.

The annual period of operation for the packing line will be referred to as a "season". The total volume of product from a crop year to be processed and the rate of product output determine the season of operation.

Direct operating inputs are the sources of costs to be compared. These are referred to as "operating inputs" and include machinery and equipment (durables) and labor, utilities, and consumed supplies (variables). Operating inputs do not include products (apples) that are being processed.

The Problem

Typical of many fresh food items sold in national markets, the cost of marketing fresh apples is closely related to production costs and producer prices. Table 2 illustrates the grower price and marketing margins by major category for Washington Delicious apples in two major markets. The table illustrates that production-point marketing margins or costs of packing, storage, and selling accounted for 23 to 27 per cent of the total margin for the period 1956 through 1960 in the two markets. Packing and storage margins accounted for 17 to 22 per cent of the total retail price of apples in the same period.

TABLE 2

WASHINGTON DELICIOUS APPLES: PRICES AND MARKETING
MARGINS TO CHICAGO AND NEW YORK MARKETS PER CARTON^a
BY SEASONS^b

Item	1956-57	1957-58	1958-59	1959-60	1960-61
	<u>Chicago</u>				
Grower Price	<u>3.28</u>	<u>.77</u>	<u>1.23</u>	<u>1.95</u>	<u>2.84</u>
Marketing Margins					
Packing	1.34	1.34	1.35	1.40	1.40
Storage	.32	.32	.32	.31	.31
Transportation	.90	.98	.91	.90	.91
Terminal charges	.21	.16	.19	.21	.23
Wholesale-retail	<u>3.54</u>	<u>4.14</u>	<u>3.74</u>	<u>4.24</u>	<u>3.57</u>
Total Margin	<u>6.31</u>	<u>6.94</u>	<u>6.51</u>	<u>7.06</u>	<u>6.42</u>
Retail Price	<u>9.59</u>	<u>7.71</u>	<u>7.74</u>	<u>9.01</u>	<u>9.26</u>
	<u>New York</u>				
Grower Price	<u>3.20</u>	<u>.92</u>	<u>1.35</u>	<u>2.16</u>	<u>2.35</u>
Marketing Margins					
Packing	1.34	1.34	1.35	1.39	1.39
Storage	.32	.32	.32	.32	.32
Transportation	1.06	1.15	1.12	1.12	1.12
Terminal Charges	.21	.17	.24	.26	.27
Wholesale-retail	<u>3.10</u>	<u>3.65</u>	<u>3.12</u>	<u>3.68</u>	<u>4.20</u>
Total Margin	<u>6.03</u>	<u>6.63</u>	<u>6.15</u>	<u>6.77</u>	<u>7.30</u>
Retail Price	<u>9.23</u>	<u>7.55</u>	<u>7.50</u>	<u>8.93</u>	<u>9.65</u>

^aFiberboard carton, gross weight 46 pounds, net weight 42 pounds.

^bVictor G. Edman, Agricultural Economist, Marketing Economics Division, Economic Research Service, USDA, Prices and Marketing Margins for Washington Delicious Apples Sold in Chicago and New York City 1956-61, Marketing Research Report No. 586, February 1963, p. 4-5.

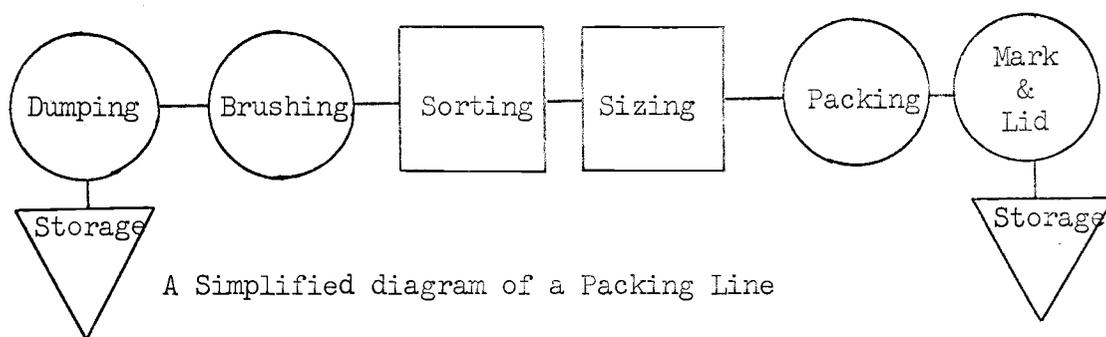
These costs associated with plant operation are substantial, and they are one part of the marketing margin over which apple producers have some direct control through their cooperative plants or selection of a private plant to handle their crop.

Another approach to estimating the size of apple packing and storage margins can be made through the price reports of the Statistical Reporting Service of the United States Department of Agriculture. This agency compiles annual packing-house-door prices (net prices to the grower) and FOB prices. The difference between these two prices represents the cost of packing, storage, and selling. During the last several years this difference has been \$2.00 per 48-pound box. For Washington's 42-pound box this 48-pound cost differential of \$2.00 reduces to \$1.75. This production-point marketing margin is comparable to the margins illustrated in Table 2.

These costs have shown a tendency to rise gradually since 1960. The report of the National Commission on Food Marketing indicates that Washington Delicious apples had a total marketing margin of \$8.04 per 42-pound carton in 1965 (28, p.48). This total marketing margin is compared to an average in the New York and Chicago markets of \$6.91 in 1959-60 and \$6.86 in 1960-61. Production-point market costs (including packing, storing, and selling) were compiled by the Washington Growers' Clearing House Association from industry records in the North Central Washington area for the 1965 crop year. The total production-point marketing margin of \$1.85 per 42-pound carton was up substantially from the \$1.71 in 1959-61.

As stated earlier, the specific purpose of this study is to compare the relative efficiency of two alternative technologies and to derive cost estimates for the particular phase of plant operation involving these technologies. The scope of the study is limited to the operations of grading, sizing, and packaging fresh apples. This is only one phase of a multiphased operation performed by apple plants at the point of production in the fresh apple industry of North Central Washington.

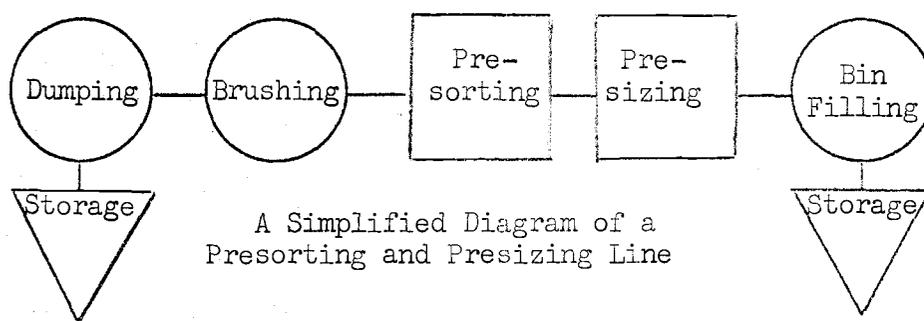
The standard technology is the current procedure used by the fresh apple industry in Washington. The following highly simplified diagram of a packing line illustrates the integrated continuous nature of this operation.²



The new technology introduces a new process in the form of presorting and presizing. The development of equipment and procedure to provide the commercial capability of performing the new technology has been the subject of research for at least ten years.

²See Appendix 1, page 57, for a description of symbols used in the diagram.

Prototype equipment capable of processing commercial volumes of apples without affecting product quality has been constructed and laboratory tested. The following diagram illustrates the additional process of presorting and presizing that would be added to the standard technology. The integration of the two would create the new technology.



The costs to be compared are limited to those costs of the one phase of market preparation that may be affected by the new technology. These are not the total costs of grading, sizing, and packaging fresh apples. Other costs of marketing not affected by this new technology, such as direct per unit cost of materials that are included in the finished product and piece-rate packing costs as well as allocated costs of land, buildings, and administration, could be added to these costs for estimating total per unit costs of output.

The new technology of presorting and presizing the input product could result in an improved rate of output for the packing line. Increased output per unit of time with relatively little change in

continuous line input costs would result in reduced costs per unit of output. It is essential to estimate these potential cost savings as well as to estimate the added cost of performing presorting and pre-sizing operations to compare relative costs.

However, cost reduction or savings per unit of output in this specific phase of marketing fresh apples is not assumed to be the primary advantage of this new technology. Improved flexibility in merchandising and potential cost savings in other phases of the marketing process are assumed to be the major values of this new technology. Saving of storage space and the improvement of efficiency in future prepackaging operations are other possible values of the application of the new technology. However, estimates of the values of these benefits are beyond the scope of this study.

CHAPTER II

METHODOLOGICAL FRAMEWORK

Theoretical Framework and Past Research

Cost and efficiency studies of processing plants are based on elaborations and modifications of the conventional economic theory of production. The kind of elaborations that may be needed are suggested by an examination of the way particular plants are operated. Apple plants integrate several operating phases. Uncontrollable and partially controllable institutional factors place limits on the operation of the plant and its various phases.

The problem of measuring and comparing costs may be approached in a number of different ways. The most appropriate method will depend upon the specific objectives of the study and upon the resources available for carrying out the research. If the objectives are broad and the resources limited, careful analysis of average costs based on accounting records may give a useful approximation of economies of scale and variations in relative efficiency among plants. On the other hand, the development of improved methods of performing particular operations or operational phases within a plant may require a more detailed analysis.

French, Sammet, and Bressler (13, p. 543-592) have developed a methodology for an economic-engineering approach to the study of costs and efficiency within agricultural processing plants. This paper

provides a theoretical framework for such studies based on elaborations and modifications of the conventional economic theory of production. The discussion of the nature of plant operations suggests a need for four important modifications or elaborations of the conventional economic theory of production. These modifications stress the time dimension in output variation, plant segmentation involving the use of many identical machines, continuous variation in rates of output, and multiple-stage plants.

Most economic studies of apple plants have been directed toward establishing the economies of size in these plants. Accounting records are the major source of data for developing economic models to determine relative economies of plant size. Size is usually measured by the capacity of the storage and packing facilities to handle apples.

These studies of economies of size in apple plants have consistently shown that the average overall cost per unit of product handled declined until the seasonal output capacity reached approximately 400,000 boxes of apples (12, p.4; 17, p.9; 22, p.43). There is some indication of possible additional economies of plant size at volumes higher than 400,000 boxes, but this has not been well established, and indications are that costs do not decline as rapidly above this quantity. There have been few plants with annual volumes above 400,000 boxes to provide a basis for measured comparison.

Hunter, Kefer, and Meyer (16, p. 3-6) studied the sorting table as a part of the packing line. Their interest was largely in

evaluating different types of sorting tables in relation to the productivity rate. They state that the major factors influencing the rate of flow of apples over the sorting table were (1) type of sorting table, (2) quality of fruit, (3) size of fruit, (4) physical capacity of workers, and (5) management factors. Two other factors were mentioned, namely, the number of grades into which the apples were sorted and the ease with which the apples may be visually inspected. They report a marked decrease in volume of apples handled as the percentage of apples unsuitable for the fresh pack increased in the field-run input.

Franklin (11, p.94-95), in an analysis of records from ten packing plants in Central Washington for the 1964 crop season, came to the following conclusions:

1. The variation in rate of flow from lot to lot of apples within a packing house is great. The fact that such variance occurs suggests the possibility of discovering those conditions which make for more rapid operation together with lower per unit costs. Most of the packing lines included in this study can operate more than one-third faster if they operate near the upper range of what the report showed to be possible.
2. The packing lines operate at a definitely slower rate when the Golden Delicious variety is being packed than when the other varieties are being handled. Data were insufficient to indicate whether differences in packing rate in other varieties were great enough to be significant.

3. Although there were some apparent exceptions, small apple size generally reduced the rate of flow of apples over the packing line. The degree of change and rate of flow as the size of apples change varies greatly among packing lines.
4. The response of packing lines to change in percentage of low grade fruit is inconsistent. In some cases increasing the percentage of low grade fruit reduces the rate of flow (measured in boxes of input), and in others an increase in the proportion of low grade fruit results in faster operation.
5. The proportions of extra fancy versus fancy grades of fruit may influence rate of operation on some lines.
6. Additionally important and perhaps unknown variables are apparently affecting the rate of flow over the apple packing lines.
7. It appears that the dissimilarities between packing lines are too great to permit generalization with respect to the specific relationships between rate of flow and the determinants of rate of flow.

This analysis compares the relative costs of packing lines with the application of the two technologies. Average operating input costs per unit of output are used as a basis for cost comparisons. Records that permit cost measurement of this specific phase of plant operation are not available. It is, therefore, essential to estimate costs associated with the two technologies as accurately as possible.

Since the new technology adds a new process as an adjunct to the standard technology, effects of the new process on the operating efficiency of the standard technology are analyzed and included in the cost estimates. Operating cost differences of the two technologies are compared on individual packing lines to measure possible differences among packing lines. The average cost difference of the representative sample of four packing lines is used as a measure of the cost difference for large plants.

To reduce the number of variations to be considered to manageable proportions, the following assumptions are used:

1. Operating procedures on packing lines are represented by the 1965-1966 operating season and will be used as standard procedures for future seasons.
2. It is assumed that variations in quality factors of grades and sizes of the input product in future seasons will be similar to those observed during the 1965-1966 season.
3. Any future changes in costs of operating inputs will be relatively proportional so that the percentage of total operating input cost of any major cost factor such as machinery, labor, or utilities will be the same as the percentage measured in the 1965-1966 season.
4. One plant size is used -- a total seasonal capacity of 400,000 boxes of field-run apples. However, two additional levels of total annual volume are introduced to represent variations in seasons.

Description of Methodology Used in This Study

Detailed descriptions in the form of process flow charts and cost data were prepared for four different packing lines (1, p. 40-73; 12, p. 592-599). This economic-engineering approach was taken in order to observe and record the functional phases that constitute a standard method of packing line operation. Recording performance data in detail by function and accumulating costs by function permitted more precise information on operating technologies and costs of operating packing lines.

Determining costs by function within the packing line permitted the integration of some of these functions into the alternative operating procedures with the new technology. Observation and measurement of operating capacity by function aided in providing a more reliable interpretation of statistical analysis of relationships between quality of input product and rate of output. Current accounting methods used by plants in North Central Washington do not provide cost data which would permit establishing the cost of packaging apples on individual lines with measurable operating time and product output comparisons. Research data that would provide this type of cost information were not available.

From records of each plant, standard shifts (time periods) of operation were established. Operating shifts used were those in which each line processed Red Delicious apples for a full eight-hour shift with no recorded interruptions. The output data for each of these standard operating shifts included total packed boxes and packed boxes

by grade, size, loose boxes of small apples, and cull apples. The volume of total packed boxes of apples produced in an eight-hour operating shift is the basic unit of operation.³

Equipment description and functional use was obtained and recorded by personal observation and from interviews with operating personnel in each plant. Equipment costs are based on 1965 replacement costs, including delivery and installation, and were provided by equipment manufacturers or their representatives. The costs of presorting and presizing equipment currently in the prototype state of manufacture were estimated by builders of the prototype equipment (4, p. 3-14).

Labor requirements and costs were obtained for the observed standard operating shifts. Data were obtained from interviews with supervisory personnel and from plant records. Labor costs were based on 1965 season wages and salaries, social security and industrial insurance, and medical and accident insurance. Labor use and costs for that portion of the new technology involving presorting and presizing are estimates based on similar functions in standard packing lines.

Quantities and costs of consumed supplies and utilities were obtained from plant records and from average-use estimates provided by suppliers. Consumed supplies are materials used in the operation

³The basic eight-hour day is actually 7.5 hours of operating time with two 15-minute "breaks for coffee" and a lunch hour in the middle of the eight-hour period. The entire operation stops during the break periods and the lunch period.

of a packing line and not an identified part of the output product. Examples of consumed supplies are lubricating oil, fungicidal chemicals, coffee, and disposable cups.

Fire and property damage insurance costs are median averages of premium rates based on values as estimated by insurance companies. Property taxes are also median averages for the area obtained from county assessors.

Cost of capital is represented by a six per cent interest rate applied to the total operating input costs. This is a median rate based on interviews with management of financial institutions that provide both long-term investment and short-term operating capital for these plants.

Costs of land, buildings, and general administration were not included in the analysis. The two technologies do not significantly affect these costs. Most plants have adequate land or building space for application of the new technology. Plants without adequate land or buildings would need to consider these as additional requirements in their specific situation. Direct per unit costs of output, such as cost of packaging materials and piece rate per unit of packing, were not included. These costs would not be affected by the application of either technique.

A judgment sample of four packing lines was used for two reasons: (1) These four packing lines represent the major differences in techniques applied in this phase of plant operation. The major differences in equipment used in standard packing lines are: one or two

sorting tables per line, size and capacity of sizing unit, size of packing tubs, and optional capacity for removing small size fruits.

(2) Time required to perform detailed economic-engineering analysis and input-output analysis for each line limited the number of lines that could be studied.

The judgment sample was selected on the basis of representative plants with seasonal capacities of 250,000 boxes or more. Thirty plants with volumes of 250,000 boxes or more were visited to observe packing line functions.

Average costs of operating a packing line for an eight-hour shift were calculated. Average costs per unit of output (packed box with 42 pounds of apples) were derived by relating the number of boxes of output and the average cost of line operation for a standard eight-hour shift. Variations in the average cost per unit of output in standard operating shifts on a given line are the result of variations in rate of output and total seasonal output.

