To the Graduate Council:

I am submitting herewith a thesis written by Robert Mason Ball entitled "An Economic Feasibility Study for a Fresh Vegetable Packing Facility." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

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A Thesis

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DEDICATION

I would like to dedicate this thesis to Cindy Gant. Cindy's strength, support and encouragement has helped make this Master's degree possible.

I would also like to dedicate this thesis to my former wife's family who has been a source of strength after Ruth Ann's death in March, 1986.

ABSTRACT

The Packing Simulation (PACKSIM) model was used in an analysis to determine the effects that variations in product prices, crop yields, operating level, interest rate, financing and packing charges would have on the operation of a fresh vegetable packing facility. The initial analysis consisted of 15 vegetables (spring and fall broccoli, cantaloupe, cucumber, okra, Irish potatoes, sweet potatoes, tomatoes, bell peppers, fall greens, sweet corn, squash, pole beans and spring and fall cabbage). The initial assumptions were that product prices were based on a five-year average of Atlanta wholesale prices, crop yields were based on the 1988 vegetable budget, operating level was set at 70 percent of rated capacity, packing charges were obtained from several sources and 90 percent of the total capital was financed at 10 percent interest. In the analysis, product prices were varied 25 percent above and below the Atlanta wholesale prices, crop yields were reduced 10 and 20 percent below budget levels, operating level was set at 50 and 90 percent of rated capacity, packing charges were adjusted to 10 cents per unit above packing cost, interest rates were changed to 8 and 12 percent and the total amount financed was changed to 80 percent.

Analysis of the facility packing 15 vegetables revealed that several vegetables had packing cost greater than their packing charge. Coordinating the harvest, delivery and packing of 15 vegetables would be difficult.

The analysis was also conducted on several combinations of vegetables taken from the original 15. These models included a six-vegetable facility (Irish potatoes, tomatoes, bell peppers, sweet corn and spring and fall cabbage), a five-vegetable facility (Irish potatoes, tomatoes, bell peppers and spring and fall cabbage), a five-vegetable facility with a hydrocooler (tomatoes, bell peppers, sweet corn and spring and fall cabbage) and a four-vegetable facility (tomatoes, bell peppers and spring and fall cabbage). Due to the design of the program, changes in product prices exhibited no effect on the break-even analysis of the facility in these models.

This study also revealed that decreases in yield by 10 and 20 percent required that acreage be increased about 10 percent and 25 percent, respectively, for all the facilities analyzed. Change in yield had no effect on packing cost per crate, average variable cost, average fixed cost and total fixed cost.

A decrease in packing level to 50 percent of rated capacity required acreage to increase to a range of 37 to 49 percent to maintain the break-even level of operation. An increase to 90 percent of rated capacity required acreage to decrease to a range of 12 to 17 percent to maintain the break-even level of operation. Average variable cost per unit of output decreased 12 to 19 percent at the 50 percent packout level and increased 6 to 10 percent at the 90 percent packout level. Average fixed cost declined 29 to 32 percent at the 50 percent packout level and increased 14 to 19 percent at the 90 percent packout level. Total fixed cost was not effected by changes in packing level. Total

variable cost increased 43 to 62 percent at the 50 percent packout level and decreased 13 to 21 percent at the 90 percent packout level.

Acreage was required to decline in a range of 13 to 19 percent when packing charges per unit of output were adjusted to 10 cents above packing cost. Packing cost per crate increased 5 to 10 percent, average fixed cost increased 19 to 25 percent, total variable cost declined 17 to 18 percent and total crates sold declined 17 to 18 percent. Average variable cost and total fixed cost were not effected by the change in packing cost.

Changes in interest rates exhibited no effect on packing cost per crate, average variable cost and average fixed cost. In order to maintain the break-even level of packinghouse volume, acreage was reduced in a range of 6 to 10 percent at 8 percent interest rate and increased in a range of 5 to 11 percent at 12 percent interest rate. Total fixed cost, total variable cost and total crates sold decreased in a range of 7 to 8 percent at 8 percent interest rate and increased in a range of 7 to 8 percent at 12 percent interest rate.

Financing at the 80 percent level required the break-even acreage to decline in a range of 3 to 9 percent. This change in financing level exhibited no effect on packing cost per crate, average variable cost and average fixed cost; however, total fixed cost declined 4 percent, total variable cost declined 4 to 5 percent and total crates sold declined 4 to 5 percent.

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CHAPTER I

INTRODUCTION

A. FRESH VEGETABLES: AN ALTERNATIVE CROP

At a conference on Alternative Farming Opportunities for the South, participants emphasized that as the farm crisis in the South takes its toll on farmers, many are turning their attention to high value alternative crops as a partial solution to their problems. The process of evaluation and change always has occurred in agriculture. The rapid decline in profitability for many traditionally Southern commodities and the increased profitability of other minor crops have forced producers to rapidly re-examine their farm production decisions (Estes, 1987). Many farmers are considering growing vegetables for the commercial fresh market as an alternative or addition to their present production enterprises. Before undertaking commercial vegetable production, farmers should be aware of production and marketing requirements and opportunities for their region. They must learn the needs of the commercial vegetable market and meet those they are most capable of meeting with respect to management and/or resources (Runyan, et al., 1986).

Changes in per capita consumption of selected fresh vegetables have been rather dramatic over the past 25 years, particularly in the last decade, as indicated in Table I-1. The shifts in consumption figures tend to parallel and support the increasing consumer concern for diet and nutrition, and the resulting expansion and proliferation of

salad bars in food services facilities. Related to these changes are notable increases in the consumption of those vegetables that can be eaten raw, as opposed to those that require cooking (Runyan, et al., 1986).

TABLE I-1

PER CAPITA CONSUMPTION OF SELECTED FRESH VEGETABLES (FARM WEIGHT), UNITED STATES, SELECTED YEARS

Item	1950	1955	1960	1965	1970	1975	1980	1985
	pounds							
Broccoli	1.0	0.5	0.4	0.3	0.5	1.0	1.6	2.9
Cabbage	14.3	11.1	10.5	8.9	8.8	9.2	a	a
Cantaloupe	9.1	9.4	8.4	7.9	8.9	6.9	a	a
Cauliflower	2.3	2.2	2.4	1.0	0.7	0.9	1.3	2.2
Lettuce	18.6	20.5	20.0	21.7	23.1	24.5	26.8	25.5
Peppers	2.3	2.2	2.4	2.3	2.4	3.1	a	a
Spinach	1.7	1.0	1.0	0.6	0.5	0.5	a	a
Sweet corn	7.7	8.2	8.1	8.1	7.9	7.9	7.3	7.7
Tomatoes	12.9	13.4	12.6	12.0	12.3	12.1	13.4	15.8

[a]Data not available.

Source: Agricultural Statistics 1965, 1980 and 1986, U. S. Department of Agricultural.

In a Virginia study, Runyan, et al. (1986), stated that there are market opportunities for local growers who wish to produce vegetables for the local market. Risks such as weather, both locally and in traditional production areas, and competitive sources of supply can result in a lower price. But the opportunities for successful entry for some producers are there.

Runyan suggests that successful market entry requires a serious commitment. Neighboring states and other parts of the country are looking for produce opportunities too, and they are also looking at Virginia and neighboring markets. In order to meet this potential competition, local growers must band together to establish an identity and dependability that will win the confidence of the local produce buyers. They must agree to pack to accepted quality standards and to merchandise products with pride. Above all, growers, buyers, county extension agents and university specialists must work together as a team.

The 1982 agricultural census data for Tennessee reports that a total of 2,070 farms with 30,096 acres were involved in the production of fresh vegetables (Census of Agriculture, 1984). As producers switch from the more traditional commodities to producing fresh vegetables, one of the problems that will need to be addressed is the establishment of consistent markets for their produce. Tennessee's fruit and vegetable industry is characterized by numerous, small-scale growers who produce a large assortment of crops even though there are several large scale growers (Brooker, 1985). However, considering any one particular crop, Tennessee is a minor supply region with respect to total United States production. The diversity of crops produced, widely scattered small-scale production and relatively minor position with respect to total U. S. production creates serious market access barriers for Tennessee fruit and vegetable growers attempting to enter commercial wholesale markets. In 1985 sales of fruits and vegetables from Tennessee farms were recorded as $73.3 million. Because production is widely dispersed

across Tennessee and often sold directly to consumers, some sales were not recorded. Vegetable sales in 1985 included 1) tomatoes $23.9 million, 2) snapbeans for processing $2.3 million, 3) potatoes $2.2 million and 4) sweet potatoes $985 thousand (Tennessee Agricultural Statistics, 1987).

According to a Tennessee Agricultural Extension report (Jenkins, p. 3, 1985), fruits and vegetables contribute a substantial amount of income to Tennessee producers, and prospects for the future appear good. Five reasons for an optimistic view were presented:

1. Closeness to consumers. About two-thirds of all U. S. consumers are located within one day's haul of Tennessee.

2. Ample water supplies, in contrast to some major production areas.

3. Many adapted varieties, with university researchers regularly finding better suited cultivars.

4. Increasing awareness and support for fruit and vegetable production and marketing by farm groups and government.

5. Development of marketing facilities and expertise, both for intrastate and interstate sales (Jenkins, p. 3, 1985).

Farmers considering vegetable production as an alternative crop should also realize the risk and uncertainty associated with vegetables (Motes, et al., 1987):

1. Vegetables, as well as many other alternatives, are not a sure way out of a debt crisis situation for a farmer.

2. Vegetable production profits are potentially high if: yield is good, quality is good, price is good, and all is marketed. Potentially high profits will diminish quickly if any of these four factors becomes a problem.

3. Vegetable crops are much more labor and capital intensive than traditional agricultural enterprises.

When evaluating alternatives, producers should be encouraged to examine their physical and financial resources, management issues and marketing concerns.

Low volume producers of fruits and vegetables, as well as new producers attempting to enter this industry, are often confronted with a serious market access barrier. This can be briefly described as the problem growers confront when attempting to enter a market where the marketing channel is dominated by high volume buyers purchasing from established, large volume sellers. While several factors have contributed to the problem, changing from a centralized to a decentralized market system has contributed to the factors creating the market access barrier (Brooker, 1983).

The terminal markets in major consumption centers once served as commodity aggregation points, often selling products to wholesalers and retailers via auctions. Growth of large wholesaler-retailer organizations have diminished the importance of these terminal markets by procuring supplies directly from the major production areas, thus by-passing the terminal markets (Brooker, 1983). Hence, the fresh fruit and vegetable marketing channel tends to encourage sales of large volumes at points of production and the acquisition of supplies from traditional locations.

Growers in the southern region of the U. S. are concerned about the potential of expanding production and capturing a larger share of the fresh produce market. To achieve this objective will require overcoming market barriers (Brooker, 1983). New producers entering the production of fresh vegetables and other small-scale producers may

consider the option of organizing a facility to grade, package and market their produce as a group instead of trying to locate and establish markets as individuals. The formation of a growers' cooperative or growers' association provides an opportunity for pooling resources and for establishing a reputation of marketing quality vegetables. Both aspects will help to open more marketing opportunities for local production. Buyers or their field representatives are more receptive to meeting with and discussing their needs with groups of local growers than with individual growers, unless the latter had substantial acreage of a particular commodity (Runyan, et al., 1987).

B. OBJECTIVES

The specific objectives of the study were:

1. To determine the costs involved in constructing and operating a packing and marketing facility for fresh vegetables.
2. To analyze the impact on economic returns from handling selected combinations of fresh vegetables and the sensitivity of returns from adjusting various input components of the packinghouse model.

C. PROCEDURE

The study focused on an eight-county area of Tennessee centered on Grundy and seven contiguous counties: Bledsoe, Coffee, Franklin, Marion, Sequatchie, Van Buren and Warren counties. Information from extension specialists were used to determine which fresh vegetable commodities to examine in the feasibility analysis.

To determine the cost of constructing, equipping and operating the packing and marketing facility, several packing facilities in Tennessee, Alabama and Kentucky were personally visited. Cost information for equipment and supplies was obtained from manufacturers and dealers. The costs of labor, taxes, land, interest, business expenses, packing materials, equipment, building and other expenses were acquired from appropriate sources. An economic-engineering approach was used to construct the hypothetical facilities.

A computer simulation model developed at Oklahoma State University (Falk, et al., 1986) was used to help in the feasibility analysis. Different specifications regarding combinations of commodities, interest rate, percent of financing, packing charges, packing rate, crop yields and product prices were examined to provide insight regarding the effects on net returns.

CHAPTER II

METHODOLOGY OF COST FEASIBILITY STUDIES

Cost analysis is a complex process used to account for costs in conducting business operations and analyzing cost for feasibility study purposes. As a business functions, many assets lose their original identity. The business operation converts some of the assets into some other form. For example, raw materials of many kinds may go into a final manufactured product. Many of these raw materials may be unrecognizable in the end product. However, costs are traced through the business operations as the assets and resources are converted into goods and services. Because the profits and losses of a business are measured as the difference between the revenue received from customers and the costs associated with the delivery of the products or services, a project cannot be judged as feasible or profitable without dependable cost estimates (Stevens and Sherwood, 1982).

A. ESTIMATION OF PLANT COST RELATIONSHIPS

Approaches to estimating plant cost and efficiency relationships may be grouped into three broad categories: 1) descriptive analysis of accounting data, which mainly involves combining point estimates of average costs into various classes for comparative purposes; 2) statistical analysis of accounting data, which attempts to estimate functional relationships by econometric methods; and 3) the economic-engineering approach, which "synthesizes" production and cost relationships from

engineering data or other estimates of the components of the production function (French, 1977).

Descriptive Analysis of Accounting Data

There appear to be four main reasons for the popularity of the accounting data approach to business feasibility analysis. First, it is relatively cheap compared to economic-engineering analysis or to statistical studies. Second, it is easily understood by plant managers. Third, since the costs are "real," they provide a means for managers to relate their own cost experience to the experience of others. Finally, they provide a record of cost experience useful to agencies and groups interested in broader questions pertaining to levels of marketing costs and margins (French, 1977).

There are, however, significant limitations to the approach. First, unless the record-keeping system is highly standardized among plants, the costs compared may vary widely--especially among component costs--simply because of differences in accounting classification or allocation systems and the time of purchase of durable inputs. Second, in addition to differences in accounting systems, plant costs are affected by so many factors--managerial efficiency, scale, production methods, input prices, degree of plant utilization, environmental conditions and random variations in plant performance--that the types of cross-classification or groupings typically possible usually do not permit clear separations of the influence of individual factors. Finally, this type of study gives us only snapshots of past experience. It provides no quantitative measures of parameters and few general clues

regarding the types of functional relationships suggested by a microeconomic-theory framework (French, 1977).

Statistical Analysis of Accounting Data

Statistical analysis uses much the same data as descriptive analysis. It is distinguished from the latter by the attempt to develop quantitative estimates of production and cost functions in order to test theoretical hypothesis about functional relationships.

The statistical approach has been considerably less popular in studies of marketing firm efficiency than straight descriptive analysis or the economic-engineering approach. Offhand, this may seem surprising since research costs of statistical analysis are not especially high and the state of statistical science is generally well advanced. The explanation appears to be in the difficult specific methodological issues encountered, the limited uses of purely statistical analysis and the availability of an alternative approach (economic-engineering) which, although more costly, may be more satisfactory for many purposes (French, 1977).

Statistical studies using accounting records face all the data limitations of descriptive studies. The data defects may be of greater importance, however, because of the potential for biasing quantitative functional estimates. The five problems most commonly encountered are identified in the following list from French, pp. 125-126, 1977:

1. Measures of durable input costs, in the form of depreciation figures, may vary among plants due to differences in accounting systems, the acquisition dates of the factors and depreciation rates that do not accurately reflect the real input costs.

2. Accounting values are averages for a period of time and may conceal variations in rates of output and plant utilization within accounting periods.

3. Factor prices, including variable factors, may vary among plants owing to locational and institutional rigidities and over time owing to price level changes.

4. Time series of long duration may reflect variations in the physical plant structure and productive technique.

5. Cost values for multiple-product plants may involve arbitrary and variable systems of allocating costs among products.

The Economic-Engineering Approach

The alternative to descriptive and statistical analysis of plant accounting data is to synthesize cost functions from engineering, biological or other detailed specifications of input-output relationships. This approach has come to be referred to most commonly as economic-engineering analysis (French, 1977). It has also been called the building block approach, the engineering approach or the synthetic approach.

The economic-engineering approach, as defined here, encompasses studies ranging from simple descriptive comparisons of labor time requirements, through industrial engineering-oriented studies of methods improvement, to detailed estimates of short-run and long-run cost functions.

The nature of economic-engineering analysis perhaps can be described most clearly in terms of a series of procedural steps (French, pp. 137-139, 1977):

1. System description. The economic-engineering method requires much greater familiarity with technical aspects of production than does the typical analysis of accounting data. The researcher thus must become familiar, through plant visits and consultations, with the production systems and organization of activities within and among the firms of concern.

2. Specification of alternative production techniques. Unless the research is concerned only with the development of a short-run cost function for a single plant, the researcher must consider the variations of production technique that might be employed at each stage of the plant operation.

3. Estimation of the production function. The total plant production function is obtained by combining the production functions for the various operating stages or components. The "building blocks" for the stage production functions are the building and equipment capacities and the associated input-output relationships for labor, chemicals, energy and materials.

   Equipment capacities may be determined by measurements in plants selected for detailed study or from manufacturer's and/or engineers' specifications. Building space requirements are determined by space requirements for equipment, work space, storage and traffic movement. Typically, these requirements are determined by observations in sample plants. Alternative building designs and constructions are developed by consultation with building contractors or construction engineers.

   The specification of equipment, layout (or route organization and distance for collection and delivery systems) and building space generally prescribes the types of jobs to be performed, although some variation in crew organization and work procedures may be possible. Labor performance standards for various tasks may be developed from any of several sources. Most commonly they are derived from work measurement data obtained by time, production or work sampling studies in a sample of plants which utilize the various production techniques to be considered.

   Plant record data may, however, serve a very important and often neglected purpose--that of establishing the credibility and character of the estimated component production functions. The synthesized functions may reflect standardized conditions not found in any particular plant, and comparison with actual input-output observations can provide a type of "ballpark" check plus an indication of the level of performance being modeled.

4. Synthesis of cost functions. Once the production functions have been specified, the cost functions are determined by applying factor prices. Short-run cost functions are obtained by specification of a set of production techniques and their capacities (thus defining a particular plant) and computing variable operating costs for a range of output rates up to or in excess of the design capacity limits. Time and partial product dimensions can be eliminated or varied by specifying operating conditions such as length of season and ratios of each stage from raw product to the final product or products.