Grades and sizes of apples as related to rate of output were statistically analyzed. Correlation coefficients of percentage change in cull grade plus fancy grade and rate of output were determined for each packing line and for the four lines combined. Correlation coefficients for size indexes and rate of output for each line and for the combined lines were also determined. Multiple correlation coefficients relating the percentage of the two grades and size indexes to rate of output were calculated. The percentage of the cull grade is based upon input volume, since culls are removed in the process. The

percentage of the fancy grade is based on output volume, since this grade is a portion of the output. The size index was a weighted average number of apples required to make up each unit of output.

The presorting and presizing function added to the standard packing line would change the input product. Analysis of statistical relationships between the quality and sizes of fruit and the rate of output, along with recorded observations of packing line operation by functional stages, were used to determine possible improved efficiency. On the basis of these measurements, estimated efficiencies were introduced into the standard packing line in calculating cost relationships for the two technologies.

In all industry plants a limiting factor on packing line operation is the total volume of product available for processing in a given season. Plant storage capacity also limits the total volume of product processed. Uncontrollable weather conditions in a growing season cause unpredictable variations in the total seasonal volume. As a basis for economic model building, a standard plant input volume of 400,000 boxes (35 pounds of fruit per box) was used. This is equivalent to 16,471 pallet bins, each containing 850 pounds of apples. All apples are harvested in bins; however, in plant records volume in bins is converted to loose field box equivalents (35 pounds of fruit per box). This unit of input is used in recording input volumes and is also used to record culls or processing grade output on packing lines.

Variable volumes of raw product input represent unpredictable variations caused by seasonal growing conditions. Volumes of 300,000

boxes and 500,000 boxes are introduced into the economic models to allow for cost differences caused by these fluxuations (32, p.29). Variations in rates of output per standard eight-hour shift are due to relative efficiencies of the two technologies. Differences in average costs per unit of output among models are due to variations in both rate of output per standard shift and in length of seasonal operation.

CHAPTER III

EMPIRICAL RESULTS

Costs Associated with the Standard Technology

Process charts and cost data were developed and used in combination with packing line operating records to develop operating and cost models for each of the four lines (see Appendix 1 for an example of the analysis used on each packing line). Average costs of operating inputs per unit of output were used as a basis for comparison. Table 3 is an example of one operating and cost model for a standard packing line.

Seasonal output volume (280,000 boxes in Table 3) is derived by applying an apple industry input-output conversion ratio of 70 per cent of the input to output. In the example in Table 3, an average of 15 per cent of the input of 400,000 boxes were culls. One per cent of the input was eliminated small apples. The remaining 336,000 boxes of field-run apples with 35 pounds of apples each were packaged for the fresh market. This volume is then packaged in 42-pound units of output product. The conversion resulted in 280,000 boxes of output (42-pound boxes).

The operating and cost models were developed by accumulating costs of operation for each function of the packing line. These functional costs were derived from the process charts and cost data records (Appendix 1). The cost accumulation and summary for each

OPERATING & COST MODEL - FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 1Input¹ 400,000 Output² 280,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output ⁸	AC Unit ⁹
1. Dumping	\$1,528.67	137	\$11.16	\$ 46.71	\$ 57.87	2042	\$.028
2. Brushing	599.79	137	4.38	7.69	12.07	2042	.006
3. Sorting	431.99	137	3.15	147.18	150.33	2042	.074
4. Sizing	730.81	137	5.33	8.19	13.52	2042	.007
5. Packing	781.90	137	5.71	43.38	49.09	2042	.024
6. Lidding	1,168.71	137	8.53	32.87	41.40	2042	.020
Total	\$5,241.87		\$38.26	\$286.02	\$324.28		\$.159

¹Field-run boxes with 35 pounds of apples.

²Packed boxes with 42 pounds of apples.

³Season Fixed Costs of machinery and equipment.

⁴Standard 8-hour operating shifts required to process assumed input volume.

⁵Average Season Fixed Costs per 8-hour operating shift.

⁶Season Variable Costs of labor, utilities, and consumed supplies.

⁷Total Costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs.

⁸Average Output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios.

⁹Average Costs per unit of output.

operating function includes seasonal fixed costs of equipment and machinery and seasonal variable costs of labor, utilities, and consumed supplies. Seasonal fixed costs for each function were divided by the number of operating shifts required to process a given seasonal output (280,000 boxes in the example) with an average rate of output for the packing line (2,042 boxes in the example) to calculate an average seasonal fixed cost for a standard shift. Seasonal variable costs were assumed to be fixed for each shift since the operating inputs would not usually be changed during this short period. The average seasonal fixed cost for each operating shift plus the average seasonal variable cost for each operation shift results in the total operating input cost for each function for each operating shift. This operating input cost divided by the average output for a shift results in an average cost for each unit of output. Average costs for each unit of output for all functions were added to obtain an average packing line operating input cost per unit of output.

Twelve operating and cost models were developed, three models for each of the four packing lines (Appendix 2). Each of the three models for a packing line represents a different volume of total seasonal product output, 210,000 boxes; 280,000 boxes; and 350,000 boxes.

Each packing line integrated variable combinations of operating inputs to perform similar functions. A great deal of variation existed in rates of output among lines (Appendix 3). The highest average rate of output of 3,879 boxes per eight-hour shift is nearly

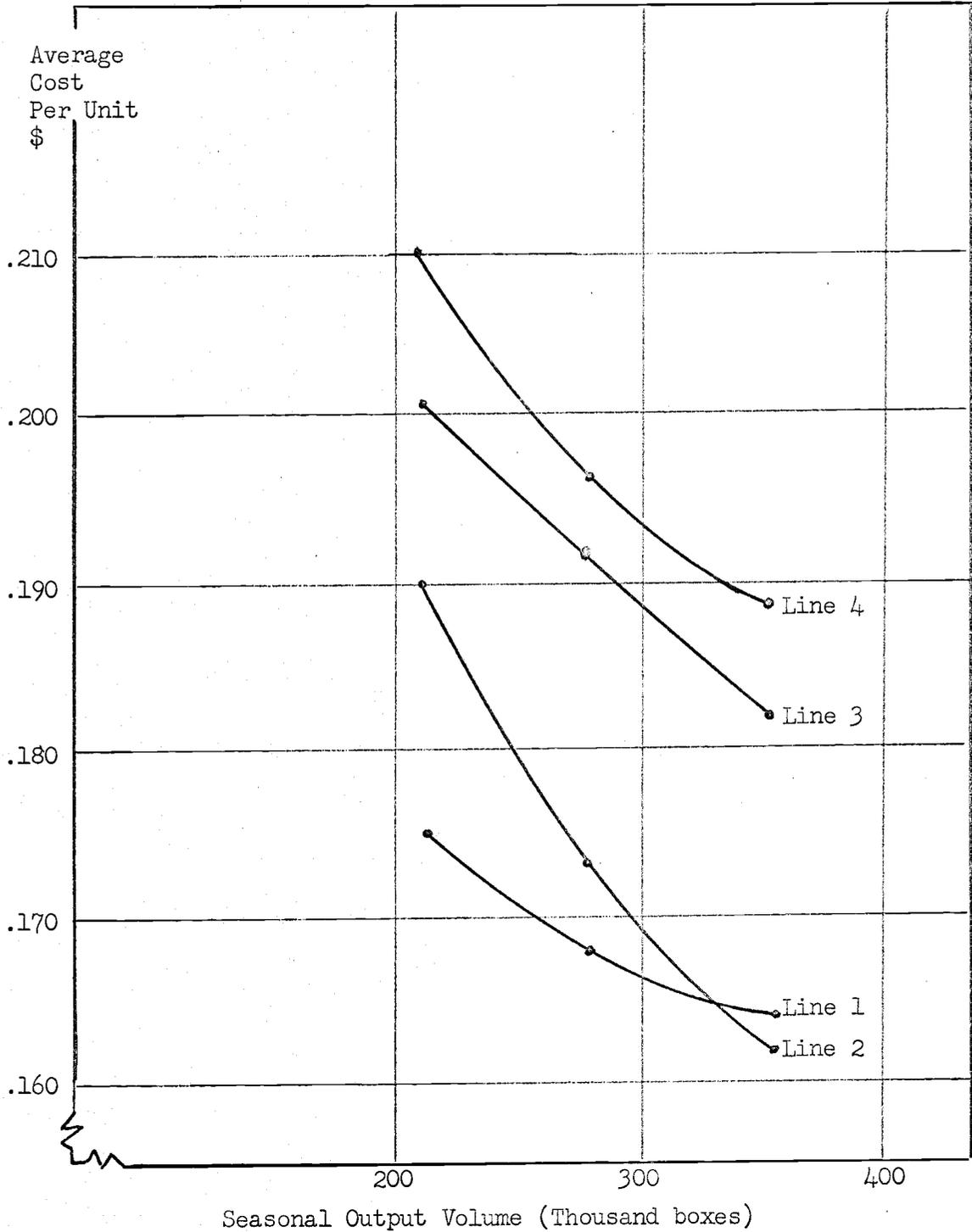
twice the lowest average rate of 2,042 boxes. With fixed volumes of seasonal output, average costs per unit of output did not vary proportionately with rates of output. Chart 2 summarizes the average costs per unit of output for the four lines.

Chart 2 shows declining average costs per unit of output with increasing seasonal output volume for each packing line. Average seasonal fixed costs for each unit of output decline because larger seasonal volumes increase the number of operating shifts. The rate of decline associated with increasing total seasonal output volume varies among packing lines. These variations are caused by differences in the proportion of total average operating input cost per shift related to average seasonal fixed costs per shift. For example, with an increase in seasonal output from 210,000 boxes to 350,000 boxes, packing line one had a decline in average operating input cost for each unit of output of \$.011 compared to \$.029 for packing line two. Average seasonal fixed cost per shift as a percentage of total operating input cost per shift at 280,000 box seasonal output is 12 per cent for packing line one and 30 per cent for packing line two.

Average operating input costs for each unit of output vary among the lines for the three seasonal output volumes. These different cost levels for each packing line illustrate differences in cost efficiency among the lines. Efficiency in this case is the relationship of total average operating input costs to the rate of output.

Most of the plants studied operate in the lower range of these seasonal volumes with between 300,000 and 400,000 boxes of seasonal

AVERAGE OPERATING INPUT COST PER UNIT OF OUTPUT RELATED
TO TOTAL SEASONAL VOLUME
STANDARD TECHNOLOGY



capacity. Due to the potential increase in production discussed in the first chapter, these plants could be near the higher assumed volume of 500,000 boxes in three to five years. This range in volume is also representative of likely interseasonal variations due to the effects of weather on apple set and growth.

Four lines were selected on a judgment basis as a sample representative of packing lines currently used by larger plants in the industry. Average costs per unit of output of the four lines are used as an industry average cost for the standard technology (Table 6).

Costs Associated with the New Technology

Costs of performing the presorting and presizing process were estimated by developing operating and cost models (Table 4). The basis for these models is process chart and cost data analysis similar to that used in analyzing standard packing lines. Equipment costs, however, are engineering estimates. Labor, utility, and supply requirements are estimates based on similar functions in standard packing lines. Labor, utility, and supply costs are the averages of the four standard lines where similar operations are performed (Appendix 1).

The new technology is based on presorting and presizing some proportion of the field-run apples prior to their introduction to the packing line. Presorting and presizing all of a 400,000-box seasonal input would result in an increased cost of \$.078 per box of output (Appendix 2). However, past research, as cited in Chapter II, reports some relationship between rate of packing line output

OPERATING & COST MODEL - FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Presorting and Presizing LineInput¹ 200,000 Output² 140,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output ⁸	AC Unit ⁹
1. Dumping	\$1,732.00	40	\$43.30	\$ 39.16	\$ 82.46	3500	\$.024
2. Brushing	1,246.00	40	31.15	4.89	36.04	3500	.010
3. Sorting	1,262.30	40	31.56	102.93	134.49	3500	.038
4. Sizing	1,543.50	40	38.59	17.87	56.46	3500	.016
5. Packing	1,761.00	40	44.02	12.68	56.70	3500	.016
Total	\$7,544.80		\$188.62	\$177.53	\$366.15		\$.105

¹Field-run boxes with 35 pounds of apples.

²Packed boxes with 42 pounds of apples.

³Season Fixed Costs of machinery and equipment.

⁴Standard 8-hour operating shifts required to process assumed input volume.

⁵Average Season Fixed Costs per 8-hour operating shift.

⁶Season Variable Costs of labor, utilities and consumed supplies assumed to be fixed costs per 8-hour operating shift.

⁷Total Costs of machinery, labor, utilities and used supplies per 8-hour operating shift -- operating inputs.

⁸Average Output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios.

⁹Average costs per unit of output.

and quality of the field-run input apples. Major quality factors related to packing line operation were identified in the process analysis (Appendix 1). Plant operating records for each standard operating shift, including major quality factors of per cent cull grade, per cent fancy grade, and apple size were recorded (Appendix 3). The relationship of these quality factors and rate of product output were statistically analyzed to determine if higher percentages of these lower grades and relatively smaller apples were related to lower rates of output. Statistical coefficients of determination and corresponding significance levels are recorded in Table 5 for each of the four packing lines. Coefficients of determination show the relative proportion of the variation in rate of output that can be explained by varying percentages of the two lower grades, apple sizes and the combination of the two quality factors. Each packing line shows some relationship between varying proportions of these quality factors and rate of output. Significance levels show the chance of error related to the application of each relationship. The multiple coefficient of determination for these two quality factors and rate of output for the combined lines is .466, and it is statistically significant at a level of 5 to 10 per cent. Regression coefficients are consistently negative for each quality factor and rate of product output on each packing line and the combined packing lines. These results suggest a relationship of increasing percentages of lower grades and proportions of small apples to reduced rates of

output. These statistical correlations indicate the "goodness of fit" of the relationships between the variables in a statistical sense, but they do not show causal relationships.

TABLE 5

COEFFICIENTS OF DETERMINATION AND SIGNIFICANCE LEVELS
OF APPLE QUALITY AND RATE OF OUTPUT

Packing Line	Correlation of % Culls Plus % Fancy to Rate of Output (r^2)	Sig. Level (t)	Correlation of Apple Size Index to Rate of Output (r^2)	Sig. Level (t)	Multiple Correlation of % Grades & Size Index to Output (R^2)	Sig. Level (F)
1	.445	1%	.021	5-10%	.465	1%
2	.041	5-10%	.477	1%	.510	1%
3	.282	1%	.237	1-5%	.419	1%
4	.563	1%	.540	1%	.706	1%

Process chart and operating record analysis (Appendix 3) showed a negative relationship between the percentage of low grades and smaller apples and rates of output. Direct supervisory personnel stated that two to four sorters were maintained on the packing line to improve the output of lower-quality batches of apples.

The operating capacity of the sorting function was the lowest of all functions on each of the four packing lines. Apples of the two lower grades were individually removed from the sorting table and placed in a different location in the sorting function. Increasing numbers of apples in these grades required sorters to change the

location of proportionally more apples. Proportionally smaller sized apples, with a constant percentage in each grade, required the relocation of increasing numbers of apples in order to maintain an equal rate of output (42-pound box). Analyses of operating records of the four packing lines (Appendix 3) show that in general the lower 50 per cent of rates of output are associated with higher percentages of the two lower grades and smaller apples. Process chart and operating record analyses indicate a causal relationship between higher proportions of the two lower grades and relatively smaller apples and lower rates of output.

Presorting and presizing would result in five per cent or less of the cull grade in the input product. It would result in more uniform batches of other grades and sizes for processing on a packing line. Processing of the fancy grade with a small percentage, five per cent or less, of the first grade (extra fancy) would be changed in the sorting function so that individual apples in the first grade would be relocated instead of apples of the fancy grade. The resulting input product for a packing line would be more uniform in proportion of apple grades and sizes than any input product found in the operating records of the four lines. The percentage of apple grades that required relocation by individual apple in the sorting function would be less than those found in any input product of the four packing lines. With these changes of the input product, which are beyond the range of operating records of the four packing lines, it is not possible to predict the precise effect on rate of output of a packing line.

Based on these analyses, it is assumed that presorting and presizing the portion of the total seasonal volume equivalent to 50 per cent of the output would increase all four packing lines' average seasonal rates of product output. An additional assumption is that the 50 per cent of the volume presorted and presized would be that portion with the lowest quality. It is also assumed that this presorting and presizing operation would result in the average rate of output per shift becoming equal to the average of the higher 50 per cent of measured operating records.

A standard packing line operation following presorting and presizing of the input product should become more efficient as a result of the greater uniformity of the input product. In addition to increasing the average rate of output per shift, as discussed in the previous paragraphs, efficiencies in the sorting function, allocated maintenance costs, and allocated direct supervision costs are included in the analysis (Appendix 1). Two sorters (labor) are eliminated from each line since they were maintained under the standard technology to aid in improving the flow of lower quality apples. The proportion of allocated maintenance and direct supervision costs required for the presorting and presizing function were deleted from standard line costs since these operations can be performed by the same personnel using the same equipment as originally included in the standard technology.

Cost Comparison of Two Technologies

Operating and cost models were developed for each line (see Appendix 2 for samples of cost models of each line for both the standard technology and the new technology). These models provide the average cost per unit of output of the new technology for comparison with average costs of the standard technology for each line (Table 6). Average costs per unit of output for the four lines are used to represent an industry average in Table 6.

Average costs per unit of output for packing line operation would be increased by an average of 13 per cent by adopting the new technology. This is an average increase of the four lines with three input volumes (Table 6). The range in average increase in costs for the three levels of seasonal output volume would be from 11 per cent for the highest volume to 16 per cent for the lowest volume. Increase in the production-point marketing margin of \$1.84 (31, p. 103-106) per unit of output would be about one per cent.