   To develop long-run cost functions, considerations must be given to all alternative stage production techniques and to the measurement of prices of durable inputs. The usual procedure for the latter is to specify an expected life of the equipment, divide this into the installed cost and add an amount to cover the cost of borrowed capital, taxes, insurance and in some cases, a portion of average maintenance costs.

The economic-engineering approach avoids many of the problems encountered in strictly statistical studies. Moreover, it can be applied in cases wherein accounting record data are not available, and it can more readily handle cost functions with multiple products and the added dimensions of length of operation. And it is usually the only approach possible when the objective is to compare methods or develop improved methods of operation.

A major limitation of the economic-engineering approach is the high research cost. The amount of technical detail required to synthesize cost functions can be relatively expensive when compared with the analysis of accounting data. Moreover, as the size and complexity of the operation increases, so does the possibility that the model builder will omit some aspect of cost. In view of the expense involved, the objectives and expected benefits should be weighed carefully against the research cost in each individual study (French, 1977).

The economic-engineering approach has been criticized for the lack of findings pertaining to diseconomies of scale. This had been attributed to the use of constant input coefficients (especially for labor) and the inability to measure or account for coordination problems as plant scale increases. Furthermore, although the engineering approach may handle technical aspects of production processes with considerable accuracy, estimates pertaining to management, sales and service activities are apt to be very crude.

On balance, the economic-engineering approach appears to offer more in terms of analytical power (at a higher cost) than either the descriptive approach or the statistical approach. However, the optimal choice of method depends on the objectives of the study and the funds and data available. An amalgamation of all three approaches may be appropriate in some cases.

B. A METHODOLOGICAL APPROACH TO COST MEASUREMENT

The development of improved methods of performing particular operations may require very detailed industrial analysis or time and motion study. The economic-engineering approach that is outlined here is designed for studies concerned with comparing the relative efficiency of alternative technologies and with specific cost functions for individual plants and long-run functions involving plants of different size. However, the general methodology would also be appropriate for studies with slightly different objectives (French, et al., 1956).

The measurement problems differ somewhat among the major types of inputs and will be discussed under four headings: labor, materials, other operating inputs and durables.

Labor

Two main sources of data can be used to estimate basic physical and cost-output relationships for labor: 1) plant payroll and output records and 2) engineering studies of actual operations.

Plant records. Plant payroll records usually show the hours of labor per day or week and the pay rates for each worker in the plant. Where these records indicate, or can be made to indicate, the nature of each individual's job, they may be related to the corresponding volumes of products to develop labor input-output functions for most of the plant stages. It must be recognized, of course, that the changes in output and input from period to period may result from both changes in rates and changes in hours of operation.

The disadvantage of payroll records is that they usually reveal little of the specific details of many of the plant jobs. For example, they may conceal the fact that a considerable portion of the man-hours involved in performing a particular job may consist of idle time and that a higher rate of performance or output could be attained under other circumstances. Another difficulty is that the records may contain errors or be incomplete in classifying workers as to the type of work performed. Moreover, because accounting procedures are far from standardized, difficulty in obtaining strictly comparable records from a number of plants may occur.

Engineering studies. Engineering studies provide a means of obtaining basic labor data that are not readily available from accounting records. Four specific types of studies are important in this regard: 1) detailed descriptions of plant operations; 2) time studies; 3) work sampling studies; and 4) analysis of standard work data (French, et al., 1956).

The descriptive type of study is useful mainly to provide a general picture of the plant organization--the crew setup, kinds of operations performed, and the like. It consists of detailed descriptions of each plant job, number of workers employed on each job and stage for the observed rates of output and the flow of materials through the plant. It is intended as a supplement rather than a substitute for other types of studies but in some cases may provide all the needed information.

Time studies usually involve stop-watch measurement of unit time requirements over a short period of production--say, 20 to 60 minutes. Prior to actual measurement, the job is described or analyzed and the production units defined. Individual measurements are then made of the elapsed time between the beginning and end of work for each production unit.

The disadvantages of this type of study are in the rating procedure and in the fact that only a few workers are observed, and they are observed over short periods of time. Where only a few workers are studied for short periods, the observations may not be fully representative of the usual activity associated with the job, particularly if there is worker reaction to the time study. This disadvantage is

reduced, however, if the rating procedure achieves its objective. In spite of these limitations, the rating procedures will usually result in a "tightening" of the scatter of observations and thus reduce the possible range of error.

A study using the work sampling technique, commonly called ratio delay, is essentially a procedure of sampling workers' activities through time. It provides estimates of the proportions of time spent by various workers on various operations. When related to the total man-hour inputs and corresponding outputs, it yields estimates of the unit time requirements for the detailed elements for each job.

One of the limitations of time studies--all workers not working at the same rate--is still not overcome by the use of the work sampling method. However, this problem may be reduced, at least, in that the studies cover a longer period of time and more workers and, therefore, may provide a better representation of "normal" performance. Other advantages are: it can be applied to some jobs where time study is quite ineffective; the studies reveal where delays and idleness occur, which disclosures may lead to the development of means of minimizing them; the work sampling studies may require less field time to obtain a given amount of data or to cover a given number of operations; and finally, the sampling procedure involved in this method provides an objective measure of the reliability of the time measurements.

Standard work data require a detailed description of each operation and manipulation involved in the job. This includes specifying each arm and hand motion, type of grasp, weights and dimensions of objects moved, body turns and so on. If each micromotion is adequately

described, standard time requirements can be taken from motion and time tables. The sum of the time requirements for all microelements in a job represents an estimate of the basic unit time requirements.

The standard work data method might be a great time-saver as it eliminates actual direct measurement. Unfortunately, in some cases, the element descriptions and computations involved are themselves so time consuming that they may offset much of the gain from eliminating actual measurement. Other difficulties with this method are that it requires a somewhat specialized skill, and there is some question as to the reliability of the standard data themselves. On the whole, this method may be useful to supplement or check against direct measurement, but probably it cannot yet be considered an adequate substitute.

Calculation procedures. The analytical process may be viewed as consisting of three steps: 1) development of the physical standards of performance; 2) verification of these standards; and 3) development of cost standards.

Determining standard input-output functions may require any of a wide variety of analytical procedures, including mathematical and graphic statistical techniques. For some operations, plant records may prove the most productive source of data; for other cases, engineering studies may be most useful in many instances, two or more sources may yield data that reinforce and supplement each other. However, regardless of the specific procedures and kinds of data that seem most appropriate for a particular operation, the analysis should yield functions representing rates of input and output. The rate functions may then be

converted to appropriate functions where volume is increased by increasing hours at constant rates of output. Failure to separate the effects of variations in rates and variations in time may give completely unrealistic descriptions of the true nature of the production function.

The standard input-output relations may be discontinuous, taking account of the fact that workers must be hired in whole units. For standards based on engineering studies, the measurement process gives results initially in terms of "basic" labor time requirements--"instantaneous" functions. Allowances for rest periods and necessary delays are added and the standards expressed more conveniently as average rates over time.

Step two involves the standards based on engineering studies may cover only a short period of time and perhaps includes only a limited number of workers. Adjustment or "leveling" of the time values to some norm may reduce the variation in the estimates, but the norm itself may not be well established. Thus, there is a need to compare these standards with rates of performance to see if they appear to represent "reasonably efficient" levels of performance.

A study by French, et al., 1952, revealed that, aside from variations in average fruit size, the major factors contributing to low rates of performance on some days were delays in the plant operations and imperfect adjustment of the packing crew size to rates of fruit flow. The standards represent operating conditions where these delays and imperfect adjustments are reduced to a reasonable minimum.

Calculation of cost standards is step three. To be of use in the decision-making process, the physical performance standards must be

transformed into estimates of cost as functions of the rate of output. This is a fairly simple problem in theory but, in actual measurement, it is complicated because wage rates may be on an hourly or a piece-rate basis.

The physical performance standards do not directly determine labor costs. They determine the number of workers that must be employed to achieve a given rate of output. The labor cost is then estimated by multiplying the required number of workers by the appropriate wage rates.

When labor is paid on a piece-rate basis--not all jobs are adapted to this method of payment--the problem of transforming physical inputs to a cost basis is simplified in one respect and complicated in others. Direct labor costs are determined, not by units of input, but by units of output. In this respect, the labor cost function is simply a linear function of the rate of output with the slope of the function equal to the level of the piece-rate.

Materials

The cost of materials contained within the final product are probably the easiest of the inputs to measure for they commonly enter the production process in rigidly fixed proportions. The physical inputs may be measured quite effectively by the simplest of engineering studies. A fruit packing box, for example, consists of so many nails, various pieces of wood, glue and labels. Given these specifications, the costs of the materials are obtained by simply multiplying the physical quantities by their prices which may be constant or some

function of the quantity purchased. Price data usually may be obtained from catalogs and listings of the manufacturers of the basic materials.

An alternative source of materials cost data are the plant accounting records. Operating statements commonly contain materials cost information on a per unit of product basis. If not, it can be calculated from the inventory records. An advantage of record data is that they usually reflect any loss due to breakage or damage that should properly be considered a cost of materials. And the materials price data reported by plants may be somewhat more realistic than figures listed by manufacturers because actual sales may involve discounts and various "special deals." A disadvantage of the record data is that inventory records may carry materials costs on the basis of past purchase prices for particular "batches" rather than reflecting current costs.

Other Operating Inputs

Other operating inputs, in addition to labor and materials, are involved in cost analysis. Other operating inputs may consist of items such as power, fuel, water and chemicals, miscellaneous supplies and general expenses and administrative costs.