The packing lines vary in their response to the new technology. The average operating input costs for the two technologies on each packing line for the three seasonal output volumes are shown in Chart 3. Additional costs associated with the application of the new technology are the least for packing line four and the most for packing line two. These differences in average cost increases for each seasonal output volume are inverse relationships caused by differences in the rate of product output associated with the new technology. Packing line four had an increase of 15 per cent in

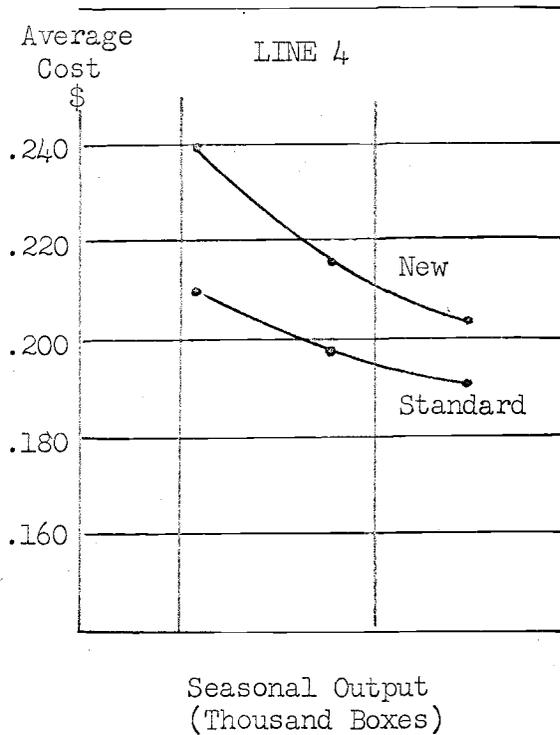
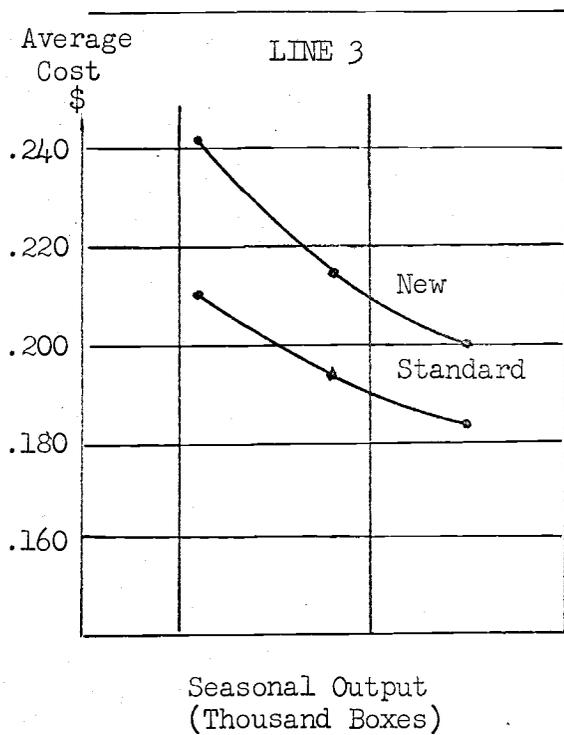
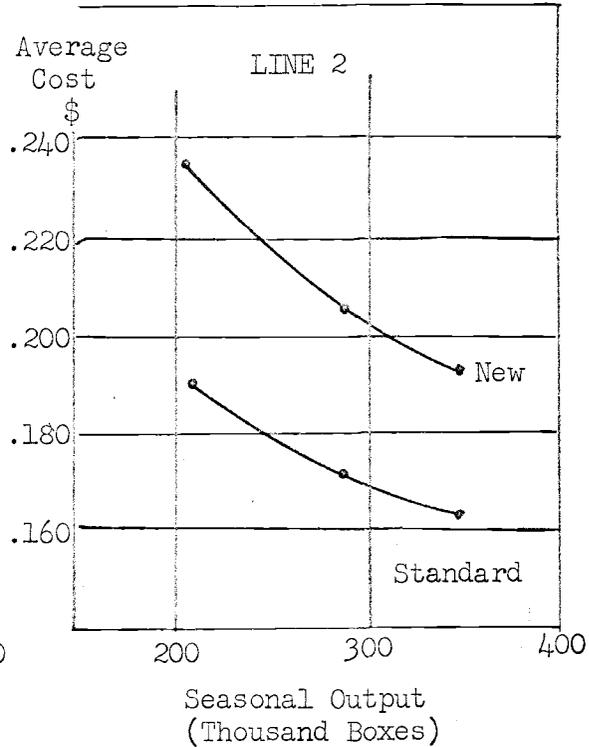
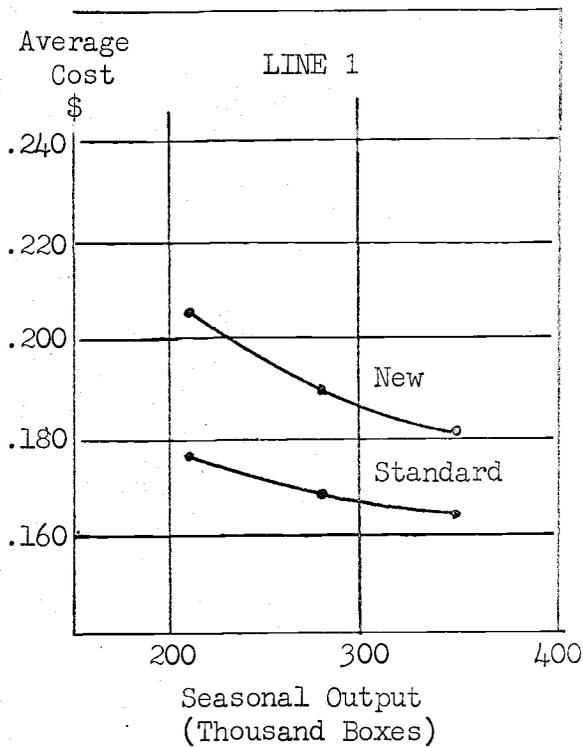
COMPARATIVE COSTS OF THE TWO TECHNOLOGIES
(AVERAGE COST PER UNIT OF OUTPUT)

Output Volume (42-pound boxes)	Packing Line	Standard Technology	Standard Technology	Difference
350,000	1	\$.164	\$.180	+ \$.016
	2	.162	.192	+ .030
	3	.182	.198	+ .016
	4	.189	.202	+ .013
	Average	\$.174	\$.193	+ \$.019
280,000	1	\$.168	\$.188	+ \$.020
	2	.173	.208	+ .035
	3	.192	.213	+ .021
	4	.197	.215	+ .018
	Average	\$.183	\$.206	+ \$.024
210,000	1	\$.175	\$.205	+ \$.030
	2	.190	.235	+ .045
	3	.209	.240	+ .031
	4	.210	.238	+ .028
	Average	\$.196	\$.230	+ \$.034

rate of output associated with the application of the new technology and the lowest average cost increase for the four packing lines.

Packing line two had an increase of 9 per cent in rate of output and the highest average cost increase. Packing lines one and three had average rate of output increases of 12 per cent and 14 per cent with proportionate inverse average cost increases.

COMPARATIVE COSTS OF THE TWO TECHNOLOGIES
FOR EACH PACKING LINE
(AVERAGE COST PER UNIT OF OUTPUT)



Cost differences between the two technologies increased as the seasonal output volume decreased for each packing line. This is caused by different proportions of average seasonal fixed costs per shift and total average costs per shift. This is the same relationship as that discussed previously under costs associated with the standard technology. Operating and cost models for presorting and presizing (Appendix 2) show that the proportion of average seasonal fixed costs as a part of total average input costs is greater than any packing line. As seasonal output volume declines, fewer operating shifts cause a more rapid increase in average seasonal fixed costs per shift for presorting and presizing as compared to the standard technology.

CHAPTER IV

SUMMARY AND MARKET ORIENTATION

The additional cost of operating inputs associated with use of the new technology is approximately \$.025 for each 42-pound box of fresh market apple output of representative packing lines. This additional cost is only 1.33 per cent of the \$1.84 (31, p. 103-106) production-point marketing margin.

The range of additional costs associated with the new technology is from \$.015 to \$.045 per unit of output. This range is due to the relative operating efficiencies of different packing lines and total seasonal volume of product output. This range varies from 1.0 per cent to 2.5 per cent of the \$1.84 production-point marketing margin.

Although they are relatively small, there are additional costs associated with the application of the new technology. If the value of the new technology is confined to the packing line phase of plant operations, it is not as economically efficient as the standard technology. However, as stated in the description of the problem, the greatest values of the new technology would likely come in other phases of marketing, including the greater selectivity of grades, size groups, and packaging methods during the twelve-month marketing season, and savings in storage space.

The author knows of no research reference or apple industry analysis indicating the benefits that could be derived from greater

selectivity during the market season. However, interviews with major selling organization leaders at the point of production indicate their strong feeling regarding this possibility. Industry representatives state that in view of the increased trend to consumer packaging, packing on order of the buyer, and the continuing trend toward mixed-car shipments, it would appear desirable to presort and presize some apples. These representatives state that the present standard packaging and grading lines require packaging large volumes of certain grades and sizes. In many instances the type of container desired by the market is not known at the time the fruit is placed on the continuous packing line. As the market season progresses there are opportunities to sell selected grades and sizes in different types of containers which are not available at the time. This lack of flexibility in packaging has in the past caused the loss of sales which would have been to the advantage of the fruit producer and his marketing organization.

Presorting and presizing of apples that are returned to storage in bins offers an opportunity to save storage space and therefore costs of storage. Approximately 20 per cent more fruit by weight can be stored in the same storage space in bins as compared to storing in finished packed boxes placed on pallets (14, p. iv summary). This offers an efficiency in use of present refrigerated storage space. A plant confronted with increasing seasonal volume and fixed storage capacity would likely find cost savings as the result of the application of this new technology. For example, a plant with 300,000 box

storage capacity and a potential for increase to 400,000 boxes of seasonal volume must examine the need for new storage capacity. Refrigerated apple storages have been constructed and operated for an annual cost of \$.26 (31, p. 103-106) per 42-pound box of apples. A new 100,000 box storage would result in an annual average cost of \$26,000. Construction of a new 100,000 box storage is one alternative. A second alternative is to presort and presize 50 per cent of the input volume which would result in an average of 15 per cent of 200,000 boxes or 30,000 boxes of the cull grade which could be diverted directly to processing. A 20 per cent saving in storage space requirement for the remaining 170,000 boxes of presorted and presized apples would increase capacity of the storage by 34,000 boxes. Additional costs per unit of output of \$.025 per box on 280,000 packed boxes due to the application of the new technology would result in \$7,000 increase in total plant costs. New storage requirements would be reduced to a 36,000 box capacity. The annual average cost for new storage (36,000 x \$.26) would be \$8,160. The total annual average cost for the second alternative is \$15,160 compared to \$26,000 for the first alternative, or an annual saving of \$10,840.

An increasing proportion of the Washington apple crop is placed in modified atmosphere (C.A.) refrigerated storage. Red Delicious apples are stored as field-run fruit in bulk bins in C.A. storage. Presorting would permit the removal of approximately 15 per cent of the normal crop which falls into the cull grade. This would increase the volume of higher value product that could be placed in C.A.

storage. C.A. storage costs are approximately \$.65 per box more than regular refrigerated storage.⁴ Placing the higher value product of both size groups and grades in C.A. storage would permit more efficient utilization of this kind of storage. For example, a plant with a 50,000-box C.A. storage capacity is placing an average of 7,500 boxes of the cull grade in the C.A. storage (15 per cent). At \$.65 per box this is a storage cost of \$4,875. The additional cost of \$.025 per box for applying the new technology would be \$1,250 for the 50,000 boxes in the C.A. storage. This represents a potential cost saving for plant operation of \$3,625 assuming the new technology is applied to a total seasonal volume of 400,000 boxes.

Research performed by John Powell Nicholes (19) on a specific storage operation in Michigan showed that the operator could have expected a net gain over variable costs of \$14,234 per year for the operating years of 1961, 1962, and 1963 from the adoption of a presorting and sizing system. This conclusion was based on an assumption that 80 per cent of the utility and cull grades were removed by the presorting and presizing function and that the cost of performing this operation was a variable cost of \$.08 per bushel. These results were based on analysis of one operating unit with a 100,000 bushel C.A. storage.

Presorting and presizing of apples could benefit the future market preparation of fresh apples where consumer packages of varying types are utilized. Summaries of packaging research work performed

⁴Based on reports of C.A. storage managers for the 1965 season.

by the Agricultural Marketing Service, United States Department of Agriculture (6, p.3; 10, p. 5-6) include observations that it appears economically feasible to prepackage high quality apples at point of shipment provided the additional expenses for packaging materials are kept at a minimum. A prepackager who planned to market substantial quantities of prepackaged apples would probably find it advantageous to use a separate bagging table with a battery of chutes attached in order to reduce his labor costs in the prepackaging operation. Use of a separate bagging table would require some sort of pregrading and presizing.

The above examples suggest that there are cost savings for total plant operation associated with the application of the new technology. Some major factors affecting the economic value of the new technology to each plant are: seasonal apple volume, relative efficiency of the two technologies, relative value of improved storage utilization, adjustment to consumer packaging, and new land and building space needed for its application. Additional packing line operating input costs associated with integrating this presorting and presizing operation into higher-volume apple packing plants are low enough to encourage its application.

This study suggests several areas for additional research relative to apple plant operations. Unidentified factors are associated with some of the variation in the rate of product output on the packing lines. The sorting function in packing line operation appears to be

the most limiting function relative to rate of product output. Additional research directed toward improving the rate of product output could result in improved economic efficiency in the packing line phase of plant operation. Additional research involving both the packaging phase and the storage phase of plant operation could result in more efficient combination of these two plant operations. Additional research directed toward measurement of the economic value of greater merchandising flexibility involving selectivity of apple grades, sizes, and kind of packaging could result in improved apple marketing and plant management. Extension of the marketing period in recent years suggests that research in this area could have increasing value to apple packing plants.

BIBLIOGRAPHY

1. Barnes, Ralph M. Motion and time study. London, John Wiley and Sons, 1958. 665 p.
2. Blanpied, G. D., E. D. Markwardt and C. D. Ludington. Harvesting, handling and packing apples. Ithaca, New York State College of Agriculture, 1962. 32 p. (Cornell. Agricultural Extension Service. bulletin 750)
3. Burt, Stanley W. Apple handling and packing in the Appalachian area. Washington, D.C., 1959. 92 p. (U.S. Dept. of Agriculture. Agricultural Marketing Service. Marketing research report no. 476)
4. Burt, Stanley W. and Glenn O. Patchen. Grading and sizing apples with brushes. Washington D.C., 1966. 14 p. (U.S. Dept. of Agriculture. Agricultural Research Service. ARS 52-18)
5. Burt, Stanley W. Packing apples in the Northeast. Washington, D.C., 1962. 35 p. (U.S. Dept. of Agriculture. Agricultural Marketing Service. Market research report no. 543)
6. Carlsen, Earl W. and Donald R. Stokes. Prepacking apples at point of production. Washington, D.C., 1951. 52 p. (U.S. Dept. of Agriculture. Production and Marketing Administration. bulletin no. 29)
7. Carman, Hoy Fred. Cost-volume relationships for packing apples in Michigan. Ph.D. thesis. (Abstract) East Lansing, Michigan State University, 1964. 2 numb. leaves.
8. Dalrumple, Dana G. Economic aspects of apple marketing in the United States. Ph.D. thesis. East Lansing, Michigan State University, 1962. 389 numb. leaves.
9. Edman, Victor G. Prices and marketing margins for Washington Delicious apples sold in Chicago and New York City, 1956-61. Washington D.C., 1963. 10 p. (U.S. Dept. of Agriculture. Economic Research Service. Marketing Economics Division. Marketing research report no. 586)
10. Fountain, James B. Prepacking medium size apples in shrinkable films at shipping point. Washington D.C., 1962. 23 p. (U.S. Dept. of Agriculture. Agricultural Marketing Service. Marketing research report no. 534)

11. Franklin, Earl R. Factors affecting performance rates of apple packing lines in Washington. Master's thesis. Pullman, Washington State University, 1966. 101 numb. leaves.
12. French, B. and D. G. Gillette. Cost of assembling and packing apples as related to scale of operation. East Lansing, 1959. 67 p. (Michigan State University. Dept. of Agricultural Economics. Technical bulletin 272)
13. French, B., L. L. Sammet and R. G. Bressler. Economic efficiency in plant operations with special reference to the marketing of California pears. *Hilgardia* 24 (19):543-721. 1956.
14. Herrick, Joseph F. et al. Apple packing and storage houses--- layout and design. Washington, D.C., 1964. 42 p. (U.S. Dept. of Agriculture. Agricultural Marketing Service. Marketing research report no. 602)
15. Herrick, Joseph F., Stanley W. McBirney and Earl W. Carlson. Handling and storage of apples in pallet boxes. Washington, D.C., 1958. 41 p. (U.S. Dept. of Agriculture. Agricultural Marketing Service and Agricultural Research Service. AMS-236)
16. Hunter, Lloyd D., Francis Kafer and Charles H. Meyer. Apple sorting methods and equipment. Washington, D.C., 1958. 24 p. (U.S. Dept. of Agriculture. Agricultural Marketing Service. Marketing research report no. 230.)
17. McMillian, Wendell M. Economic considerations regarding future storing and packing facilities for apple growers in Entiat, Washington area. Washington, D.C., 1959. 22 p. (U.S. Dept. of Agriculture. Farmer's Cooperative Service. Service report no. 47)
18. Meyer, Charles H. Comparative costs of handling apples at packing and storage plants. Washington, D.C., 1958. 75 p. (U.S. Dept. of Agriculture. Agricultural Marketing Service. Marketing Research Division. Marketing research report no. 215)
19. Nicholes, John Powell. Some economic considerations of sorting and sizing apples from bulk storage. Master's thesis. East Lansing, Michigan State University, 1965. 54 numb. leaves.
20. Powell, Jules W. Appalachian apples---packing costs and efficiency. Washington, D.C., 1960. 20 p. (U.S. Dept. of Agriculture. Agricultural Marketing Service. Marketing research report no. 435)

21. Rehberg, W. A. and Earl Franklin. Regional apple study-- consumption relationships. Pullman, 1965. 12 p. (Washington. State University. Agricultural Experiment Station. Station circular 445)
22. Sax, Leo Arthur. The economics of scale of fruit packing warehouses in the Oroville area. Master's thesis. Pullman, Washington State University, 1960. 54 numb. leaves.
23. Thompson, John C., Jr. Apple storage costs in New York State. Ithaca, 1962. 56 p. (Cornell University. Agricultural Experiment Station. A.E. Research 87)
24. Thor, Eric, Miriam Reuzan and Jerome B. Siebert. A guide for measuring relative profitableness of alternative work methods in agricultural and processing operations. Berkeley, 1965. 108 p. (California. University. Agricultural Experiment Station. Information series in Agriculture Economics no. 65-4)
25. U.S. Department of Agriculture. Agricultural Research Service. A review of literature on harvesting, handling, storage and transportation of apples. Washington, D.C., 1965. 215 p. (Agricultural Marketing Service. ARS 51-4)
26. U.S. Department of Agriculture. Crop Reporting Board. Summaries of crop production. Washington, D.C., 1945 - 1966. (Annual summaries not paged)
27. U.S. Department of Agriculture. Economic Research Service. Projections of apple production in the United States. Washington, D.C., 1964. 7 p. (Committee Print, 88th Congress, 2d Session. Prepared for the use of the United States Senate Committee on Commerce)
28. U.S. National Commission on Food Marketing. Cost components of farm-retail price spreads for foods. Washington, D.C., 1966. 55 p. (Technical study no. 9)
29. Washington Growers' Clearing House Association. Listing of cold storage capacities and managers in Wenatchee-Okanogan district. Wenatchee, 1966. n.p.
30. Washington State Apple Advertising Commission. Where Washington apples are marketed. Wenatchee, 1966. 19 p. (Supplement no. 19, including 1960 through 1965 marketing season)
31. Washington State Horticultural Association. Proceedings of the sixty-second annual meeting. Pullman, Pullman Herald, Dec. 5, 6, 7, 1966. 296 p.

32. Washington State Horticultural Association et al. Washington fruit tree census. Pullman, 1964. 100 p. (Washington. State University. Agricultural Experiment Station. Station circular 441)
33. Wenatchee Valley Traffic Association. Shipments, Wenatchee and Yakima season, 1959 to 1966. Wenatchee, Washington, 1966. (Weekly bulletins not paged)

APPENDIX 1

PROCESS CHART AND COST DATA, Packing Line 1, Standard Technology

COST ACCUMULATION, Packing Line 1, Standard Technology

PROCESS CHART AND COST DATA, Presorting and Presizing with Brushes

COST ACCUMULATION, Presorting and Presizing with Brushes

PROCESS CHART AND COST DATA, Packing Line 1, New Technology

COST ACCUMULATION, Packing Line 1, New Technology

PROCESS FLOW CHART AND COST DATA

Job: Fresh apple grading, sizing, and packaging

Method: Continuous process line with apples placed on fiber-pulp or plastic trays in fiber boxes, boxes lidded, inventoried, and marked

Subject followed: Apples

Diagram begins with: Field run apples in precooling storage in bins (bulk harvest containers with net capacity of approximately 850 pounds of apples)

Diagram ends with: Graded, Sized, and packaged apples delivered to entrance of refrigerated storage

Charted by: Richard D. Bartram

Plant & Location: Packing Line 1, Standard technology

Date: May, 1966

Cost Data: Costs based on 1965 operating season costs

Fixed Costs Per Season include an allocated straight line depreciation applied to all equipment used directly in the continuous process line. Considering use wear, time wear, and obsolescence a 10-year life period is applied to each piece of equipment. Fire Insurance premiums and Property Taxes are included. Building space and land costs are not included.

Season Variable Costs include direct labor costs--salaries, Social Security Insurance, consumed supplies and utilities. These season variable costs are assumed to be Fixed Costs per 8-hour shift since they are not usually subject to change during this short period regardless of volume of output. Direct operating supervision, maintenance, and heating costs are allocated to functional stages in the line operation. General plant administrative costs and direct costs

of packaging material and piece-rate packing labor per 42-pound box are not included.

Cost data is summarized by six (6) functions of the continuous process line. These functions are likely to respond to the introduction of the new technology of presorting and presizing apples.

Cost Source:

Plant Records, Equipment Manufacturing and Distribution Companies,
Utility Suppliers and Municipal Taxing Agencies

COST SUMMARY - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, Standard Technology Year 1965 Days Operating Season 107

Function	Fixed Costs Per Season	Fixed Cost Per Season By 8-Hour Shift	Season Variable To Fixed Costs Per 8-Hr. Shift	Total Fixed Costs per 8-Hour Shift
1. Bring up and dumping	\$1,528.67	\$ 14.29	\$ 46.71	\$ 61.00
2. Brushing and Small Fruit Elimination	599.79	5.61	7.69	13.30
3. Sorting	431.99	4.04	147.18	151.22
4. Sizing	730.81	6.83	8.19	15.02
5. Packing	781.90	7.31	43.38	50.69
6. Stamping, Checking, Weighing & Lidding	1,168.71	10.92	32.87	43.79
TOTAL	\$5,241.87	\$48.99	\$286.02	\$335.01

DEFINITION OF PROCESS SYMBOLS

Operation



An operation occurs when an object is intentionally changed in any of its physical or chemical characteristics, is assembled or disassembled from another object, or is arranged for another operation, transportation, inspection or storage. An operation also occurs when information is given or received or when planning or calculating takes place.

Transportation



A transportation occurs when an object is moved from one place to another, except when such movements are a part of the operation or are caused by the operator at the work station during an operation or an inspection.

Inspection



An inspection occurs when an object is examined for identification or is verified for quality or quantity in any of its characteristics.

Delay



A delay occurs to an object when conditions, except those which intentionally change the physical or chemical characteristics of the object, do not permit or require immediate performance of the next planned action.

Storage



A storage occurs when an object is kept and protected against unauthorized removal.

Combined
Activity



When it is desired to show activities performed either concurrently or by the same operator at the same work station, the symbols for those activities are combined, as shown by the circle placed within the square to represent a combined operation and inspection.

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
1		Fruit in Cold Storage. Move loose apples in bins (24 bu.) from storages to head of line 300 to 650 ft. Serves <u>two</u> lines.	Cost not included 2,000 lb. Clark lift truck with L.P. gas power	200+	$\frac{1}{2}$ \$3,000.00T \$ 300.00A	one \$1.60 per hour \$12.80 salary \$1.18 other \$13.98 $\frac{1}{2}$ for line= \$6.99	Gas \$.93 $\frac{1}{2}$ for line= \$.46
2		Bins on dock, stacked two high waiting for placement on rollers to dumper.	0	200+	0	0	0
3		One bin at a time placed on rollers to dumper. Serves two lines.	2,000 lb. Clark lift truck with L.P. gas power	200+	$\frac{1}{2}$ \$3,000.00T \$ 300.00A	one \$1.60 per hour (\$ $\frac{1}{2}$ time per line) \$6.99	$\frac{1}{2}$ Gas=\$.46 5 8

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
4		Bins move to dumper. Roller track holds 8 bins.	12 ft. long steel roller track 4 ft. wide, rollers on 3 inch center plus 20 ft. chain-drive track 4 ft. wide, powered by 1-horse electric motor	200+	\$85.00T \$ 8.50A \$636.00T \$ 63.60A <u>motor drive</u> \$170.00T \$ 17.00A	0	Kilowatts <u>5.968</u> \$.20
5		Immersion dumping. Bin of fruit lowered into 5 ft. square steel tank of water. Fruit floats out of Bin. Fruit moved into water floatation tubing by water current. Bin raised & hand powered onto empty bin return.	Hydraulic operated immersion dumper unit (N.W. Equip. Co.) powered by one 2-horse motor serving 2 lines	200+	\$3,600.00T \$ 360.00A	one \$1.50 per hour \$12.00 salary <u>\$1.13 other</u> \$13.13	Kilowatts <u>5.968</u> \$.20

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
			Water from plant owned well $\frac{1}{4}$ allocated for each packing line with one 3-horse electric pump for 2 lines & other half for refrigeration in storage		\$500.00T \$ 50.00A	0	Kilowatts $\frac{1}{4}$ of 3-horse motor <u>8.952</u> \$.30
6		Empty bins moved from dumper onto rollers & removed from end of rollers above lift truck (Refer. No. 3).	50 ft. long side wheel rollers 40 inches wide & bins powered by hand & gravity	200+	Included with Refer. No. 5	Same as Refer. No. 1, 3 & 5	0
		Stacked on dock for movement to empty bin storage by fork lift (Refer. No. 1)	0		0	0	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
7		Water current moves fruit to elevator	16 ft. of steel tubing 4 ft. wide & 1 ft. deep, 3/4 full of water, 1/2-horse electric motor powers small water pump for water current Mold retardant chemical--Decasol	200+	Tubing \$320.00 Motor & pump \$350.00 \$670.00T \$ 67.00A	0	Kilowatts <u>2.984</u> \$.10 Chemical <u>2.7 gal.</u> per day \$4.00 per gal. \$10.80
8		Fruit elevated 18 inches to brushing unit.	30 moving plastic covered 2" diameter rollers 4 ft. wide rotated by chain drive on 45° slope, powered by 1/2-horse electric motor with variable speed gear head	200+	\$470.00T \$ 47.00A	0	Kilowatts <u>2.984</u> \$.10

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
9		Brushing fruit for cleaning & polishing. Water spray applied in early part of brushing & last half of brushing for polish.	10 ft. long, 4 ft. wide Van Doren Equip. Co. Brushing Unit powered by two 1-horse electric motors	200+	Unit \$2,800.00T \$ 280.00A	0	Kilowatts <u>11.936</u> \$.41
10		Small fruit elimination by 2 1/4 in. diameter & smaller fruit falling through screen to moving belt.	Small fruit eliminator 2 ft. long, 4 ft. wide, heavy 2 1/4 in. mesh screen rolling over two 5 in. diameter rubber covered rollers, powered by chain drive to brush unit	200+	\$600.00T \$ 60.00A	0	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
11		Transport of small fruit to bin. Fruit drops from end of belt into bin.	20 ft. of moving canvas belt 4 in. wide powered by 1/2-horse electric motor with gear head	200+	\$300.00T \$ 30.00A	0	Kilowatts <u>2.984</u> \$.10
12		Full bins move to storage by fork lift (Refer. No. 1).	Same as Refer. No. 1	200+	0	0	0
13		Hand sorting into 3 or 4 grades depending on variety of fruit. Fruit rotated along table with special lighting. All grades except first grade (Extra Fancy) hand lifted by individual fruit to belts above table.	Food Machinery Corp. reverse roll sorting table, 16 ft. long, 4 ft. wide, 2 levels of 4 in. wide moving belts above table for 2nd & 3rd grades powered by two 1/4-horse & one 1-horse electric motors	120	\$2,000.00T \$ 200.00A	11 \$1.40 per hour \$123.20 salary \$11.77 other \$134.97	Kilowatts motors <u>5.968</u> \$.20

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
14		Processing grade, hand placed from sorting onto moving belt & moved to a 10 in. wide, 24 ft. long belt which serves 2 lines. Fruit drops into bin, bin changed by fork lift, Refer. No. 1.	Bank of 16--six ft. tubes florescent lights above sorters, Life Line Sylvania F 72T12 Heavy canvas, continuous belts 4 in. wide, 16 ft. long (34 ft. belting) & 1/2 share of 10 in. wide, 24 ft. long (50 ft. of belt) - both powered by 1/2-horse electric motor with gear head	200+	\$32.80T \$ 6.56A (5 year life) \$113.75 T \$ 11.40 A	0 0	Kilowatts lights <u>7.040</u> \$.24 Kilowatts motors <u>2.984</u> \$.10
15		Storage for processing.	0		0	0	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
16		Transport of fruit from sorting to sizer 108 ft. from beginning of sorting to end of three sections of sizers & packing tubs in line.	Two-inch fiber belts over sorting table move fruit to each of 3 sections of sizers & packing tubs, powered by 1/2-horse electric motor with gear head	200	\$227.64T \$ 22.76A	0	Kilowatts motor <u>2.984</u> \$.10
17		Sizing by grades into 13 possible sizes & sizers release each sized fruit into a 24-in. diameter tub. Sizing cups operated at a capacity of 344 cups per minute. Fruit rolls sizer to tub.	Double rows of canvas sizing cups carry fruit in each of 3 sections, each cup released by weight spring based on fruit weight, all sections powered by one 5-horse electric motor	150	\$5,000.00T \$ 500.00A	0	Kilowatts motors <u>29.840</u> \$1.01
18		Material Storage	Stacked on floor near dumper	200+	0	0	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
19		Place empty packing boxes, trays, wrapping paper on overhead carrier.	Two small hand trucks & 160 ft. of overhead conveyor line Van Doren Equip. Co., powered by $\frac{1}{2}$ -horse electric motor with drive	200+	\$6.50 per ft. installed \$1225.00T \$ 122.50A	two \$1.50 per hour salary \$24.00 \$2.26 other \$26.26	Kilowatts motor 2.984 \$.10
20		Packing by hand from tubs into (42 lb. fruit weight) fiber boxes with trays.	16 packing carts 20 packers stamps Packer & box size marking cards	200+	\$630.00T \$ 63.00A \$100.00A	16 packers \$4.40 Ind. Insurance	0
21		Packing cart pushed by packer about 3 ft. to side-wheel track. Box mechanically shifted to track. Track moves box to stamper & weighing.	200 ft. of side-wheel track 15 inches wide with center chain drive, powered by two $\frac{1}{2}$ -horse electric motors	200+	\$10.00 per ft. installed \$2,220.00T \$ 222.00A		Kilowatts 5.968 \$.20

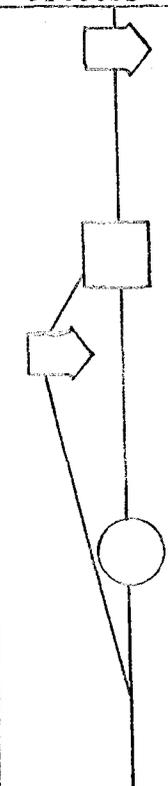
PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
22		At end of sizing & packing line boxes of apples accumulate on tracks.	0	200+	\$118.00T \$ 12.00A	0	lights 22.00 \$.75
23		Stampers hand stamp size, grade, grower number, code number on end of box. Stamper also accumulates packer & grade-size punch cards.	Hand Stamps 2 "Barton" stampers 1 side-wheel stamp complete with sizes 3 rocker-bar stampers 3 stamp pads 50 1/2-inch square stamps All manufactured by R. M. Church, Inc.	200+	\$150.00T \$ 15.00A	1 \$1.40 per hour \$16.90 salary \$1.61 other \$18.51T	Ink \$.17

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A-Annual	Man requirements in 8 hours & cost	Utility Cost per 8 hours
24		Transport of packed boxes to automatic segregator & lidder.	50 ft. of side-wheel track with center-chain drive powered by 1/2-horse electric motor with gear head	200+	\$10.00 per ft. installed \$611.00T \$ 61.00A	0	Kilowatts motor <u>2.984</u> \$.10
25		Segregation of boxes.	15 ft. of side-wheel track with center-chain drive powered by same motor as No. 24		\$10.00 per ft. installed \$150.00T \$ 15.00A	0	0
26		Loose filled & telescope top boxes bypass lidder & transport direct to storage.					
27		Glue lidding of packed boxes.	Automatic glue lidder (converted Chrisholm Ryder) powered by 3/4 horse motor	900 packed boxes per hour	\$6400.00T \$ 640.00A	one \$1.50 per hour \$12.00 salary <u>\$1.13 other</u> \$13.13 1/2 for line =\$6.56	Kilowatts motors <u>4.476</u> \$.15

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
28		Transport to storage one storage on same level & one lower level.	100 ft. of side-wheel track with center-chain drive powered by two 1/2-horse electric motors	200+	\$10.00 per ft. in-- installed \$1,222.00T \$ 122.20A	0	Kilowatts motor <u>5.968</u> \$.20
			35 ft. heavy canvas 10 inches wide moving belt to lower storage powered by one 1/2-horse electric motor	200+	\$226.50T \$ 26.65A		Kilowatts motors <u>2.984</u> \$.10
		Cold Storage.	Costs not included.				

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Cost per 8 hours
		<u>ALLOCATED COSTS</u>					
		One full-time maintenance man for two packing lines and storage equipment. Unit accounting records allocate time & expendable, supplies for years operating on packing line.	Small tools and equipment estimated replacement annually & use of miscellaneous supplies for one packing line by plant manager	200+	\$400.00A (\$66.67 per function)	one \$18.70 salary \$1.60 other \$20.30 $\frac{1}{2}$ per line \$1.70 per function	0
		One supervisor-inspector & one assistant for 2 packing lines inspecting dumping, sorting & packing.	0	200+	0	one \$40.00 one \$20.00 \$60.00 salary \$4.60 other $\frac{1}{2}$ for line \$32.20 (\$5.38 per function)	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, Standard Technology CROP YEAR 1965 DAYS (8-hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
		For rest periods & provision for emergency care.	One 40 cup coffee maker, 3 picnic tables with benches Three 8 ft. long wood benches, coffee & apple juice furnished daily		\$150.00T \$ 15.00A	0	Coffee, juice disposable cups \$5.00
		Fire Insurance 1.15% of value (\$1,635.00 for packing lines in 1965).			$\frac{1}{2}$		
		Heat for area.	Steam heat unit with fuel oil burner, oil tank, steam generator, ducts & fans for 2 lines, $\frac{1}{2}$ allocated for single line		\$1,125.00T \$ 112.50A $\frac{1}{2}$ for sorters $\frac{1}{2}$ for packing \$56.25 per		Fuel \$4.18 $\frac{1}{2}$ for sorting $\frac{1}{2}$ for packing \$2.09 per
		Real Estate tax 50 mills per year on 25% of equipment value.					