Power, fuel, water and chemicals. Power and fuel costs may be estimated either from accounting records or by engineering studies of chemical processes and various machine requirements. Data from accounting records usually consist of monthly figures based on bills from power or water companies or a total figure for the accounting period for various chemicals and fuels used.

Cost estimates in a functional form can be obtained through engineering estimates based on data concerning chemical process and machine requirements and to a lesser extent from regression analysis of record data. Technical data concerning chemical requirements and the effects of varying quantities of chemicals on rates of final output are commonly available through plant engineers and chemists. The physical functions can be converted to cost functions, as in the case of materials and labor, by applying the appropriate prices obtained either from the plant or the suppliers of the power and chemicals.

Miscellaneous supplies and general expenses. Miscellaneous supplies consist of items such as paper, pencils and janitorial materials. The quantities required of these items may be some function of the size of plant but may bear little relation to the variation in rates of output within the plant. Estimates of these costs must be obtained primarily from plant operating statements giving the aggregate cost of these items for the accounting period.

General expenses consist of such items as dues, donations, licenses, etc. They are usually quite minor in total and can be determined only from plant records.

Administrative costs. Administrative costs consist of the salaries of managers and executives. They are probably as difficult to estimate of any of the various inputs. Accounting records are the chief source of these data, but frequently the needed information is carried in an inaccessible "confidential" account. And even where the records

are freely available, salaries may be difficult to separate from profits.

Durable Goods

Three main sources of data are useful in estimating the costs of durable goods: 1) plant accounting records; 2) engineering-architecture estimates of building costs; and 3) data supplied by manufacturers of equipment and buildings. The objective in measuring the cost of durable items is to provide estimates of the future maintenance and replacement costs of these items.

The engineering-architecture approach to this problem consists of first estimating the physical requirements involved in replacing any specified structure--i.e., quantities of various materials and man-hours of various types of construction labor. To these physical estimates is applied a set of prices which appears most nearly to reflect costs that can be expected to prevail over some future period. The choice of price level is, of course, purely arbitrary.

The process outlined above provides an estimate of investment replacement costs in terms of current or future prices. Estimates of repair costs and expected useful life based on operating and engineering experience are then used with the estimated investment cost to estimate the average long-run cost rates of replacement and maintenance.

C. AGGREGATION AND INTEGRATION

The measurement procedures outlined above, when completed, provide a set of "building blocks" for estimating individual plant cost

functions. These functions are the basis for comparing the efficiency of alternative technologies and for determining the possible economies that may be associated with the scale of operation.

Cost measurements are only approximations of the theoretical functions. But, if carefully executed with proper empirical models, the cost functions should provide reasonably close approximations and thus be a useful tool for managerial decision-making (French, et al., 1956).

CHAPTER III

PACKINGHOUSE OPERATIONS

The basic operations in a packinghouse are sorting, sizing, grading and packing. Depending on the kind of produce, additional activities may include degreening, curing, washing, bunching, chemical treatments and precooling (Akamine, et al., 1975). The sequence of activities varies with different crops. These operations are essential preparatory steps to storage, transportation and subsequent marketing.

A. PRECOOLING

High temperatures are detrimental to the keeping quality of fruits and vegetables. However, elevated produce temperature is inevitable, especially when harvesting is done during hot days (Akamine, et al., 1975). Precooling is a means of removing this field heat. The general aim is to slow down the respiration of the produce, minimize the susceptibility to attack of microorganisms, reduce water loss and ease the load on the cooling system of the transport vehicle or ship's cargo space. These methods of precooling are discussed next (Akamine, et al., 1975).

Air Cooling

The temperature difference between the coolant and the commodities or packages must be reduced rapidly for precooling to be effective. Cooling may be accomplished by the use of coolants such as air, iced water, ice or vacuum. The temperature of the cooling air must not be

below 30°F to avoid freezing. An air-circulation coefficient (ratio of hourly air output from the fans in cubic meters to the volume of the room) of 150 is maximum. Prompt storage is essential to achieve the benefits of precooling.

Precoolers using air are cold rooms and tunnels. A cold room has a very intensive air circulation, high refrigeration capacity and fairly low ceilings. The cold room is advantageous for large-scale operations. Precooling tunnels are long, narrow cold rooms in which air circulates at high speed. Precooling tunnel use is limited and the capacity absorbed by fans is so large that it exceeds 50 percent of compressor capacity. Only a few packinghouses in well developed countries use this method of precooling.

Forced-air precooling has commercial feasibility. The precooler forces air through the void spaces of the fruit. The final air temperature is 30 to 35°F. In tents, in which the final air temperature was 30°F, fruit exhibited no decay. Weight loss averaged less than 1 percent. The precooling operation may last for one to one and one-half hours.

Hydrocooling

Hydrocooling quickly extracts field heat from the produce. It has been used with advantage for leafy vegetables to retain texture and freshness (Dalal and Subramanyam, 1970). The hydrocooling equipment consists of a large tank of iced water, a high-capacity pump for circulating the water to a sprinkler system and a conveyor belt for carrying the produce to the sprinkler. There are two styles of hydrocoolers:

the conventional single-layer flood type and a unit-load type. The latter is better adapted to mechanical handling equipment (Grizzel and Bennett, 1968).

Vacuum Cooling

Vacuum cooling is the most rapid method of precooling for leafy vegetables. The principle utilized is evaporative cooling. As an example of the speed of this method, vacuum cooling takes head lettuce from 80°F to 32° in three to four minutes.

B. WASHING

As clean produce is demanded by consumers, most fruits and vegetables are washed after harvesting. Washing improves the appearance of the produce. Frequently grime, soil, scale insects, sooty molds, etc., are present to render the crop unsightly. Residues of fungicides and insecticides are often present. Washing with a detergent removes them (Thompson and Van Middelen, 1955). Cucumbers and sweet potatoes are usually cleaned by brushing or wiping dry, rather than by washing.

Reports are rather conflicting as to the benefits of washing. Fellers and Pflug (1967) showed that washing cucumbers reduced the storage life to half that of unwashed fruit. Field-washed tomatoes may have an increased incidence of bacterial soft rot and necrosis (Segall, 1967). Prolonged washing of fruits that easily become water-soaked, inability to exclude decaying pieces completely, slow replenishment of dirty water and use of water without disinfectants may negate the advantages of washing. Employing water jets instead of dips could solve many of these problems.

Trimming and removal of decaying pieces are done prior to washing. The outer leaves and stalks of vegetables such as broccoli are trimmed to remove all decayed, injured and unsightly leaves. Sizing and grading may also be done before washing.

In most packinghouses, fruits and vegetables are usually dipped in a chlorine solution, followed by a clean water rinse. The fruits are allowed to dry before packing. For large operations, mechanical washing methods are employed. Briefly, these involve a soap or detergent bath, followed by scrubbing with brushes.

Soft brush bristles are preferred in washing; the stiffness must be just enough to remove the dirt without injuring the fruits. The brush speed should not exceed 200 rpm. The recommended rate of climb for the washer is three-fourths inch per foot. To prevent fruit injury, brushes should be inspected regularly and replaced promptly if worn out.

After brushing, fruits are rinsed with clean water. Spray nozzles are usually used. Excess water is removed as the fruit moves along the rollers. The fruits may be dried and waxed after washing.

C. DRYING

Drying removes excess surface water from the fruit or vegetable. This is facilitated by heated air blown on the fruit or vegetables as they pass through sponge roller conveyors. Drying may also be done by a series of rotating brush dryers made of soft bristles. Minimum heat and dryer brush speed should be used to avoid injury to the fruits.

D. WAXING

Fruits and vegetables have a natural waxy layer on the outer surface which is partly removed by washing. An extra discontinuous layer of wax applied artificially with sufficient thickness and consistency to prevent anaerobic conditions within the fruit provides the necessary protection against decay organisms. Waxing is especially important if tiny injuries and scratches on the surface of the fruit or vegetable are present. These can be sealed by wax. Another obvious advantage of waxing is the enhancement of the gloss of fruits or vegetables. Appearance is therefore improved, making the produce more acceptable to consumers.

Several wax formulations have been developed and experimentally tested. Water-wax emulsions are safer to use than solvent waxes, which are highly flammable. Water-wax emulsions can be used without the necessity of drying the fruit prior to application. For solvent type wax the fruit surface must be free of moisture to ensure a good shine.

E. GRADING

Fruits and vegetables show considerable variations in quality due to genetic, environmental and agronomic factors. Grading is necessary to get suitable returns commensurate with quality. Grades are based on soundness, firmness, cleanliness, size, weight, color, shape, maturity and freedom from foreign matter and diseases, insect damage and mechanical injury.

The three general categories of classification could be "extra" class, class 1 and class 2 (Akamine, et al., 1975). The "extra" class is of superior quality, possesses the shape and color of the variety and without internal defects likely to affect the inherent texture and flavor. A 5 percent (by number or weight) tolerance is allowed for errors. Class 1 produce is almost the same quality as the "extra," except that a 10 percent tolerance is allowed. Individual fruit is allowed a slight defect in shape, color and minor skin defects which do not affect the general appearance or keeping qualities. Class 2 products may exhibit some external or internal defects, provided they are fit for consumption while fresh. This class is best fitted for local or short-distance transactions. Products in this category will satisfy the needs of customers who are not too demanding and for whom price is more important than quality.

F. SIZING

After grading, the produce is sized for uniformity. Hand-sizing is useful for small-scale packing. One packer is assigned to each size. However, studies have shown that this method is inadequate for separation of commodities into uniform size groups. For large operations, various sizing devices are used, based on either shape or weight of the produce. Sizing devices may consist of rollers that have varying spacing, conveyor lines with differing size holes or spring-balance scale cups.

G. REFRIGERATION

Most vegetables and fruits require some refrigeration during storage and shipment. Mechanically refrigerated storage gives the grower a chance to delay sales until a more favorable price can be obtained. Generally two refrigeration temperature ranges are used (Jenkins, 1985). One, for fruits and some vegetables, temperatures are maintained just above the freezing point of the commodity, usually about 30-34°F. Ripe tomatoes especially, as well as some other crops, lose flavor when stored this cold. Tomatoes need to be stored near 50°F. Green tomatoes should not be held below 55°F because they will not develop color and flavor.

Equipment capacities needed for storage facilities should be chosen so that temperatures are lowered quickly as produce is loaded. General guidelines state that 1) about one ton of refrigeration is required for each 1,000 bushels of capacity and 2) at least 1,100 cubic feet per minute (CFM) of air must be moved across the evaporator coils at speeds not exceeding 500 feet per second. Good insulation, sound design and construction, use of plastic curtains on doors and loading in small batches can reduce the load on refrigeration equipment.

CHAPTER IV

FACTORS AFFECTING PACKINGHOUSE OPERATION COSTS

Packinghouse size, season length, operating level and packing margin are factors that affect the cost of fresh vegetable packinghouse operations. Evaluation of the feasibility (or profitability) of fresh vegetable packing operations depends upon three necessary components: sufficient quantities of the product at mutually acceptable prices, ability of the packinghouse to operate efficiently and ability of the plant to sell its product (Brooker and Pearson, 1972).

The ability of a new packinghouse operation to sell its product would probably be the most difficult of the three components to satisfy. The manager and directors of an existing packinghouse with well established markets could invest in a new facility and know its sales potential reasonably well. A new firm without established markets would be facing a very competitive market where demand is already being met by existing suppliers and only through vigorous sales effort could entry into the market be obtained.

Packinghouse size refers to the "rated" packout capacity of the operation. Season length refers to the number of hours per year of actual vegetable packing activity. Operating level refers to the average percentage of rated capacity at which the packinghouse is able to operate over the planning period. There could be several reasons why a packinghouse would operate at less than full capacity. For instance, the quality of fruit may necessitate a slower packing rate; but this does not imply inefficient management or labor. Also, a short supply of

incoming fruit can require the packinghouse to operate at less than rated capacity in order to retain an adequate labor force. Workers usually insist on being paid for a minimum of four hours each day they report for work (Brooker and Pearson, 1973). Although the term efficiency is used in many studies concerning economies of size, the term efficiency is not usually intended to imply that one packinghouse is operating more efficiently than another but that the packinghouse is operating at a particular level of its rated capacity.

The packing margin is of critical importance to the packinghouse operation because it is per-unit gross return. Packing margin is the fee charged for grading and packing the commodities (Brooker and Pearson, 1973).

A. EFFECT OF VOLUME ON COST OF OPERATION

In a study by Berberich (1977), 34 cooperatives in the U. S. relied heavily on members for volume, with only six cooperatives reporting more than 10 percent nonmember business and only three cooperatives more than 20 percent. Cooperatives with relatively small sales volume are especially vulnerable in their struggle to meet operating costs and remain solvent. Generally, they rely on grading and packing services to their members for additional income.

Berberich mentioned several cooperatives in his study that failed. One cooperative closure in 1970 was attributed to the lack of commitment by members, which resulted in a deterioration of support. Most members "used" the association when the price was right, but only

about five members fully supported the cooperative. It was also difficult to persuade growers to pack produce to buyers' specifications.

According to Berberich, the members' committed volume of produce determine the success of the marketing cooperative, not the number of members. A marketing contract between the cooperative and its members helps assure that committed volume. The cooperative can then plan sales operations more efficiently and maximize returns to growers. The agreement gives management an opportunity to more accurately project financing operations. And the contract can be used to specify certain rights, duties and obligations of the two parties to the agreement.

B. EFFECT OF QUALITY ON COST OF OPERATION

A successful fruit and vegetable marketing cooperative must be able to assure customers of uniform quality produce. To fill requirements of different classes of buyers, the cooperative must use objective grading standards and controls (Berberich).

Good quality control is the key to a reliable cooperative brand. Basically, the brand is a symbol of the packaged produce and, as such, is as good as the quality it represents.

Marketing any vegetable is made much easier if high quality is present. Although quality is sometimes only cosmetic, producers must recognize the importance of marketing and realize they must produce to the buyers' standards and not their own (Motes, et al., 1987). Quality begins with the selection of the correct variety for the production area and market. All aspects of production can influence quality. Pest control and harvesting at the correct stage of maturity are most impor-

tant in bringing high quality out of the field. Handling, grading, packing, cooling and transportation are postharvest activities that must be conducted properly to maintain high quality when produce is delivered to buyers and consumers. Markets sometimes exist for less than top quality vegetables; however, the lower quality will likely be sold at substantial discounts.

Cooperatives that handle grading and packing operations are in a good position to control quality. This can include federal-state inspection, cooperative inspection or a combination of both. A vegetable cooperative should consider a quality control program that begins at the farm with the use of good seed. Standards should be established to assure comparable cultural practices and orderly harvesting procedures (Berberich).

C. EFFECT OF QUALITY ON COSTS AND MARGINS

A study on the effect of quality on packing costs of tomatoes in Texas was conducted by Robert Bohall, et al. (1963). They reported that quality and productivity may be related by several methods, depending on the particular group of workers involved. The simplest assumption is that output is limited by the number of graders. With this assumption, a relation may be estimated between output per grader and quality of tomatoes. A second assumption is that different sections of the packing line may limit productivity when quality and volume change. If quality and output are high, dumpers and packers may limit productivity. If quality is poor, graders may limit output. On the basis of this assump-

tion, a relation may be established between quality and output for all workers on the line.

Bohall, et al., report that the following classifications of cost factors are useful in determining costs affected by quality variations (Bohall, et al., p. 22, 1963):

1. Cost directly related to the amount of cull fruit disposed of.

2. Costs directly related to the number of hours the shed operates. Examples are shed labor, and some repairs and utilities.

3. Costs directly related to the number of containers packed. Examples are container costs and marketing order committee assessments.

4. Costs incurred annually regardless of the number of containers packed, hours operated or amount of culls. Examples are interest on investment and property taxes.

Because the amount of culls depends on quality of the tomatoes dumped, costs associated with the volume of culls will vary with changes in quality. Therefore, costs will be higher with poor quality fruit because both the cost of cull disposal will be higher and because the packout will be smaller.

Costs directly related to the number of hours a shed operates will also vary with quality. Quality influences costs through limiting the volume packed in any given hour. With lower quality tomatoes, therefore, either output in a day will be lower, or a longer number of hours will be worked. In either event, those costs which are related to the hours of operation will increase. Therefore, costs directly related to the number of hours a shed is operated are considered as quality associated costs (Bohall, et al., 1963). Factors included in this

category were: shed labor, variable equipment costs (power and repairs) and miscellaneous utilities.

Quality will affect costs which are fixed aggregate amounts per year. With given quantity of tomatoes delivered to the shed, the total packout will decrease with poorer quality (Bohall, et al., 1963). Hence, the fixed annual charges must be spread over fewer units of output, and average unit costs will rise. In actual circumstances quality may have an even more pronounced effect on fixed costs. Tomatoes usually are delivered to the shed as long as growers can cover harvest costs. With poor quality produce there is the chance that fewer tomatoes will be delivered to the shed, thus further reducing packout and increasing unit costs. Fixed costs include depreciation, insurance, repairs, taxes and interest on buildings and equipment, all salaried labor and miscellaneous annual fixed expenses.

CHAPTER V

ESTIMATION OF PACKINGHOUSE COST OF OPERATION

The economic engineering method of cost estimation was used to specify the operation cost of the designed packing facility for fresh vegetables. Information was obtained for the cost of labor, packing materials, facilities, administration, land, general expenses and cost of packing. Market prices were specified to be the average of those received on the Atlanta wholesale market during the summer months of 1982-1986. These Atlanta prices were adjusted for transportation expense from the study area.

Several sources were used to determine the resources necessary to operate a packing facility for fresh vegetables. Packing facilities in Monticello and Russell Springs, Kentucky, Henegar, Alabama, and Ripley and Tazewell, Tennessee, were visited. The managers of these facilities were interviewed concerning design of facility, general cost of operation, volume of produce delivered to the facility and marketing strategy. The general cost categories include labor, packing materials, fixed overhead and administrative salaries, general expenses, building and equipment and land. The packing fees they charged farmers were also obtained from the managers. These cost and revenue items are discussed next and summarized in Appendix Tables A-1 through A-5.

A. LABOR

The minimum wage of $3.35 per hour was paid to all the employees except forklift operators. The forklift operator was paid a slight

premium above minimum wage ($4.00 per hour) due to the special skills needed to operate the forklift. Unemployment information was obtained from the state and federal unemployment tax offices. Labor requirements for the packing facility came from Snell and Jenkins.

B. PACKING MATERIALS

The cost of packing materials was gathered from several different sources. Mr. George Holt, a potato producer in Fayetteville, Tennessee, provided the cost of 50-pound potato bags. The cost of packaging materials for sweet potatoes and okra was obtained from Anderson Box Company. Monte Package Company furnished cost of packaging materials for bell peppers, tomatoes, cabbage, broccoli, fall greens, cantaloupes, sweet corn, squash, pole beans and cucumbers. Mr. Jim Scheerer, Sales Representative for Cumberland Clarklift in Knoxville, Tennessee, said that most pallet mills charge $7.00 per pallet. The cost of bands and ice for broccoli came from the price quotes used in the packing simulation model developed by Constance Falk, et al. (1986).