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, Standard Technology Year 1965 Days Operating Season 107

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
1. Bring up	Fork Lift trucks	\$600.00			\$ 600.00
and dumping	Lift truck operator		\$13.98	\$1,495.86	\$1,495.86
	L.P. Gas for lift truck		.92	98.44	98.44
	Maintenance equipment	66.67	1.70	181.90	248.57
	12 ft. of bin roller track	8.50			8.50
	20 ft. of bin chain drive track	63.60			63.60
	One 1-horse electric motor	17.00			17.00
	Water facilities equipment	50.00			50.00
	Electric power		.20	21.40	21.40
	Direct Supervision		5.38	575.66	575.66
	Dumper equipment	360.00			360.00

(continued)

TOTALS: SEASON

8-HOUR SHIFT

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKING

Plant Packing Line 1, Standard Technology Year 1965 Days Operating Season 107

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
1. Continued	Fire Insurance	\$141.80			\$ 141.80
	Dumper Operator		\$ 13.13	\$1,404.91	1,404.91
	Property Tax	154.10			154.10
	Electric Power		.20	21.40	21.40
	Chemical (Decosal)		10.80	1,155.60	1,155.60
	16-ft. steel tubing, motor pump &	67.00			67.00
	Electric Power (2 water pumps)		.40	42.80	42.80
TOTALS: SEASON		<u>\$1,528.67</u>		<u>\$4,997.97</u>	<u>\$6,526.64</u>
	8-HOUR SHIFT	<u>\$14.29</u>	<u>\$46.71</u>		<u>\$61.00</u>

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKING

Plant Packing Line 1, Standard Technology Year 1965 Days Operating Season 107

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
2. Brushing	Elevator	\$ 47.00			\$ 47.00
and Small	Electric Power		\$.10	\$ 10.70	10.70
(2½ inch	Brushing Unit	280.00			280.00
diameter &	Electric Power		.41	43.87	43.87
less) fruit	Small Fruit Eliminator	90.00			90.00
elimination	Electric Power		.10	10.70	10.70
	Maintenance of equipment	66.67	1.70	181.90	248.57
	Fire Insurance	55.62			55.62
	Direct Supervision		5.38	575.66	575.66
	Property Tax	60.50			60.50
TOTALS: SEASON		<u>\$599.79</u>		<u>\$822.83</u>	<u>\$1,422.62</u>
8-HOUR SHIFT		<u>\$5.61</u>	<u>\$7.69</u>		<u>\$13.30</u>

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, Standard Technology Year 1965 Days Operating Season 107

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
3. Sorting	Sorting table unit	\$200.00			\$200.00
fruit into	Electric Power		\$.20	\$ 21.40	21.40
3 grades &	Lighting fixtures	6.56			6.56
cull or	Electric Power		.24	25.68	25.68
processing	11 Sorters (labor)		134.97	14,441.79	14,441.79
grade	Cull Belts	11.40			11.40
elimination	Electric Power		.10	10.70	10.70
	Maintenance of Equipment	66.67	1.70	181.90	248.57
	Fire Insurance on Equip.	40.06			40.06
	Direct Supervision		5.38	575.66	575.66

TOTALS: SEASON (CONTINUED)

8-HOUR SHIFT

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, Standard Technology Year 1965 Days Operating Season 107

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
3. Continued	Rest period equipment ($\frac{1}{2}$)	\$ 7.50			\$ 7.50
	Rest Period ($\frac{1}{2}$)		\$ 2.50	\$267.50	267.50
	Property Tax	43.55			43.55
	Heat for workers	56.25	2.09	223.63	279.88

TOTALS: SEASON \$431.99 \$15,748.26 \$16,180.25
 8-HOUR SHIFT \$4.04 \$147.18 \$151.22

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, Standard Technology Year 1965 Days Operating Season 107

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HOUR SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
4. Sizing	Belts to sizing, 3 sections	\$ 22.67			\$ 22.67
fruit and	Electric Power		\$.10	\$ 10.70	10.70
transport to	3 Sizing-Machine units with				
packing tubs	packing tubs	500.00			500.00
	Electric Power		1.01	108.07	108.07
	Maintenance of equipment	66.67	1.70	181.90	248.57
	Direct Supervision		5.38	575.66	575.66
	Fire Insurance	67.77			67.77
	Property Tax	73.70			73.70
TOTALS: SEASON		<u>\$730.81</u>		<u>\$876.33</u>	<u>\$1,607.14</u>
8-HOUR SHIFT		<u>\$6.83</u>	<u>\$8.19</u>		<u>\$15.02</u>

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, Standard Technology Year 1965 Days Operating Season 107

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HOUR SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
5. Pack fruit	16 packing carts, machine				
into shipping	cards and 20 stamps	\$163.00			\$ 163.00
containers	Industrial Insurance on				
and transport	16 packers		\$ 4.40	\$ 470.80	470.80
to checker	200 ft. chain-drive track	222.00			222.00
and stamper	Electric Power		.20	21.40	21.40
	Overhead conveyer & 2 hand				
	trucks for packing materials				
	handling	122.50			122.50
	Electric Power		.10	10.70	10.70

TOTALS: SEASON (Continued)

8-HOUR SHIFT

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, Standard Technology Year 1965 Days Operating Season 107

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
6. Stamping,	Hand stamps	\$ 15.00			\$ 15.00
Checking,	1½ stampers & chedkers		\$ 18.51	\$1,980.57	1,980.57
Weighing,	Ink		.17	18.19	18.19
Lidding, and	65 ft. track with center-				
Transport to	chain drive	76.00			76.00
storage (ends	Electric Power		.10	10.70	10.70
at storage	Automatic glue lidder	640.00			640.00
room entry)	Electric Power		.15	16.05	16.05
	Glue lidder operator		6.56	701.92	701.92
	chain drive				
	100 ft. track with center/	122.20	.		122.20
	Electric Power		.20	21.40	21.40

TOTAL: SEASON (continued)

8-HOUR SHIFT

PROCESS FLOW CHART AND COST DATA

Job: Fresh apple presorting and presizing with Unitized Brushing Unit.

Method: Proposed process line with graded and size-grouped apples placed in bins (bulk containers with net capacity of approximately 850 pounds of apples) for storage.

Subject followed: Apples

Diagram begins with: Field-run apples received from orchard or in precooling storage in bins.

Diagram ends with: Graded and size-grouped apples in bins delivered to entrance of refrigerated or C. A. storage.

Charted by: Richard D. Bartram

Source of Data: Prototype of Unitized Brush-Sizer located at Krispy-K apple packing company, Monitor, Washington and functional operating data from four continuous process apple grading, sizing, and packing lines.

Date: February, 1967

Cost Data: Costs are based on 1965 operating season costs.

Fixed Costs Per Season include an allocated straight-line depreciation applied to all equipment in the process line. Considering use wear, time wear and obsolescence a 10-year life period is applied to each piece of equipment. Fire insurance premiums and property taxes are included. Building space and land costs are not included.

Season Variable Costs include direct labor costs - Salaries, Social Security, Insurance, consumed supplies, and utilities. Direct operating supervision and

maintenance costs are allocated by functions in the line operation. These Season Variable Costs are assumed to become Fixed Costs Per 8-Hour Shift since they are not usually subject to change during this short period regardless of volume of output. General plant administrative costs and direct costs of apple containers are not included. Cost data is summarized by five (5) functions of the process line. Synthesis of the process and costs was based on data from similar functions of empirically analyzed fresh apple grading, sizing and packing lines.

Cost Source:

Plant Records, Equipment Manufacturing and Distribution Companies, Utility Suppliers and Municipal Taxing Agencies

COST SUMMARY - FRESH APPLE GRADING, SIZING, AND PACKAGING

Plant Presorting and Presizing with Brushes Year 1965 Days Operating Season 40

FUNCTION	FIXED COSTS PER SEASON	FIXED COST PER SEASON BY 8-HOUR SHIFT	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	TOTAL FIXED COSTS PER 8-HOUR SHIFT
1. Bring up and Dumping	\$1,732.00	\$ 43.30	\$ 39.16	\$ 82.46
2. Brushing & Small Fruit Elimination	1,246.00	31.15	4.89	36.04
3. Sorting	1,262.30	31.55	102.93	134.48
4. Sizing	1,543.50	38.59	17.87	56.46
5. Bin Filling and to Storage	1,761.00	44.00	12.68	56.68
TOTAL	\$7,544.80	\$188.62	\$177.53	\$366.15

DEFINITION OF PROCESS SYMBOLS

Operation



An operation occurs when an object is intentionally changed in any of its physical or chemical characteristics; is assembled or disassembled from another object; or is arranged for another operation, transportation, inspection, or storage. An operation also occurs when information is given or received or when planning or calculating takes place.

Transportation



A transportation occurs when an object is moved from one place to another, except when such movements are a part of the operation or are caused by the operator at the work station during an operation or an inspection.

Inspection



An inspection occurs when an object is examined for identification or is verified for quality or quantity in any of its characteristics.

Delay



A delay occurs to an object when conditions, except those which intentionally change the physical or chemical characteristics of the object do not permit or require immediate performance of the next planned action.

Storage



A storage occurs when an object is kept and protected against unauthorized removal.

Combined
Activity



When it is desired to show activities performed either concurrently or by the same operator at the same work station, the symbols for those activities are combined, as shown by the circle placed within the square to represent a combined operation and inspection.

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Presorting and Presizing with Brushes CROP YEAR 1965 DAYS (8-HOUR) OPERATION 40

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T-Total A-Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
1		Storage Brings bins (24 bu. each) from storage or unloading area to receiving line for dumping. 50 to 300 ft. of travel from storage location to line.	Costs not included One fork lift truck 4,000-lb. capacity ($\frac{1}{2}$ allocated) I. P. gas powered (same lift truck serves dumper, removes empty bins, services cull and small-apple bins)	200+	$\frac{1}{2}$ \$4,150.00T \$ 415.00A	One \$1.75 per hour \$14.00 salary \$1.16 other $\frac{1}{2}$ =\$7.58T	Gas \$1.85 $\frac{1}{2}$ =\$.93
2		Loose fruit bin placement on rollers & movement to dumper, holds 5 bins. Bins moved by push from lift truck & belt powered over rollers.	15 ft. of double steel-roller line, rollers framed by angle iron & place on $3\frac{1}{2}$ -inch centers, last 11 ft. before dumper has rubber-coated fiber belt	200+	Included with dumper unit	0	Kilowatts <u>4.476</u> \$.15

PROCESS CHART AND COST DATA --FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Presorting and Presizing with Brushes CROP YEAR 1965 DAYS (8-HOUR) OPERATION 40

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility Costs Per 8 hours
3		Water immersion dumping with bin hydraulically lowered into water & fruit floated away by water current.	12-inches wide on each side revolving on rollers & powered by 3/4-horse electric motor with gear head. Immersion dumper unit powered by one 1-horse electric motor, water pump included	200+	\$5,900.00T \$ 590.00A	one \$1.55 salary \$12.40 other \$13.47T	Kilowatts motor 5.968 \$.20
4		Empty bins hand powered onto side-wheel track moved by gravity to track end & removed (same	Water 30 ft. of double side-wheel track 2 tracks each 11 inches wide with 40 inches to centers of each,	200+	\$480.00A Included with dumper	0 Same as No. 3	0 0 hand powered

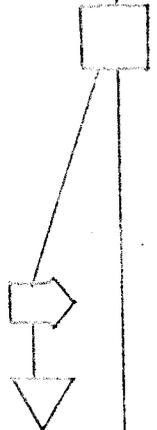
PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Presorting and Presizing with Brushes CROP YEAR 1965 DAYS (8-HOUR) OPERATION 40

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours and cost	Utility Cost per 8 hours
		lift as No. 1)	framed by 2-inch angle iron				
5		Empty bin storage	0	0	0	0	0
6		Transport of fruit to elevator. Mold retarding chemical added daily to maintain concentration.	15 ft. of steel floatation tubing 18 inches deep, 5 ft. wide, water current created by pump on dumper, mold retarding chemical	200+	Included with dumper	0	Chemical \$13.60
7		Fruit elevated from water floatation to sorting level.	Unitized Brush-Sizer Unit provides for elevation, sorting area, brushing & fruit sizing (Prototype reference ARS 52-18) powered by one 3-horse drive, 2	200	\$30,000.00T \$ 3,000.00A \$ 1,000.00 brushing \$ 1,000.00 sorting \$ 1,000.00 sizing		Kilowatts 6 electric motors <u>58.188</u> \$1.98 \$.66 brushing \$.66

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Presorting and Presizing with Brushes CROP YEAR 1965 DAYS (8-HOUR) OPERATION 40

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility Cost per 8 hours
8		Small apples ($2\frac{1}{4}$ inches in diameter & smaller) leaves & trash fall between elevator rollers & carried away. Bins placed & removed by same lift truck as No. 1.	2-horse variable speed & one $3/4$ -horse variable speed electric motors Included in Refer. No. 7	200	Same as Refer. No. 7	0	\$.66 sorting \$.66 sizing
9		Return to storage.	Same as Refer. No. 7	200+	Same as Refer. No. 1	0	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Presorting and Presizing with Brushes CROP YEAR 1965 DAYS (8-HOURS) OPERATION 40

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility Cost per 8 hours
10		Fruit hand sorted into 3 grades. Second & third grade fruit individually hand lifted to another lane or cull chute. Sorters assigned individual lanes & provided special lighting.	Same as number 7 Bank of 16 six ft tubes florescent lights Life Line Sylvania F 72TL2	200 200+	See Refer. No. 7 \$32.80T \$ 3.30A	Eight \$1.40 \$11.20 salary \$1.00 other \$12.00 each \$97.60T	Kilowatts lights <u>7.040</u> \$.24
11		Cull (processing) grade removed from line & placed in bins. Bins placed & removed by fork lift No. 1.	Same as No. 7	200	See Refer. No. 7	0	0
12		Return to storage.	Same as Refer. No. 1	200+	See Refer.	0	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Presorting and Presizing with Brushes CROP YEAR 1965 DAYS (8-HOUR) OPERATION 40

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man Requirements in 8 hours & cost	Utility Cost per 8 hours
13		Brushing of fruit to clean & polish. This is an optional process in that brush rotation can be adjusted to perform or just carry on transport function to sizing selection.	Same as No. 7	200	Same as Refer. No. 7	0	See Refer. No. 7
14		Fruit sized into selected size groups by adjusting spacing of brushes. Sized fruit drop to a vibrating inclined plane which lowers them to a take-away belt.	Same as No. 7	200	Same as Refer. No. 7	0	See Refer. No. 7 Disinfectant and cleaning material \$1.00

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Presorting and Presizing with Brushes CORP YEAR 1965 DAYS (8-HOUR) OPERATION 40

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility Cost per 8 hours
15		Each of 2 grades sized in 4-size groups move on distribution belts to bin filler.	8 plastic belts each 7 ft. long (15 ft. of belting) 6 inches wide powered by two 1/2-horse electric motors for take-away under sizing section, 2 plastic belts, each 15 ft. long (32 ft. belting) 16 in. wide powered by two 3/4-horse electric motors for accumulation & distribution	200	\$2,400.00T \$ 240.00A	0	Kilowatts 4 motors <u>14.920</u> \$.51

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Presorting and Presizing with Brushes CROP YEAR 1965 DAYS (8-HOUR) OPERATION 40

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility Cost per 8 hours
16		Return of presorted and group sized fruit to bins (24 bushels or 1,000 pounds fruit each).	8 bin fillers Pomona make powered by one 1/3 and one 1/4-horse electric motor each	200+	\$10,000.00 T \$ 1,000.00 A	one \$1.55 hour salary \$12.40 other \$13.47 T	Kilowatts 16 motors <u>27.688</u> \$.94
17		Transport bins to storage.	One lift truck 4,000 pound capacity, L.P. gas powered, delivers empty bins to bin fillers & moves filled bins to storage (1/2 allocated)	200+	1/2= \$4,150.00T \$ 4.5.00A	One \$1.75 hour salary \$14.00 other \$15.16T 1/2=\$7.58T	gas \$1.85 1/2=\$.93
		Storage	Costs not included				

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Presorting and Presizing with Brushes CROP YEAR 1965 DAYS (8-HOUR) OPERATION 40

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility Costs per 8 hours
		<u>ALLOCATED COSTS</u>					
		One full time maintenance and repair man for plant allocated time and expendable supplies.	Small tools, equipment and supplies		\$1,020.00T \$ 120.00A $\frac{1}{4}$ allocated \$25.50 (\$5.12 per function)	one \$2.10 hour \$16.80 salary \$1.34 other \$18.14 T $\frac{1}{4}$ allocated \$4.53 (\$.91 per function)	
		One supervisor-inspector for packing lines and presorting, presizing line				One \$4.00 hour \$32.00 salary \$2.27 other $\frac{1}{3}$ allocated \$11.62 (\$2.32 per function)	

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKING

NAME Presorting and Presizing with Brushes CROP YEAR 1965 DAYS (8-HOUR) OPERATION 40

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility Cost per 8 hours
		Rest periods and emergency care	Equipment supplies		\$290.00T \$ 29.00A 1/3 allocated \$10.00A	0	Coffee, juice, paper
		Heat for area.	Same as presently maintained				
		Real estate tax 50 mills per year on 25% of equipment value					
		Fire insurance 1.15% of value of equipment.					

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Presorting and Presizing with Brushes Year 1965 Days Operating Season 40

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
1. Bringing up	Lift Truck	\$ 415.00			\$ 415.00
& dumping	L.P. Gas		\$.93	\$ 37.20	37.20
begins with	Lift Truck Operator		7.58	303.20	303.20
fruit in	Immersion Dumper Unit	590.00			590.00
storage.	Electric Power		.35	14.00	14.00
	Dumper Operator		13.47	538.80	538.00
	Water	480.00			480.00
	Chemical		13.60	544.00	544.00
	Maintenance	5.00	.91	36.40	41.40
	Direct Supervision		2.32	92.80	92.80
	(Continued)				

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Presorting and Presizing with Brushes Year 1965 Days Operating Season 40

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
2. Brushing	Elevator and Brusher Section				
and small	of Unitized Brush-Sizer Unit	\$1,000.00			\$1,000.00
fruit	Power		\$.66	\$ 26.40	26.40
elimination.	Disinfectant & Cleaning Mater'l		1.00	40.00	40.00
	Maintenance	5.00	.91	36.40	41.40
	Direct Supervision		2.32	92.80	92.80
	Property Tax	125.00			125.00
	Fire Insurance	116.00			116.00
TOTALS: SEASON		\$1,246.00		\$ 195.60	\$1,441.60
8-HOUR SHIFT		\$ 31.15	\$ 4.89		\$ 36.04

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Presorting and Presizing with Brushes Year 1965 Days Operating Season 40

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
3. Sorting	Sorting Section of Unitized				
fruit into	Brush-Sizer Unit	\$1,000.00			\$1,000.00
3 grades,	Power		\$.66	\$ 26.04	26.04
cull	Eight Sorters		97.60	3,904.00	3,904.00
elimination.	Lighting	3.30	.24	9.60	12.90
	Maintenance	5.00	.91	36.40	41.40
	Direct Supervision		2.32	92.80	92.80
	Property Tax	127.00			127.00
	Fire Insurance	117.00			117.00
	Rest Period Equip. & Supplies	10.00	1.20	48.00	58.00
TOTALS: SEASON		<u>\$1,262.30</u>		<u>\$4,117.20</u>	<u>\$5,379.50</u>
	8-HOUR SHIFT	<u>\$ 31.55</u>	<u>\$102.93</u>		<u>\$ 134.48</u>

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Presorting and Presizing with Brushes Year 1965 Days Operating Season 40

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
4. Sizing fruit	Sizing Section of Unitized				
into four	Brush-Sizer Unit	\$1,000.00			\$1,000.00
groups of	Electric Power		\$.66	\$ 26.40	26.40
each of two	Distribution Belts	240.00			240.00
grades.	Electric Power		.51	20.40	20.40
	Operator		13.47	538.80	538.80
	Maintenance	5.00	.91	36.40	41.40
	Direct Supervision		2.32	92.80	92.80
	Property Tax	155.50			155.50
	Fire Insurance	143.00			143.00

TOTALS: SEASON \$1,543.50 \$714.80 \$2,258.30
 8-HOUR SHIFT \$ 38.59 \$ 17.87 \$ 56.46

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Presorting and Presizing with Brushes Year 1965 Days Operating Season 40

FUNCTION	COST ITEM	FIXED COSTS PER SEASON	SEASON VARIABLE TO FIXED COSTS PER 8-HR. SHIFT	VARIABLE COSTS PER SEASON	SEASON SUB TOTAL BY FUNCTION
5. Filling	Eight Bin Fillers	\$1,000.00			\$1,000.00
bins and	Electric Power		\$.94	\$ 37.60	37.60
return of	Fork Lift	415.00			415.00
filled bins	L.P. Gas		.93	37.20	37.20
to storage.	Fork Lift Operator		7.58	303.20	303.20
	Maintenance	5.00	.91	36.40	41.40
	Direct Supervision		2.32	92.80	92.80
	Property Tax	178.00			178.00
	Fire Insurance	163.00			163.00
TOTALS: SEASON		<u>\$1,761.00</u>		<u>\$507.20</u>	<u>\$2,268.20</u>
	8-HOUR SHIFT	<u>\$ 44.00</u>	<u>\$ 12.68</u>		<u>\$ 56.68</u>

COST SUMMARY - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, New Technology Year 1965 Days Operating Season 107

Function	Fixed Costs Per Season	Fixed Cost Per Season By 8- Hour Shift	Season Variable To Fixed Costs Per 8-Hr. Shift	Total Fixed Costs Per 8- Hour Shift
1. Bring Up & Dumping	\$1,523.37	\$ 14.24	\$ 44.01	\$ 58.25
2. Brushing & Small Fruit Elimination	586.87	5.49	4.99	10.48
3. Sorting	405.33	3.79	119.94	123.73
4. Sizing	717.93	6.71	5.49	12.20
5. Packing	766.37	7.16	40.68	47.84
6. Stamping, Checking, Lidding	1,155.52	10.80	30.17	40.97
TOTAL	\$5,155.39	\$ 48.18	\$245.28	\$293.46

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T- Total A- Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
1		Fruit in Cold Storage. Move loose apples in bins (24 bu.) from storage to head of line 300 to 650 ft. Serves <u>two lines.</u>	Cost not included 2,000 lb. Clark lift truck with L.P. gas power	200+	$\frac{1}{2}$ = \$3,000.00T \$ 300.00A	one \$1.60 per hour \$12.80 salary \$1.18 other \$13.98 $\frac{1}{2}$ for line= \$6.99	Gas \$.93 $\frac{1}{2}$ for line= \$.46
2		Bins on dock, stacked two high waiting for placement on rollers to dumper.	0	200+	0	0	0
3		One bin at a time placed on rollers to dumper. Serves <u>two lines.</u>	2,000 lb. Clark lift truck with L.P. gas power	200+	$\frac{1}{2}$ = \$3,000.00T \$ 300.00A	one \$1.60 per hour ($\frac{1}{2}$ time per line) \$6.99	$\frac{1}{2}$ Gas=\$.46

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
4		Bins move to dumper. Roller track holds eight bins.	12 ft. long steel-roller track 4 ft. wide, rollers on 3-inch center plus 20 ft. chain-drive track 4 ft. wide, powered by 1-horse electric motor	200+	\$ 85.00T \$ 8.50A \$ 636.00T \$ 63.60A motor drive \$ 170.00T \$ 17.00A	0	Kilowatts <u>5.968</u> \$.20
5		Immersion dumping. Bin of fruit lowered into 5 ft. square steel tank of water. Fruit floats out of bin. Fruit moved into water floatation tubing by water current. Bin raised & hand powered onto empty bin return.	Hydraulic operated immersion dumper unit (N.W. Equip. Co.) powered by one 2-horse motor serving 2 lines	200+	\$3,600.00T \$ 360.00A	one \$1.50 per hour \$12.00 salary <u>\$1.13 other</u> \$13.13	Kilowatts <u>5.968</u> \$.20

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
			Water from plant owned well $\frac{1}{4}$ allocated for each line one 3-horse electric pump for two lines & other half for refrigeration in storage		\$500.00T \$ 50.00A	0	Kilowatts $\frac{1}{4}$ of 3-horse motor $\frac{8.952}{\$.30}$
6		Empty bins moved from dumper onto rollers & removed from end of rollers above lift truck (Refer. No. 3)	50 ft. long side-wheel rollers 40 inches wide & bins powered by hand & gravity	200+	Included with Refer. No. 5	Same as Refer. No. 1, 3 & 5	0
		Stacked on dock for movement to empty bin storage by fork lift (Refer. No. 1).		0	0	0	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
7		Water current moves fruit to elevator.	16 ft. of steel tubing 4 ft. wide & 1 ft. deep, 3/4 full of water, 1/2-horse electric motor power small water pump for water current Mold retardant chemical-Decasol	200+	Tubing \$320.00 Motor & pump \$350.00 \$670.00T \$ 67.00A	0	Kilowatts <u>2.984</u> \$.10 Chemical <u>2.7 gal.</u> per day \$4.00 per gal. \$10.80
8		Fruit elevated 18 inches to brushing unit.	30 moving plastic covered 2"-diameter rollers 4 ft. wide rotated by chain drive on 45° slope, powered by 1/2-horse electric motor with variable speed gear head	200+	\$470.00T \$ 47.00A	0	Kilowatts <u>2.984</u> \$.10

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
9		Brushing fruit for cleaning & polishing. Water spray applied in early part of brushing & last half of brushing for polish	10 ft. long, 4 ft. wide Van Doren Equip. Co. Brushing Unit powered by two 1-horse electric motors	200+	Unit \$2,800.00T \$ 280.00A	0	Kilowatts <u>11.936</u> \$.41
10		Small fruit elimination by 2 1/4 in. diameter & smaller fruit falling through screen to moving belt.	Small fruit eliminator 2 ft. long, 4 ft. wide, heavy 2 1/4 in. mesh screen rolling over two 5-in. diameter rubber covered rollers, powered by chain drive to brush unit	200+	\$600.00T \$ 60.00A	0	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
11		Transport of small fruit to bin. Fruit drops from end of belt into bin.	20 ft. of moving canvas belt 4 in. wide powered by 1/2-horse electric motor with gear head	200+	\$300.00T \$ 30.00A	0	Kilowatts <u>2.984</u> \$.10
12		Full bins move to storage by fork lift (Refer. No. 1).	Same as Refer. No. 1	200+	0	0	0
13		Hand sorting into 3 or 4 grades depending on variety of fruit. Fruit rotated along table with special lighting. All grades except first grade (Extra Fancy) hand lifted by individual fruit to belts above sort-table.	Food Machinery Corp. reverse roll sorting table, 16 ft. long, 4 ft. wide, 2 levels of 4 in. wide moving belts above table for & 3rd grades powered by two 1/4-horse & one 1-horse electric motors	120	\$2,000.00T \$ 200.00A	9 \$1.40 per hour \$100.80 salary \$ 9.63 other \$110.43	Kilowatts motors <u>5.968</u> \$.20

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
14		Processing grade, hand placed from sorting onto moving belt & moved to a 10 in. wide, 24 ft. long belt which serves two lines. Fruit drops into bin, bin changed by fork lift, Refer. No. 1.	Bank of 16 six-ft. tubes florescent lights above sorters, Life Line Sylvania F 72T12 Heavy canvas, continuous belts 4 in wide, 16 ft. long (34 ft. belting) & 1/2 share of 10 in. wide, 24 ft. long (50 ft. of belt) - both powered by 1/2-horse electric motor with gear head	200+	\$ 32.80T \$ 6.56A (5 yr. life) \$113.75T \$ 11.40A	0 0	Kilowatts lights <u>7.040</u> \$.24 Kilowatts motors <u>2.984</u> \$.10
15		Storage for processing.	0		0	0	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
16		Transport of fruit from sorting to sizer 108 ft. from beginning of sorting to end of three sections of sizers & packing tubs in line.	Two-inch fiber belts over sorting table move fruit to each of 3 sections of sizers & packing tubs, powered by 1/2-horse electric motor with gear head	200	\$ 227.64T \$ 22.76A	0	Kilowatts motor <u>2.984</u> \$.10
17		Sizing by grades into 13 possible sizes & sizers release each sized fruit into a 24-in. diameter tub. Sizing cups operated at a capacity of 344 cups per min. Fruit rolls from sizer to tub.	Double rows of canvas sizing cups carry fruit in each of 3 sections, each cup released by weight spring based on fruit weight, all sections powered by one 5-horse electric motor	150	\$5,000.00T \$ 500.00A	0	Kilowatts motors <u>29.840</u> \$1.01
18		Material Storage	Stacked on floor near dumper	200+	0	0	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
19		Place empty packing boxes, trays, wrapping paper on overhead carrier.	Two small hand trucks & 160 ft. of overhead-conveyor line Van Doren Equip. Co., powered by 1/2-horse electric motor with drive	200+	\$6.50 per ft. installed \$1225.00T \$ 122.50A	two \$1.50 per hour salary \$24.00 \$2.26 other \$26.26	Kilowatts motor 2.984 \$.10
20		Packing by hand from tubs into (42-lb. fruit weight) fiber boxes with	16 packing carts 20 packers stamps Packer & box size marking cards	200+	\$630.00T \$ 63.00A cards \$100.00A	16 pkrs. \$4.40 Ind Insurance	0
21		Packing cart pushed by packer about 3 ft. to side wheel track. Box mechanically shifted to track. Track moves box to stamper & weighing.	200 ft. of side-wheel track 15-inches wide with center-chain drive, powered by two 1/2-horse electric motors	200+	\$ 10.00 per ft. installed \$2220.00T \$ 222.00A		Kilowatts 5.968 \$.20

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
22		At end of sizing & packing line boxes of apples accumulate on tracks.	0	200+	\$118.00T \$ 12.00A	0	Kilowatts lights 22.00 \$.75
23		Stampers hand stamp, size, grade, grower number, code number on end of box. Stamper also accumulates packer & grade-size punch cards.	<u>Hand Stamps</u> 2 "Barton" stampers, 1 side-wheel stamp complete with sizes, 3 rocker-bar stampers, 3 stamp pads 50 1/2-inch square stamps All manufactured by R. M. Church, Inc.	200+	\$150.00T \$ 15.00A	One and one half \$1.40 per hr. \$16.90 salary \$1.61 <u>other</u> \$18.51 T	Ink \$.17

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
24		Transport of packed boxes to automatic segregator & lidder.	50 ft. of side-wheel track with center-chain drive powered by 1/2-horse electric motor with gear head	200+	\$10.00 per ft. installed \$611.00T \$ 61.00A	0	Kilowatts motor <u>2.984</u> \$.10
25		Segregation of boxes.	15 ft. of side-wheel track with center-chain drive powered by same motor as No. 24	200+	\$ 10.00 per ft. installed \$150.00T \$ 15.00A	0	0
26		Loose filled & telescope-top boxes bypass lidder & transport direct to storage.					
27		Glue lidding of packed boxes.	Automatic glue lidder (converted Chrisholm Ryder) powered by 3/4-horse motor	900 packed boxes per hr.	\$6400.00T \$ 640.00A	one \$1.50 per hour \$12.00 salary \$ 1.13 other <u>\$13.13</u> 1/2 for line = \$6.56	Kilowatts motors <u>4.476</u> \$.15

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
28		Transport to storage: one storage on same level & one lower level.	100 ft. of side-wheel track with center-chain drive powered by two 1/2-horse electric motors	200+	\$10.00 per ft. installed \$1,222.00T \$ 122.20A	0	Kilowatts motor <u>5.968</u> \$.20
			35 ft. heavy canvas 10-inch wide moving belt to lower storage powered by one 1/2-horse electric motor	200+	\$ 226.50T \$ 26.65A		Kilowatts motors <u>2.984</u> \$.10
		Cold Storage	Costs not included.				

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
		<u>ALLOCATED COSTS</u>					
		One full-time maintenance man for two packing lines and storage equipment. Unit accounting records allocate time & expendable supplies for year's maintenance on packing line.	Small tools and equipment est. replacement annually & use of miscellaneous supplies for one packing line by plant manager	200+	\$369.00A (\$61.49 per function)	one \$18.70 salary \$1.60 other \$20.30 $\frac{1}{2}$ per line & \$.76 for pregrading \$.94 per function	0
		One supervisor-inspector & one assistant for 2 packing lines inspecting dumping, sorting & packing.	0	200+	0	one \$40.00 one \$20.00 \$60.00 salary \$1.60 other \$64.60 $\frac{1}{2}$ for line \$32.20 less \$11.62 for pre-grading (\$3.44 per function)	0

PROCESS CHART AND COST DATA - FRESH APPLE GRADING, SIZING, & PACKAGING

NAME Packing Line 1, New Technology CROP YEAR 1965 DAYS (8-Hour) OPERATION 107

Reference Number	Process	Description	Equipment	Equipment operating capacity (24-bu. bins in 8 hours)	Equipment total cost & annual depreciation T - Total A - Annual	Man requirements in 8 hours & cost	Utility costs per 8 hours
		For rest periods & provision for emergency care.	One 40-cup coffee maker, 3 picnic tables with benches		\$150.00T \$ 15.00A	0	Coffee, juice, disposable cups \$5.00
		Fire Insurance 1.15% of value (\$1,635.00 for packing lines in 1965)					
		Heat for area.	Steam heat unit with fuel oil burner, oil tank, steam generator, ducts & fans for 2 lines, $\frac{1}{2}$ allocated for single line		$\frac{1}{2}$ = \$1,125.00T \$ 112.50A $\frac{1}{2}$ for sorters $\frac{1}{2}$ for packers \$56.25 per function		$\frac{1}{2}$ = Fuel \$4.18 $\frac{1}{2}$ for sorting $\frac{1}{2}$ for packing \$2.09 per function
		Real Estate tax 50 mills per year on 25% of equipment value.					