C. FIXED OVERHEAD AND ADMINISTRATIVE

The annual cost for insurance, maintenance and repairs on the building and equipment was provided by Cumberland Farm Products in Monticello, Kentucky. The executive secretary salary of $5.00 per hour was a general estimate that will vary among packing facilities. Jenkins suggested that the managers usually average about $24,000 per year. Larry Snell, Manager of Cumberland Farm Products, said that if a packing

facility hired an inspector for 16 weeks (average length of a season), it would cost the cooperative about $8,000.

D. GENERAL EXPENSES

The cost of utilities, telephone, office supplies and postage was based on general operating expenses of Cumberland Farm Products. The cost of office furniture was obtained from Acuff Office Supply Incorporate. Computerland, Synergistic Business Systems, Xerox Sales Office, Paymaster Checkwriter Company and Time Controls Incorporate, located in Knoxville, Tennessee, quoted prices for a computer system, typewriter, copy machine, check writer and time clock, respectively. An air conditioning/heater unit will be used in the offices and reception area. The price quote was provided by Sears at West Town Mall in Knoxville, Tennessee.

E. BUILDING AND EQUIPMENT

The design of the packing facility was patterned after the facilities in Russell Springs, Kentucky, operated by Cumberland Farm Products. Larry Snell, General Manager, provided information concerning the cost of the building, refrigeration units and truck scales. He also explained how they purchase field crates and bulk bins and lease these out to the individual producers. Semco Manufacturing Company (Pharr, Texas) provided cost information for the hydrocooler and ice machine. Jim Scheerer, Sales Representative for Cumberland Clarklift in Knoxville, Tennessee, supplied cost information for an electric forklift and manual hand forklift. Larry Johnson, Sales Representative with

Agri-Tech Incorporated (Woodstock, Virginia), provided blueprint design and cost information for the packing equipment and return flow conveyor system.

F. LAND

The Monteagle, Tennessee, area was chosen as a representative site location due to access to the interstate and because it is fairly centrally located within the study area. The Marion County tax office quoted that land would sell for about $1,500 per acre and taxes would be $65 per year.

G. PACKING CHARGES AND PRODUCT PRICES

Crop yields were based on the estimated yields published by the Tennessee Agricultural Extension Service (Jenkins, et al., 1988). The packinghouse operating level was set at 70 percent. This figure was suggested by Larry Snell and also from a study by Brooker and King (1978). The equipment was designed to packout 400 crates per hour at 100 percent operating level. Freight and brokerage fees were provided by Leroy Neelly, a local vegetable and fruit broker in Knoxville, Tennessee. Market prices used in this study were the four-year average from the Alanta wholesale market (USDA Market News, 1982-1986). The packing charges for broccoli, cucumber, okra, Irish potato, sweet potato, tomato, bell pepper, fall greens, sweet corn, squash and pole beans were taken from a study in Alabama by Zwingli, et al. The packing charges for cantaloupe and cabbage were provided by Tammy Kirkpatrick at Virginia Polytechnic Institute and State University.

Several assumptions were made concerning the operation of the packing facility.

1. The packing facility has a beginning cash balance of $10,000. This may come from several varied sources such as producer fees, government support or possible funding from agencies such as Tennessee Valley Authority.
2. The organization is able to borrow 90 percent of the cost for equipment, facilities and operations to finance the operation at an interest rate of 10 percent. The remaining 10 percent of the cost for equipment, facilities and operations would have to come from similar sources mentioned in assumption number one.
3. Payments on the building, machinery and equipment will be made quarterly.
4. Salvage value was based on ten percent of initial value. The estimated life of the grading and sizing equipment and hydrocooler was 15 years. The conveyor, ice machine, refrigeration, forklifts, scales, field crates and bulk bins have an estimated life of 10 years and the building has an estimated life of 20 years.

CHAPTER VI

RESULTS

The Packing Simulation (PACKSIM) model used in this analysis is a microcomputer application program designed for researchers, extension personnel, bankers, packing managers or other specialists who plan the operations of a packing facility or simulate its financial performance. PACKSIM produces pro forma financial statements for packing assumptions. Variations can be made in the product harvest schedule, price, quality, quantity, input costs and requirements, packing efficiency, overhead and loan terms (Falk, et al., 1987).

The PACKSIM model used in this study was designed to analyze 15 different vegetables. Alvin Rutledge and Robert Jenkins, Tennessee Agricultural Extension Service Specialists, assisted in selecting the 15 vegetables that would be appropriate for the study area. The vegetables selected for this study were spring and fall broccoli, cantaloupe, cucumber, okra, Irish potato, sweet potato, tomato, bell pepper, fall green, sweet corn, squash, pole beans and spring and fall cabbage.

The economic feasibility analysis of the packinghouse operation was performed by allowing selected variables to change, holding all other variables constant. Base solutions using 15 vegetables, six vegetables, five vegetables, five vegetables without a hydrocooler and four vegetables were established. Each base solution was calculated using a five-year average of Atlanta market wholesale fruit and vegetable prices (adjusted for transportation and brokerage fees), crop yields based on the 1988 Planning Budgets for Fruits and Vegetables,

operating at 70 percent of rated capacity, financing at 90 percent of the total capital needed and the interest rate at 10 percent. For each base solution group, product prices, crop yields, operating level, packing charges, percent of financing and interest rate were varied individually, holding all other variables constant to analyze the effect on acreages required for the packing facility to break even.

Product prices were adjusted to 25 percent above and 25 percent below the five-year Atlanta average, holding all other variables constant. The adjustment of product prices did not affect the number of acres of vegetables required for the packing facility to break even. This was due mainly to the fact that in this model, payments to the farmer are calculated as an expense to the packing facility. If market prices increase or decrease, the packinghouse retains the specified per crate packing charge before payments to the farmers are made thus, selling price affects the income of the farmer, but not the income of the packinghouse. If the model was revised to make the packaging fee a percentage of sales value instead of a constant per crate fee, then the packinghouse feasibility analysis would be affected by product price.

A. ANALYSIS OF FACILITY PACKING 15 VEGETABLES

The acreage required for each vegetable in this analysis is listed in Table VI-1. The acreage required for the packing facility to break even ranged from 54 acres of sweet corn to 67 acres of tomatoes and Irish potatoes.

The results in Table VI-1 indicated that for several of the vegetables, the packing cost exceeded the packing charge. The veget-

ables that had packing cost greater than their packing charge were spring and fall broccoli, Irish potatoes, tomatoes, fall greens, sweet corn and spring and fall cabbage. Spring and fall broccoli had a difference of $1.97 and fall greens had a difference of $1.49. This difference is most likely due to the cost of the ice machine. Spring and fall broccoli and fall greens were the only vegetables requiring icing. The ice machine cost $115,000, and the packing facility was not able to distribute the cost of the ice machine among enough vegetables being packed, thus raising the cost of spring and fall broccoli and fall greens.

TABLE VI-1

FIFTEEN VEGETABLES: ACREAGE REQUIRED FOR PACKINGHOUSE TO BREAK EVEN AND PACKING COST PER CRATE

Crops	Acres	Packing Charge	Cost Per Packed Crate			Packing Charge Minus Packing Cost
			Total	Variable	Fixed	
			dollars			
Spring broccoli	57	2.00	3.97	2.49	1.48	-1.97
Fall broccoli	57	2.00	3.97	2.49	1.48	-1.97
Cantaloupe	57	3.15	2.77	1.76	1.01	0.38
Cucumber	63	3.70	2.28	1.51	0.77	1.42
Okra	63	3.80	1.77	1.46	0.31	2.03
Irish potato	67	1.30	2.73	1.17	1.56	-1.43
Sweet potato	63	3.30	2.34	1.49	0.85	0.96
Tomato	67	2.30	2.35	1.70	0.66	-0.05
Bell pepper	65	3.00	2.78	1.53	1.25	0.22
Fall greens	65	1.60	3.09	1.75	1.34	-1.49
Sweet corn	54	2.40	3.23	1.73	1.49	-0.83
Squash	65	2.70	2.47	1.53	0.94	0.23
Pole beans	65	3.45	2.68	2.10	0.58	0.79
Spring cabbage	65	2.55	2.84	1.85	0.99	-0.29
Fall cabbage	65	2.55	2.84	1.85	0.99	-0.29

Another large difference in packing cost and packing charge was with Irish potatoes. The packing cost exceeded the packing charge by $1.43. The packing charge for Irish potatoes was taken from a study by Zwingli, et al. (1987), which did not use a mechanical weight sizer. The cost of the weight sizer probably accounted for the relatively higher cost of packing Irish potatoes, compared to the $1.30 packing charge. Other vegetables that exhibited packing cost greater than packing charge were sweet corn ($0.83), spring and fall cabbage ($0.29) and tomatoes ($0.05).

Larry Snell, Manager of Cumberland Farm Products in Monticello, Kentucky, indicated that packing 15 different vegetables at a packing facility would not be very practical. Fifteen vegetables would require too much time trying to coordinate the harvest and delivery of this many different vegetables to the packing facility. The organization of labor and changes on the packing assembly line would also create problems.

B. ANALYSIS OF FACILITY PACKING SIX VEGETABLES

The base solution of the facility packing six vegetables had the same initial specifications as the previous 15-crop model regarding financing, interest rate, operating level, crop yields and packing charges. The six vegetables were Irish potato, tomato, bell pepper, sweet corn and spring and fall cabbage.