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, New Technology Year 1965 Days Operating Season 107

Function	Cost Item	Fixed Costs Per Season	Season Variable To Fixed Costs Per 8-Hr. Shift	Variable Costs Per Season	Season Sub Total By Function
1. Bring up	Fork lift trucks	\$600.00			\$ 600.00
and dumping	Lift truck operator		\$ 13.98	\$1,495.86	1,495.86
	L.P. Gas for lift truck		.92	98.44	98.44
	Maintenance of lift truck and dumper unit	61.49	.94	100.58	162.07
	12 ft. of bin roller track	8.50			8.50
	20 ft. of bin chain-drive/ track	63.60			63.60
	One 1-horse electric motor	17.00			17.00
	Water	50.00			50.00
	Electric power		.20	21.40	21.40

TOTALS: SEASON Continued

8-HOUR SHIFT

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, New Technology Year 1965 Days Operating Season 107

Function	Cost Item	Fixed Costs Per Season	Season Variable To Fixed Costs Per 8-Hr. Shift	Variable Costs per Season	Season Sub Total By Function
1. Continued	Direct Supervision		\$ 3.44	\$ 368.08	\$ 368.08
	Dumper equipment	\$ 360.00			360.00
	Fire insurance (1.15%				
	of fixed costs)	141.74			141.74
	Dumper operator		13.13	1,404.91	1,404.91
	Property tax	154.04			154.04
	Electric power		.20	21.40	21.40
	Chemical (Decosal)		10.80	1,155.60	1,155.60
	16 ft. steel tubing, pump / & motor	67.00			67.00
	Electric power (2 water pumps)		.40	42.80	42.80
TOTALS: SEASON		<u>\$1,523.37</u>		<u>\$4,709.07</u>	<u>\$6,232.44</u>
8-HOUR SHIFT		<u>\$14.24</u>	<u>\$44.01</u>		<u>\$58.25</u>

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, New Technology Year 1965 Days Operating Season 107

Function	Cost Item	Fixed Costs Per Season	Season Variable To Fixed Costs Per 8-Hr.Shift	Variable Costs Per Season	Season Sub Total By Function
2. Brushing	Elevator	\$ 47.00			\$ 47.00
and small	Electric Power		\$.10	\$ 10.70	10.70
(2½ inch	Brushing Unit	280.00			280.00
diameter and	Electric power		.41	43.87	43.87
less) fruit	Small Fruit Eliminator	90.00			90.00
elimination.	Electric power		.10	10.70	10.70
	Maintenance of equipment	61.49	.94	100.58	162.07
	Fire insurance	47.94			47.94
	Direct supervision		3.44	368.08	368.08
	Property tax	60.44			60.44
TOTALS: SEASON		\$586.87		\$533.93	\$1,120.80
8-HOUR SHIFT		\$5.49	\$4.99		\$10.48

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, New Technology Year 1965 Days Operating Season 107

Function	Cost Item	Fixed Costs Per Season	Season Variable To Fixed Costs Per 8-Hr. Shift	Variable Costs Per Season	Season Sub Total By Function
3. Sorting	Sorting table unit	\$ 200.00			\$ 200.00
fruit into 3	Electric power		\$.20	\$ 21.40	21.40
grades and	Lighting	6.56			6.56
cull or	Electric power		.24	25.68	25.68
processing	9 sorters (labor)		110.43	11,816.01	11,816.01
grade	Cull belts	11.40			11.40
elimination.	Electric power		.10	10.70	10.70
	Maintenance of equipment	61.49	.94	100.58	162.07
	Fire insurance on equipment	25.69			25.69
	Direct supervision		3.44	368.08	368.08

TOTALS: SEASON Continued

8-HOUR SHIFT

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, New Technology Year 1965 Days Operating Season 107

Function	Cost Item	Fixed Costs Per Season	Season Variable To Fixed Costs Per 8-Hr. Shift	Variable Costs Per Season	Season Sub Total By Function
3. Continued	Rest Period Equipment ($\frac{1}{2}$)	\$ 7.50			\$ 7.50
	Rest Period Supplies ($\frac{1}{2}$)		\$ 2.50	\$267.50	267.50
	Property Tax	36.44			36.44
	Heat for workers	56.25	2.09	223.63	279.88
TOTALS: SEASON		<u>\$405.33</u>		<u>\$12,833.58</u>	<u>\$13,238.91</u>
8-HOUR SHIFT		<u>\$3.79</u>	<u>\$119.94</u>		<u>\$123.73</u>

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, New Technology Year 1965 Days Operating Season 107

Function	Cost Item	Fixed Costs Per Season	Season Variable To Fixed Costs Per 8-Hr. Shift	Variable Costs Per Season	Season Sub Total By Function
4. Sizing	Belts to sizing, 3 sections	\$ 22.76			\$ 22.76
fruit and	Electric power		\$.10	\$ 10.70	10.70
transport to	3 sizing machine units				
packing	with packing tubs	500.00			500.00
tubs.	Electric power		1.01	108.07	108.07
	Maintenance of equipment	61.49	.94	100.58	162.07
	Direct supervision		3.44	368.08	368.08
	Fire insurance	60.04			60.04
	Property Tax	73.64			73.64
Total: Season		<u>\$717.93</u>		<u>\$587.43</u>	<u>\$1,305.27</u>
	8-Hour Shift	<u>\$6.71</u>	<u>\$5.49</u>		<u>\$12.20</u>

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, New Technology Year 1965 Days Operating Season 107

Function	Cost Item	Fixed Costs Per Season	Season Variable To Fixed Costs Per 8-Hr. Shift	Variable Costs Per Season	Season Sub Total By Function
5. Packing	16 packing carts, machine				
fruit into	cards & 20 stamps	\$ 163.00			\$ 163.00
shipping	Industrial insurance on 16				
containers	packers		\$ 4.40	\$ 470.80	470.80
& transport	200 ft. chain-drive track	222.00			222.00
to checker	Electric power		.20	21.40	21.40
& stamper.	Overhead conveyer & 2 hand				
	handling trucks for packing materials/	122.50			122.50
	Electric power		.10	10.70	10.70
	2 material supply operators		26.26	2,809.82	2,809.82

TOTALS: SEASON Continued

8-HOUR SHIFT

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, New Technology Year 1965 Days Operating Season 107

Function	Cost Item	Fixed Costs Per Season	Season Variable To Fixed Costs Per 8-Hr. Shift	Variable Costs Per Season	Season Sub Total By Function
5. Continued	Maintenance of equipment	\$ 61.49	\$.94	\$ 100.58	\$ 162.07
	Direct supervision		3.44	368.08	368.08
	Fire Insurance	47.49			47.49
	Rest period supplies ($\frac{1}{2}$)		2.50	267.50	267.50
	Rest Period equipment ($\frac{1}{2}$)	7.50			7.50
	Lights for packing area	12.00			12.00
	Electric power for lights		.75	80.25	80.25
	Property tax	74.14			74.14
	Heat for workers	56.25	2.09	223.63	279.88
TOTALS: SEASON		<u>\$766.37</u>		<u>\$3,924.76</u>	<u>\$4,691.13</u>
8-HOUR SHIFT		<u>\$7.16</u>	<u>\$40.68</u>		<u>\$47.84</u>

COST ACCUMULATION - FRESH APPLE GRADING, SIZING, & PACKAGING

Plant Packing Line 1, New Technology Year 1965 Days Operating Season 107

Function	Cost Item	Fixed Costs Per Season	Season Variable To Fixed Costs Per 8-Hr. Shift	Variable Costs Per Season	Season Sub Total By Function
6. Stamping,	Hand stamps	\$ 15.00			\$ 15.00
Checking,	1½ stampers & checkers		\$ 18.51	\$1,980.57	1,980.57
Weighing,	Ink		.17	18.19	18.19
Lidding & transport to storage (ends at storage room entry)	65 ft. track with center chain drive	76.00			76.00
	Electric power		.10	10.70	10.70
	Automatic glue ladder	640.00			640.00
	Electric power		.15	16.05	16.05
	Glue ladder operator		6.56	701.92	701.92
	100 ft. track with center chain drive	122.20			122.20

Continued

TOTALS: SEASON

8-HOUR SHIFT

APPENDIX 2

OPERATING AND COST MODELS FOR THE STANDARD TECHNOLOGY AND THE NEW
TECHNOLOGY ON PACKING LINES 1, 2, 3 AND 4

OPERATING AND COST MODELS FOR PRESORTING AND PRESIZING WITH BURSHES

AVERAGE COST PER UNIT OF OUTPUT WITH SIX PER CENT INTEREST APPLIED
TO TOTAL COST PER SHIFT

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 1 Input ¹ 300,000 Output ² 210,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,528.67	103	\$ 14.84	\$ 46.71	\$ 61.55	2042	\$.030
2. Brushing	599.79	103	5.82	7.69	13.51	2042	.007
3. Sorting	431.99	103	4.19	147.18	151.37	2042	.074
4. Sizing	730.81	103	7.10	8.19	15.29	2042	.007
5. Packing	781.90	103	7.59	43.38	50.97	2042	.025
6. Lidding	1,168.71	103	11.35	32.87	44.22	2042	.022
TOTAL	\$5,241.87		\$50.89	\$286.02	\$336.91		\$.165

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift --- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL - FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 1 Input¹ 400,000 Output² 280,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,528.67	137	\$ 11.16	\$ 46.71	\$ 57.87	2042	\$.028
2. Brushing	599.79	137	4.38	7.69	12.07	2042	.006
3. Sorting	431.99	137	3.15	147.18	150.33	2042	.074
4. Sizing	730.81	137	5.33	8.19	13.52	2042	.007
5. Packing	781.90	137	5.71	43.38	49.09	2042	.024
6. Lidding	1,168.71	137	8.53	32.87	41.40	2042	.020
TOTAL	\$5,241.87		\$38.26	\$286.02	\$324.28		\$.159

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 1 Input ¹ 500,000 Output ² 350,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,528.67	171	\$ 8.94	\$ 46.71	\$ 55.65	2042	\$.027
2. Brushing	599.79	171	3.51	7.69	11.20	2042	.005
3. Sorting	431.99	171	2.53	147.18	149.71	2042	.073
4. Sizing	730.81	171	4.27	8.19	12.46	2042	.006
5. Packing	781.90	171	4.57	43.38	47.95	2042	.023
6. Lidding	1,168.71	171	6.83	32.87	39.70	2042	.019
TOTAL	\$5,241.87		\$30.65	\$286.02	\$316.67		\$.155

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift --- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology New Technology, Packing Line 1

Input ¹ 300,000

Output ² 210,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,523.37	92	\$16.56	\$ 44.01	\$ 60.57	2282	\$.027
2. Brushing	586.87	92	6.38	4.99	11.37	2282	.005
3. Sorting	405.33	92	4.41	119.94	124.35	2282	.054
4. Sizing	717.93	92	7.80	5.49	13.29	2282	.006
5. Packing	766.37	92	8.33	40.68	49.01	2282	.021
6. Stamp, Check, Lid	1,155.52	92	12.56	30.17	42.73	2282	.019
TOTAL	\$5,155.39		\$56.04	\$245.28	\$301.32		\$.132

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology New Technology, Packing Line 1 Input ¹ 400,000 Output ² 280,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,523.37	123	\$12.39	\$ 44.01	\$ 56.40	2282	\$.025
2. Brushing	586.87	123	4.77	4.99	9.76	2282	.004
3. Sorting	405.33	123	3.30	119.94	123.24	2282	.054
4. Sizing	717.93	123	5.84	5.49	11.33	2282	.005
5. Packing	766.37	123	6.23	40.68	46.91	2282	.021
6. Stamp, Check, Lid	1,155.52	123	9.39	30.17	39.56	2282	.017
TOTAL	\$5,155.39		\$41.92	\$245.28	\$ 287.20		\$.126

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL - FRESH APPLE GRADING, SIZING, & PACKAGING

Technology New Technology, Packing Line 1

Input¹ 500,000

Output² \$350,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,523.37	153	\$9.96	\$ 44.01	\$ 53.97	2282	\$.024
2. Brushing	586.87	153	3.84	4.99	8.83	2282	.004
3. Sorting	405.33	153	2.65	119.94	122.59	2282	.054
4. Sizing	717.93	153	4.70	5.49	10.19	2282	.004
5. Packing	766.37	153	5.01	40.68	45.69	2282	.020
Stamp, 6. Check & Lid	1,155.52	153	7.55	30.17	37.72	2282	.017
TOTAL	\$5,155.39		\$33.71	\$245.28	\$278.99		\$.122

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift --- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Presorting and Presizing Line Input¹ 400,000 Output² 280,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,732.00	80	\$21.65	\$39.16	\$ 60.81	3500	\$.017
2. Brushing	1,246.00	80	15.58	4.89	20.47	3500	.006
3. Sorting	1,262.30	80	15.78	102.93	118.71	3500	.034
4. Sizing	1,543.50	80	19.29	17.87	37.16	3500	.011
5. Bin Filling	1,761.00	80	22.01	12.68	34.69	3500	.010
TOTAL	\$7,544.80		\$94.31	\$177.53	\$271.84		\$.078

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Presorting and Presizing Line Input¹ 150,000 Output² 105,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,732.00	30	\$57.73	\$39.16	\$ 96.89	3500	\$.028
2. Brushing	1,246.00	30	41.53	4.89	46.42	3500	.013
3. Sorting	1,262.30	30	42.08	102.39	145.01	3500	.041
4. Sizing	1,543.50	30	51.45	17.87	69.32	3500	.020
5. Binfilling	1,761.00	30	58.70	12.68	71.38	3500	.020
TOTAL	\$7,544.80		\$251.49	\$177.53	\$429.02		\$.123

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL --FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Presorting and Presizing Line Input ¹ 200,000 Output ² 140,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,732.00	40	\$ 43.30	\$ 39.16	\$ 82.46	3500	\$.024
2. Brushing	1,246.00	40	31.15	4.89	36.04	3500	.010
3. Sorting	1,262.30	40	31.56	102.93	134.49	3500	.038
4. Sizing	1,543.50	40	38.59	17.87	56.46	3500	.016
5. Bin filling	1,761.00	40	44.02	12.68	56.70	3500	.016
TOTAL	\$7,544.80		\$188.62	\$177.53	\$366.15		\$.105

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Presorting and Presizing Line Input¹ 250,000 Output² 175,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,732.00	50	\$ 34.64	\$ 39.16	\$ 73.80	3500	\$.021
2. Brushing	1,246.00	50	24.92	4.89	29.81	3500	.009
3. Sorting	1,262.30	50	25.25	102.93	128.18	3500	.037
4. Sizing	1,543.50	50	30.87	17.87	48.74	3500	.014
5. Bin Filling	1,761.00	50	35.22	12.68	47.90	3500	.014
TOTAL	\$7,544.80		\$150.90	\$177.53	\$328.43		\$.094

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 2 Input ¹ 300,000 Output ² 210,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$2,601.42	54	\$ 48.17	\$ 59.55	\$ 107.72	3879	\$.028
2. Brushing	1,189.17	54	22.02	11.32	33.34	3879	.009
3. Sorting	1,344.93	54	24.91	247.43	272.34	3879	.070
4. Sizing	6,102.07	54	113.00	31.94	124.94	3879	.032
5. Packing	1,359.15	54	25.17	60.77	85.94	3879	.022
6. & Tidding Stamping	1,271.97	54	23.56	49.19	72.75	3879	.019
TOTAL	\$13,868.71		\$256.83	\$440.20	\$697.03		\$.180

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 2 Input¹ 400,00 Output² 280,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$2,601.42	72	\$ 36.13	\$ 59.55	\$ 95.68	3879	\$.025
2. Brushing	1,189.17	72	16.52	11.32	27.84	3879	.007
3. Sorting	1,344.93	72	18.68	247.43	266.11	3879	.069
4. Sizing	6,102.07	72	84.75	11.94	96.69	3879	.025
5. Packing	1,359.15	72	18.88	60.77	79.65	3879	.021
6. Stamping & Lidding	1,271.97	72	17.67	49.19	66.86	3879	.017
TOTAL	\$13,868.71		\$192.62	\$440.20	\$632.82		\$.163

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL - FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 2 Input¹ 500,000 Output² 350,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$2,601.42	90	\$ 28.90	\$ 59.55	\$ 88.45	3879	\$.023
2. Brushing	1,189.17	90	13.21	11.32	24.53	3879	.006
3. Sorting	1,344.93	90	14.94	247.43	262.37	3879	.068
4. Sizing	6,102.07	90	67.80	11.94	79.74	3879	.021
5. Packing	1,359.15	90	15.10	60.77	75.87	3879	.020
6. Lidding & Stamping	1,271.97	90	14.13	49.19	63.32	3879	.016
TOTAL	\$13,868.71		\$154.10	\$440.20	\$594.30		\$.153

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift --- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology New Technology, Packing Line 2 Input ¹ 400,000 Output ² 280,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$2,596.13	66	\$ 39.34	\$ 56.85	\$ 96.19	4225	\$.023
2. Brushing	1,183.87	66	17.94	8.62	26.56	4225	.006
3. Sorting	1,339.63	66	20.30	221.39	241.69	4225	.057
4. Sizing	6,096.77	66	92.38	9.24	101.62	4225	.024
5. Packing	1,353.80	66	20.51	58.07	78.58	4225	.019
6. Stamping & Lidding	1,266.67	66	19.19	46.49	65.68	4225	.016
TOTAL	\$13,836.83		\$209.65	\$400.66	\$610.31		\$.144

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL --FRESH APPLE GRADING, SIZING, & PACKAGING

Technology New Technology, Packing Line 2 Input ¹ 500,000 Output ² 350,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$2,596.13	83	\$ 31.28	\$ 56.85	\$ 88.13	4225	\$.021
2. Brushing	1,183.87	83	14.26	8.62	22.88	4225	.005
3. Sorting	1,339.63	83	16.14	221.39	237.53	4225	.056
4. Sizing	6,096.77	83	73.46	9.24	82.70	4225	.020
5. Packing	1,353.80	83	16.31	58.07	74.38	4225	.018
6. Stamping & Lidding	1,266.67	83	15.26	46.49	61.75	4225	.015
TOTAL	\$13,836.88		\$166.71	\$400.66	\$567.37		\$.134