When yields were reduced by 10 percent, acreage had to be increased by 10 to 12 percent for all six vegetables for the packing facility to maintain the break-even financial status (Table VI-2). A 20 percent reduction in yield per acre required that acreage of potatoes,

TABLE VI-2

SIX VEGETABLES: ACREAGE REQUIRED TO BREAK EVEN AND CHANGES IN PACKING COST WHEN YIELD, OPERATING LEVEL AND PACKING CHARGE ARE VARIED FROM BASE SOLUTION.

Crop	Base	Yield		Operating Level		Adjusted Packing Charge[a]
		-10 Percent	-20 Percent	50 Percent	90 Percent	
		percentage change from base				
Break-even Acreage (acres):						
Irish potato	160	+11	+25	+46	-18	-19
Tomato	158	+11	+25	+47	-14	-18
Bell pepper	159	+12	+26	+49	-15	-19
Sweet corn	445	+10	+22	+44	-15	-19
Spring cabbage	160	+11	+25	+46	-16	-19
Fall cabbage	160	+11	+25	+46	-16	-19
Packing Cost Per Crate (dollars):						
Irish potato	2.13	0	0	-4	+2	+10
Tomato	2.14	0	0	+4	-2	+5
Bell pepper	2.30	0	0	-1	+1	+7
Sweet corn	2.86	0	0	-4	+2	+9
Spring cabbage	2.52	0	0	+1	0	+6
Fall cabbage	2.52	0	0	+1	0	+6
Variable Cost Per Crate (dollars):						
Irish potato	1.17	0	0	+19	-10	0
Tomato	1.70	0	0	+13	-8	0
Bell pepper	1.53	0	0	+14	-8	0
Sweet corn	1.73	0	0	+14	-8	0
Spring cabbage	1.85	0	0	+12	-6	0
Fall cabbage	1.85	0	0	+12	-6	0
Fixed Cost Per Crate (dollars):						
Irish potato	0.95	0	0	-32	+19	+24
Tomato	0.44	0	0	-32	+18	+25
Bell pepper	0.76	0	0	-32	+18	+24
Sweet corn	1.12	0	0	-30	+18	+23
Spring cabbage	0.67	0	0	-31	+15	+24
Fall cabbage	0.67	0	0	-31	+15	+24

[a]Packing charges were changed to 10 cents above packing cost.

tomatoes and cabbage be increased by 25 percent and peppers and corn, 26 and 22 percent, respectively. There are numerous circumstances that may reduce yields (i.e., disease, insects, weather, poor management, etc.). Reduction in yields will affect the packing facility by reducing volume of produce packed or by reducing the quality of the produce delivered. When disease or weather reduce yields, it is difficult or almost impossible to make the adjustments in acreage to allow the packing facility to operate at a break-even level. The decrease in yield of both 10 and 20 percent exhibited no effect on the per crate packing cost, average variable cost and average fixed cost. This was because the model increased the required acreage and resulting packout to allow the packinghouse to break even.

Related to the reduction in yield is the operating level of the packing facility, which was changed from the base solution of 70 percent of rated capacity to 50 and 90 percent. Brooker and Pearson (1972) suggested that there were several reasons why a packinghouse would operate at less than full capacity. The quality of vegetables may necessitate a slower packing rate; but this does not imply inefficient management or labor. Also, a short supply of incoming vegetables can require the packinghouse to operate at less than rated capacity in order to retain an adequate labor force.

When the operating level was reduced to 50 percent of rated capacity, the increased acreage required for the packing facility to break even ranged from 44 to 49 percent. The percentage change in per crate packing cost was -4 percent for Irish potatoes and sweet corn, -1 percent for bell peppers, +4 percent for tomatoes and +1 percent for

spring and fall cabbage. The increase in per crate average variable cost for each individual crop ranged from 12 to 19 percent. The average fixed cost per crate was reduced by 30 to 32 percent for each vegetable.

When the operating level was raised from the base level of 70 to 90 percent, there was a reduction in the number of acres required to break even. Required acreage declined 14 to 18 percent per vegetable. Average variable cost declined 6 to 10 percent, and average fixed cost increased 15 to 19 percent.

The PACKSIM program calculates the packing cost from all the data entered into the model. The packing charge used for this analysis was adjusted so that the packing charge for all vegetables was 10 cents above the packing cost. The acreage required to maintain operations at the break-even level was reduced 18 to 19 percent per vegetable. The packing cost per crate and average fixed cost increased when the packing charge was increased. Average variable cost was unaffected.

The computer model forced the packing facility to maintain a packout volume that would maintain the facility at the break-even level. Because of this condition, the packing facility would have to increase the total number of crates packed by 46 percent when the operating level is reduced from the base model of 70 percent to 50 percent (Table VI-3). Also, total variable cost increased 66 percent due to the increase in the number of crates required for the packinghouse to break even. Increasing the number of crates sold will affect the variable cost elements of the operation (labor, utilities for operation of facility, etc.). The largest factors affecting variable cost are labor and number

of hours the facility must operate to handle the increased number of crates packed.

TABLE VI-3

SIX VEGETABLES: TOTAL CRATES REQUIRED FOR PACKINGHOUSE TO BREAK EVEN, TOTAL FIXED COST AND TOTAL VARIABLE COST WHEN OPERATING LEVEL AND PACKING CHARGE ARE VARIED FROM BASE SOLUTION

Item	Base	Operating Level		Adjusted Packing Charge[a]
		50 Percent	90 Percent	
		--percentage change from base-		
Total fixed cost (dollars)	236,084	0	0	0
Total variable cost (dollars)	540,506	+66	-21	-19
Total crates packed	322,089	+46	-15	-19

[a]Packing charges were changed to 10 cents above packing cost.

Increasing the operating level to 90 percent of rated capacity caused total variable cost to decline 21 percent. Total crates packed was reduced 15 percent. Total variable cost went down due to the decrease in operation time, while total fixed cost was not affected by the decrease in the total number of crates sold. Total fixed cost was not affected by an increase in the packing charge. Total variable cost experienced a 19 percent reduction when packing charges were increased.

Interest rates were varied from the base solution level of 10 percent to 8 and 12 percent. The effects on crop acreage and per crate cost are listed in Table VI-4. A decrease in the interest rate from 10 to 8 percent caused the number of acres per vegetable required to remain

TABLE VI-4

SIX VEGETABLES: ACREAGE REQUIRED TO BREAK EVEN AND CHANGES IN PACKING COST WHEN INTEREST RATE AND FINANCING ARE VARIED FROM BASE SOLUTION

Crop	Base	Interest Rate		Financing
		8 Percent	12 Percent	80 Percent
Acres (percentage change from base):				
Irish potato	160	-9	+11	-9
Tomato	158	-7	+8	-3
Bell pepper	159	-6	+8	-4
Sweet corn	445	-7	+7	-4
Spring cabbage	160	-9	+7	-4
Fall cabbage	160	-9	+7	-4
Packing Cost Per Crate (dollars):				
Irish potato	2.13	2.13	2.12	2.14
Tomato	2.14	2.14	2.14	2.14
Bell pepper	2.30	2.30	2.29	2.30
Sweet corn	2.86	2.85	2.86	2.86
Spring cabbage	2.52	2.53	2.52	2.53
Fall cabbage	2.52	2.53	2.52	2.53
Variable Cost Per Crate (dollars):				
Irish potato	1.17	1.17	1.17	1.17
Tomato	1.70	1.70	1.70	1.70
Bell pepper	1.53	1.53	1.53	1.53
Sweet corn	1.73	1.73	1.73	1.73
Spring cabbage	1.85	1.85	1.85	1.85
Fall cabbage	1.85	1.85	1.85	1.85
Fixed Cost Per Crate (dollars):				
Irish potato	0.95	0.96	0.95	0.97
Tomato	0.44	0.44	0.44	0.45
Bell pepper	0.76	0.77	0.76	0.77
Sweet corn	1.12	1.12	1.13	1.13
Spring cabbage	0.67	0.68	0.66	0.68
Fall cabbage	0.67	0.68	0.66	0.68

at the break-even level to decline in the range of 6 to 9 percent. The reduction in interest rate did not have any notable effect on per crate packing cost, average variable cost or average fixed cost.

An increase in the interest rate from 10 to 12 percent resulted in increasing the required number of acres for each vegetable by 7 and 8 percent (11 percent for Irish potatoes). Similar to the results when interest rates were decreased, an increase in interest rates did not change the per crate packing cost, average variable cost or average fixed cost. Because the acreage was adjusted to maintain the break-even status, the changes in interest rates did not effect per crate packing cost, average variable cost and average fixed cost.

A reduction in the amount of financing required to build and operate the packing facility, from 90 percent in the base solution to 80 percent, caused the acreage required to break even to decrease. The Irish potato acreage was reduced 9 percent; tomato acreage, 3 percent; and the other vegetable acreages, 4 percent. A reduction in the amount of borrowed capital did not effect the per crate packing cost, average variable cost or average fixed cost. Similar to the change in interest rates, a change in the level of financing did not effect per crate cost, average variable cost and average fixed cost because the acreage was increased to maintain the facility at the break-even status.

Results in Table VI-5 show the effect of a change in interest rate on total fixed cost, total variable cost and total crates sold to maintain the break-even level of operation. Total fixed cost was reduced by 7 percent when interest rates were reduced from 10 to 8 percent. As would be expected, a decline in the amount the packing

facility pays on interest would reduce total fixed cost. The total number of crates sold to break even is reduced by 8 percent and results in lowering total variable cost by 8 percent because fewer crates are packed and less labor is required.