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 3 Input¹ 300,000 Output² 210,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,738.81	81	\$21.47	\$ 58.18	\$ 79.65	2608	\$.031
2. Brushing	717.14	81	8.85	11.47	20.32	2608	.008
3. Sorting	547.35	81	6.76	178.15	184.91	2608	.071
4. Sizing	8,019.47	81	99.00	25.46	124.46	2608	.048
5. Packing	1,537.19	81	18.98	33.56	52.54	2608	.020
6. Check, Stamp, Lid	976.93	81	12.06	39.14	51.20	2608	.020
TOTAL	\$13,536.89		\$167.12	\$345.96	\$513.08		\$.197

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift --- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 3 Input ¹ 400,000 Output ² 280,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,738.81	107	\$ 16.25	\$ 58.18	\$ 74.43	2608	\$.029
2. Brushing	717.14	107	6.70	11.47	18.17	2608	.007
3. Sorting	547.35	107	5.12	178.15	183.27	2608	.070
4. Sizing	8,019.47	107	74.95	25.46	100.41	2608	.039
5. Packing	1,537.19	107	14.37	33.56	47.93	2608	.018
6. Check, Stamp, Lid	976.93	107	9.13	39.14	48.27	2608	.019
TOTAL	\$13,536.89		\$126.52	\$345.96	\$472.48		\$.181

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 3 Input ¹ 500,000 Output ² 350,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,738.81	134	\$ 12.98	\$ 58.18	\$ 71.16	2608	\$.027
2. Brushing	717.14	134	5.35	11.47	16.82	2608	.006
3. Sorting	547.35	134	4.08	178.15	182.23	2608	.070
4. Sizing	8,019.47	134	59.85	25.46	85.31	2608	.033
5. Packing	1,537.19	134	11.47	33.56	45.03	2608	.017
6. Check, Stamp, Lid	976.93	134	7.29	39.14	46.43	2608	.018
TOTAL	\$13,536.89		\$101.02	\$345.96	\$446.98		\$.171

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology New Technology, Packing Line 3 Input ¹ 300,000 Output ² 210,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,733.51	71	\$ 24.42	\$ 55.48	\$ 79.90	2963	\$.027
2. Brushing	711.84	71	10.03	8.77	18.80	2963	.006
3. Sorting	542.05	71	7.63	151.95	159.58	2963	.054
4. Sizing	8,014.17	71	112.88	14.93	127.81	2963	.043
5. Packing	1,531.89	71	21.58	30.86	52.44	2963	.018
6. Check, Stamp, Lid	971.73	71	13.69	36.44	50.13	2963	.017
TOTAL	\$13,505.09		\$190.21	\$298.43	\$488.64		.165

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift — operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology New Technology, Packing Line 3 Input ¹ 400,000 Output ² 280,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,733.51	95	\$ 18.25	\$ 55.48	\$ 73.73	2963	\$.025
2. Brushing	711.84	95	7.49	8.77	16.26	2963	.005
3. Sorting	542.05	59	5.71	151.95	157.66	2963	.053
4. Sizing	8,014.17	95	84.36	14.93	99.29	2963	.034
5. Packing	1,531.89	95	16.13	30.86	46.99	2963	.016
6. Check, Stamp, Lid	971.63	95	10.23	36.44	46.67	2963	.016
TOTAL	\$13,505.09		\$142.16	\$298.43	\$440.59		.149

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology New Technology, Packing Line 3 Input¹ 500,000 Output² 350,00

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,733.51	118	\$14.69	\$ 55.48	\$ 70.17	2963	\$.024
2. Brushing	711.84	118	6.03	8.77	14.80	2963	.005
3. Sorting	542.05	118	4.59	151.95	156.54	2963	.053
4. Sizing	8,014.17	118	67.92	14.93	82.85	2963	.028
5. Packing	1,531.89	118	12.98	30.86	43.84	2963	.015
6. Stamp, Lid Check,	971.63	118	8.23	36.44	44.67	2963	.015
TOTAL	\$13,505.09		\$114.45	\$298.43	\$412.88		.139

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 4 Input ¹ 300,000 Output ² 210,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,711.20	82	\$ 20.87	\$ 59.51	\$ 80.83	2566	\$.031
2. Brushing	485.58	82	5.92	9.72	15.64	2566	.006
3. Sorting	589.13	82	7.18	214.20	221.38	2566	.086
4. Sizing	5,092.19	82	62.10	11.06	73.16	2566	.029
5. Packing	1,779.52	82	21.70	37.26	58.96	2566	.023
6. Lidding	912.08	82	11.12	47.96	59.08	2566	.023
TOTAL	\$10,569.70		\$128.90	\$379.71	\$508.60		\$.198

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING,& PACKAGING

Technology Standard Technology, Packing Line 4 Input ¹ 400,000 Output ² 280,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,711.20	109	\$15.70	\$ 59.51	\$ 75.21	2566	\$.029
2. Brushing	485.58	109	4.45	9.72	14.17	2566	.006
3. Sorting	589.13	109	5.40	214.20	219.60	2566	.086
4. Sizing	5,092.19	109	46.72	11.06	57.78	2566	.023
5. Packing	1,779.52	109	16.33	37.26	53.59	2566	.021
6. Lidding	912.08	109	8.37	47.96	56.33	2566	.022
TOTAL	\$10,569.70		\$96.97	\$379.71	\$476.68		\$.186

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology Standard Technology, Packing Line 4 Input¹ 500,000 Output² 350,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$ 1,711.20	136	\$12.58	\$ 59.51	\$ 72.09	2566	\$.028
2. Brushing	485.58	136	3.57	9.72	13.29	2566	.005
3. Sorting	589.13	136	4.33	214.20	218.53	2566	.085
4. Sizing	5,092.19	136	37.44	11.06	48.50	2566	.019
5. Packing	1,779.52	136	13.08	37.26	50.34	2566	.020
6. Lidding	912.08	136	6.71	47.96	54.67	2566	.021
TOTAL	\$10569.70		\$77.72	\$379.71	\$457.43		\$.178

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology New Technology, Packing Line 4 Input ¹ 300,000 Output ² 210,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,705.90	71	\$24.03	\$ 56.80	\$80.83	2953	\$.027
2. Brushing	480.28	71	6.76	7.02	13.78	2953	.005
3. Sorting	583.83	71	8.22	186.34	194.56	2953	.066
4. Sizing	5,086.89	71	71.65	8.36	80.01	2953	.027
5. Packing	1,518.23	71	21.38	34.30	55.68	2953	.019
6. Lidding	906.78	71	12.77	45.26	58.03	2953	.020
TOTAL	\$10,281.91		\$144.82	\$338.08	\$482.90		\$.164

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING,& PACKAGING

Technology New Technology, Packing Line 4 Input¹ 400,000 Output² 280,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,705.90	95	\$17.96	\$ 56.80	\$ 74.76	2953	\$.025
2. Brushing	480.28	95	5.06	7.02	12.08	2953	.004
3. Sorting	583.83	95	6.15	186.34	192.49	2953	.065
4. Sizing	5,086.89	95	53.55	8.36	61.91	2953	.021
5. Packing	1,518.23	95	15.98	34.30	50.28	2953	.017
6. Lidding	906.78	95	9.55	45.26	54.81	2953	.019
TOTAL	\$10,281.91		\$108.23	\$338.08	\$446.31		\$.151

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

OPERATING & COST MODEL -FRESH APPLE GRADING, SIZING, & PACKAGING

Technology New Technology, Packing Line 4 Input ¹ 500,000 Output ² 350,000

Function	SFC ³	Shifts ⁴	ASFC ⁵ per Shift	SVC ⁶ per Shift	TC ⁷ per Shift	Average Output per Shift ⁸	AC per Unit of Output ⁹
1. Dumping	\$1,705.90	119	\$14.34	\$ 56.80	\$ 71.15	2953	\$.024
2. Brushing	480.28	119	4.04	7.02	11.06	2953	.004
3. Sorting	583.83	119	4.91	186.34	191.25	2953	.065
4. Sizing	5,086.89	119	42.75	8.36	51.11	2953	.017
5. Packing	1,518.23	119	12.76	34.30	47.06	2953	.016
6. Lidding	906.78	119	7.62	45.26	52.88	2953	.018
TOTAL	\$10,281.91		\$86.40	\$338.08	\$424.51		\$.144

1. Field-run boxes with 35 pounds of apples
2. Packed boxes with 42 pounds of apples
3. Season Fixed Cost of Machinery & Equipment
4. Standard 8-hour operating shifts required to process assumed input volume
5. Average Season Fixed Costs per 8-hour operating shift
6. Season variable costs of labor, utilities, and consumed supplies assumed to be fixed costs per 8-hour operating shift
7. Total costs of machinery, labor, utilities, and used supplies per 8-hour operating shift -- operating inputs
8. Average output (42-pound packed boxes) per 8-hour operating shift based on assumed input volume and apple industry input-output conversion ratios
9. Average costs per unit of output

AVERAGE COST PER UNIT OF OUTPUT WITH SIX PERCENT INTEREST

APPLIED TO TOTAL COST PER SHIFT

Packing Line and Season Volume	Operating Input Cost Per Shift	Interest	Operating Input Cost + Interest	Output Per Shift	Average Cost Per Unit
Presort and Presize					
175,000	\$328.43	6%	\$348.14	3500	\$.099
140,000	366.15	6%	388.12	3500	.111
105,000	429.02	6%	454.76	3500	.130
Standard Technology Packing Line 1					
350,000	316.67	6%	335.67	2042	.164
280,000	324.28	6%	343.74	2042	.168
210,000	336.91	6%	357.12	2042	.175
New Technology Packing Line 1					
350,000	278.99	6%	295.73	2282	.130
280,000	287.20	6%	304.43	2282	.133
210,000	301.32	6%	319.40	2282	.140
Standard Technology Packing Line 2					
350,000	594.30	6%	629.96	3879	.162
280,000	632.82	6%	670.79	3879	.173
210,000	697.03	6%	738.85	3879	.190
New Technology Packing Line 2					
350,000	567.37	6%	601.41	4225	.142
280,000	610.31	6%	646.93	4225	.153
210,000	677.40	6%	718.04	4225	.170

Continued

AVERAGE COST PER UNIT OF OUTPUT WITH SIX PERCENT INTEREST

APPLIED TO TOTAL COST PER SHIFT

Packing Line and Season Volume	Operating Input Cost Per Shift	Interest	Operating Input Cost + Interest	Output Per Shift	Average Cost Per Unit
Standard Technology Packing Line 3					
350,000	\$ 446.98	6%	\$ 473.80	2608	\$.182
280,000	472.48	6%	500.83	2608	.192
210,000	513.08	6%	543.86	2608	.209
New Technology Packing Line 3					
350,000	412.88	6%	437.65	2963	.148
280,000	440.59	6%	467.03	2963	.158
210,000	488.64	6%	517.96	2963	.175
Standard Technology Packing Line 4					
350,000	457.43	6%	484.88	2566	.189
280,000	476.68	6%	505.28	2566	.197
210,000	508.60	6%	539.12	2566	.210
New Technology Packing Line 4					
350,000	424.51	6%	449.98	2953	.152
280,000	446.31	6%	473.09	2953	.160
210,000	482.90	6%	511.87	2953	.173

APPENDIX 3

OPERATING RECORDS OF PACKING LINES 1, 2, 3 AND 4 WITH RATE OF
PRODUCT OUTPUT AND PRODUCT QUALITY

OPERATING RECORD OF PACKING LINE NUMBER ONE
RATE OF PRODUCT OUTPUT AND PRODUCT QUALITY

Day and Date of 8-Hour Shift	Output (42-Pound Box)	Per Cent of Maximum Output	Per Cent Cull Grade	Per Cent Fancy Grade	Apple Size Index
Tues. 4/5	1519	62	6	37	109
Tues. 4/19	1603	65	9	46	112
Tues. 5/17	1624	66	12	48	122
Mon. 4/11	1655	67	13	38	123
Wed. 4/6	1660	67	9	41	116
Mon. 4/25	1696	69	10	36	117
Thur. 5/5	1889	77	10	22	131
Thur. 4/7	1904	77	6	27	109
Tues. 4/12	1999	81	9	31	128
Thur. 5/12	2011	81	6	16	117
Fri. 5/6	2014	81	7	21	135
Thur. 4/21	2022	82	12	31	124
Fri. 4/8	2039	82	6	33	106
Fri. 4/22	2087	85	7	34	114
Wed. 4/20	2093	85	7	34	114
Mon. 5/16	2097	85	8	29	115
Mon. 5/2	2121	86	10	31	124
Fri. 5/13	2143	86	9	33	115
Wed. 5/11	2254	91	11	31	118
Tues. 4/26	2273	92	7	21	114
Mon. 5/9	2318	94	7	25	117
Wed. 5/4	2378	96	4	17	114
Tues. 5/3	2389	97	6	21	119
Fri. 4/29	2402	97	8	28	113
Wed. 4/27	2444	99	8	28	109
Tues. 5/10	2468	100	8	24	112
Average	2042	83	8	30	117

OPERATING RECORD OF PACKING LINE NUMBER TWO
RATE OF PRODUCT OUTPUT AND PRODUCT QUALITY

Day and Date of 8-Hour Shift	Output (42-Pound Box)	Per Cent Of Maximum Output	Per Cent Cull Grade	Per Cent Fancy Grade	Apple Size Index
Mon. 1/17	3163	69	9	37	119
Tues. 1/18	3289	72	6	39	106
Thur. 1/13	3405	74	11	37	99
Wed. 10/13	3445	75	13	39	113
Fri. 12/3	3577	78	8	36	103
Tues. 9/21	3618	79	6	32	101
Thur. 12/2	3687	80	7	28	106
Wed. 1/12	3694	81	13	32	96
Thur. 9/23	3843	84	5	19	103
Mon. 10/11	3959	86	6	44	105
Mon. 10/4	4005	87	4	23	96
Wed. 9/22	4067	89	5	24	96
Fri. 10/1	4086	89	6	29	97
Tues. 10/12	4136	90	9	56	96
Wed. 9/29	4142	90	4	16	108
Wed. 12/1	4218	92	9	36	98
Wed. 12/15	4262	93	6	37	94
Thur. 12/16	4522	99	6	36	95
Fri. 12/17	4587	100	8	31	97
Average	3879	85	7	33	101

OPERATING RECORD OF PACKING LINE NUMBER THREE
RATE OF PRODUCT OUTPUT AND PRODUCT QUALITY

Day and Date of 8-Hour Shift	Output (42-Pound Box)	Per Cent of Maximum Output	Per Cent Cull Grade	Per Cent Fancy Grade	Apple Size Index
Thur. 1/20	1658	47	22	33	119
Fri. 1/7	1871	53	12	21	116
Mon. 1/24	1946	55	18	32	121
Mon. 1/10	2103	59	13	22	113
Tues. 1/18	2172	61	16	24	118
Wed. 1/19	2201	62	15	20	122
Tues. 1/25	2218	63	10	19	115
Fri. 1/28	2400	68	15	13	111
Thur. 12/2	2440	69	17	28	124
Tues. 1/11	2456	69	11	22	106
Fri. 11/26	2478	70	12	24	107
Mon. 11/29	2568	72	12	26	114
Wed. 1/26	2573	73	5	14	114
Mon. 1/17	2580	73	9	22	112
Thur. 1/13	2694	76	11	21	112
Mon. 10/18	2752	78	7	12	122
Tues. 11/30	2794	79	14	25	110
Wed. 12/3	2823	80	11	27	114
Wed. 1/12	2828	80	6	16	113
Fri. 1/21	2852	80	4	14	110
Thur. 10/14	2887	81	9	24	113
Fri. 1/14	2891	82	8	22	106
Thur. 1/27	2891	82	7	17	113
Wed. 12/1	2903	82	9	15	124
Mon. 12/13	2904	82	10	25	118
Wed. 10/13	3004	85	8	19	111
Tues. 12/14	3004	85	15	27	107
Wed. 12/15	3189	90	8	20	110
Fri. 10/15	3547	100	8	19	102
Average	2608	74	11	21	113

OPERATING RECORD OF PACKING LINE NUMBER FOUR
RATE OF PRODUCT OUTPUT AND PRODUCT QUALITY

Day and Date of 8-Hour Shift	Output (42-Pound Box)	Per Cent Of Maximum Output	Per Cent Cull Grade	Per Cent Fancy Grade	Apple Size Index
Fri. 12/3	1817	54	14	23	130
Wed. 11/17	1873	56	13	34	144
Mon. 12/6	1989	59	14	29	132
Wed. 12/8	2169	65	13	28	122
Thur. 10/7	2248	67	11	24	123
Fri. 10/22	2270	68	10	20	117
Tues. 12/7	2308	69	14	28	133
Tues. 11/16	2406	72	12	27	119
Tues. 11/30	2477	74	16	24	111
Fri. 10/1	2523	75	14	28	115
Mon. 10/25	2588	77	7	20	116
Mon. 11/22	2628	79	10	19	102
Thur. 10/21	2712	81	10	14	113
Mon. 11/29	2842	85	13	23	102
Thur. 10/28	2867	86	9	20	120
Mon. 10/4	2880	86	11	30	115
Tues. 10/5	2886	86	4	18	122
Tues. 11/23	2980	89	10	14	101
Wed. 10/27	3019	90	7	13	119
Wed. 10/6	3050	91	8	20	112
Wed. 10/20	3345	100	3	9	104
Average	2566	77	11	23	118