TABLE VI-5

SIX VEGETABLES: TOTAL FIXED COST, TOTAL VARIABLE COST AND TOTAL CRATES SOLD WHEN INTEREST RATE AND FINANCING ARE VARIED FROM BASE SOLUTION

Item	Base	Interest Rate 8 Percent	Interest Rate 12 Percent	Financing 80 Percent
		--percentage change from base-		
Total fixed cost (dollars)	236,084	-7	+7	-4
Total variable cost (dollars)	540,506	-8	+8	-4
Total crates sold	322,089	-8	+7	-5

Increasing the interest rate to 12 percent caused total fixed cost, total variable cost and total number of crates sold to increase. Total fixed cost and total variable cost increased 7 and 8 percent, respectively. The number of crates packed was increased by 7 percent. As a result of a higher interest rate, the interest payments are higher, a larger quantity of crates must be packed to maintain the facility at the break-even level of operation, thus requiring an increase in the labor force and/or an increase in the number of hours the facility operates.

When the level of financing was reduced from 90 to 80 percent, total fixed cost and total variable cost both declined by 4 percent. The total number of crates sold to maintain the break-even level of operation decreased 5 percent, which caused total variable cost to decline 4 percent because less labor was required for the facility to maintain the break-even level of operation.

C. ANALYSIS OF FACILITY PACKING FIVE VEGETABLES

The cost of packing Irish potatoes exceeded the packing charge by $1.07. Because packing cost exceeded packing charge, Irish potatoes were excluded from the analysis. The five vegetables were tomatoes, bell peppers, sweet corn, spring and fall cabbage.

A decrease in yield by 10 percent exhibited no influence on per crate packing cost, average variable cost and average fixed cost (Table VI-6). To maintain the facility at the break-even level, the required number of acres were increased 9 to 12 percent. A 20 percent decrease in yield resulted in the acreage being increased 24 to 26 percent to maintain the break-even level of operation. The effects of the 20 percent decrease in yield was similar to the 10 percent decrease in yield. Change in yield had no effect on per crate packing cost, average variable cost and average fixed cost.

The change in packout level exhibited a greater effect on cost than a decline in yield. When the packout level of the facility declined to 50 percent, acreage had to be increased 39 percent for tomatoes, 43 percent for bell peppers, 38 percent for sweet corn and 39 percent for spring and fall cabbage to maintain the facility at the

TABLE VI-6

FIVE VEGETABLES: ACREAGE REQUIRED TO BREAK EVEN AND CHANGES IN PACKING COST WHEN YIELD, OPERATING LEVEL AND PACKING CHARGE ARE VARIED FROM BASE SOLUTION

Crop	Base	Yield		Operating Level		Adjusted Packing Charge[a]
		-10 Percent	-20 Percent	50 Percent	90 Percent	
		percentage change from base				
Break-even Acreage (acres):						
Tomato	165	+12	+24	+39	-13	-18
Bell pepper	169	+9	+26	+43	-17	-22
Sweet corn	400	+10	+24	+38	-15	-18
Spring cabbage	165	+12	+25	+39	-12	-15
Fall cabbage	165	+12	+25	+39	-12	-15
Packing Cost Per Crate (dollars):						
Tomato	2.23	0	0	+3	-1	+5
Bell pepper	2.48	0	0	+2	+1	+8
Sweet corn	3.00	0	0	+4	+2	+9
Spring cabbage	2.63	0	0	0	0	+6
Fall cabbage	2.63	0	0	0	0	+6
Variable Cost Per Crate (dollars):						
Tomato	1.70	0	0	+13	-8	0
Bell pepper	1.53	0	0	+14	-8	0
Sweet corn	1.73	0	0	+14	-8	0
Spring cabbage	1.85	0	0	+12	-6	0
Fall cabbage	1.85	0	0	+12	-6	0
Fixed Cost Per Crate (dollars):						
Tomato	0.54	0	0	-30	+15	+22
Bell pepper	0.94	0	0	-29	+17	+22
Sweet corn	1.27	0	0	-28	+16	+20
Spring cabbage	0.78	0	0	-28	+15	+21
Fall cabbage	0.78	0	0	-28	+15	+21

[a]Packing charges were changed to 10 cents above packing cost.

break-even level of operation. The increase in per crate packing cost was not substantial. Average variable cost increased from 12 to 14 percent, and average fixed cost decreased 28 percent for sweet corn and spring and fall cabbage, 29 percent for bell peppers and 30 percent for tomatoes when the packing level was changed from 70 to 50 percent.

An increase in the packing level from 70 to 90 percent caused per crate packing cost of tomatoes to decline 1 percent and increased the per crate packing cost of bell peppers and sweet corn by 1 and 2 percent, respectively. Changing the packout level did not effect the per crate packing cost of spring or fall cabbage. Increasing the packout level to 90 percent did reduce average variable cost 8 percent for tomatoes, bell peppers and sweet corn. The average variable cost of spring and fall cabbage decreased 6 percent. Average fixed cost increased 15 percent for tomatoes, spring and fall cabbage, 17 percent for bell peppers and 16 percent for sweet corn.

The adjustment in packing charge exhibited a noticeable effect on acreage required to maintain the break-even level of operation and average fixed cost. Adjusting the packing charge increased packing cost per crate 5 percent for tomatoes, 8 percent for bell peppers, 9 percent for sweet corn and 6 percent for spring and fall cabbage. There was no effect on average variable cost. The required acreage was reduced 19 percent for tomatoes and sweet corn, 22 percent for bell peppers and 15 percent for spring and fall cabbage, when the packing charge was adjusted.

The results in Table VI-7 indicated no effect on total fixed cost when the packing capacity was reduced to 50 percent. The total number

of crates sold had to be increased by 40 percent to maintain the break-even level of operation when operating at the 50 percent packout level. The increase in the number of crates sold resulted in a 58 percent increase in total variable cost due to increases in labor and/or length of time the facility operated.

TABLE VI-7

FIVE VEGETABLES: TOTAL CRATES REQUIRED FOR PACKINGHOUSE TO BREAK EVEN, TOTAL FIXED COST AND TOTAL VARIABLE COST WHEN OPERATING LEVEL AND PACKING CHARGE ARE VARIED FROM BASE SOLUTION

Item	Base	Operating Level		Adjusted Packing Charge[a]
		50 Percent	90 Percent	
		percentage changes from base		
Total fixed cost (dollars)	236,409	0	0	0
Total variable cost (dollars)	505,761	+58	-20	-17
Total crates sold	290,513	+40	-13	-17

[a]Packing charges were changed to 10 cents above packing cost.

A comparison of the changes in packing level reveals that when capacity was increased to 90 percent, total crates sold were reduced 13 percent. Conversely, the total crates sold were increased 40 percent when operating at the 50 percent level. Because less labor was required, total variable cost declined about 20 percent when the facility operated at 90 percent of packing capacity. Total fixed cost was

unaffected by the adjustment in packing charge, but total variable cost and total crates sold were reduced by 17 percent.

Results in Table VI-8 show the effect of the change in interest rates and financing on required acreage and packing cost. The required acreage to maintain the facility at the break-even level of operation varied very little from the base solution when interest rates were changed to 8 and 12 percent and financing was reduced to 80 percent. The changes in interest rate and financing exhibited no effect on per crate packing cost, average variable cost and average fixed cost.

Results in Table VI-9 reveal that when the facility was able to borrow at 8 percent interest instead of 10 percent interest, total fixed cost, total variable cost and total crates sold were reduced 7 percent. At 12 percent interest, total fixed cost, total variable cost and total crates sold increased 7 to 8 percent. A reduction in financing, from 90 to 80 percent, reduced total fixed cost, total variable cost, and total crates sold 4 percent.

D. ANALYSIS OF FACILITY PACKING FIVE VEGETABLES (WITHOUT HYDROCOOLER)

The base solution was kept the same as for the six-vegetable facility, but sweet corn was eliminated from the crops. The purpose of eliminating sweet corn was to evaluate the effect of not having to purchase a hydrocooler. Sweet corn was the only vegetable in the six vegetable analysis that required hydrocooling, and the hydrocooler cost the packing facility $125,000, not including operational expenses.

TABLE VI-8

FIVE VEGETABLES: ACREAGE REQUIRED TO BREAK EVEN AND CHANGES IN PACKING COST WHEN INTEREST RATE AND FINANCING ARE VARIED FROM BASE SOLUTION

Crop	Base	Interest Rate		Financing
		8 Percent	12 Percent	80 Percent
Acres (percentage change from base):				
Tomato	165	-6	+9	-4
Bell pepper	169	-10	+5	-5
Sweet corn	400	-8	+6	-5
Spring cabbage	165	-6	+9	-3
Fall cabbage	165	-6	+9	-3
Packing Cost Per Crate (dollars):				
Tomato	2.23	2.23	2.23	2.23
Bell pepper	2.48	2.48	2.48	2.48
Sweet corn	3.00	2.99	3.01	3.00
Spring cabbage	2.63	2.63	2.62	2.63
Fall cabbage	2.63	2.63	2.62	2.63
Variable Cost Per Crate (dollars):				
Tomato	1.70	1.70	1.70	1.70
Bell pepper	1.53	1.53	1.53	1.53
Sweet corn	1.73	1.73	1.73	1.73
Spring cabbage	1.85	1.85	1.85	1.85
Fall cabbage	1.85	1.85	1.85	1.85
Fixed Cost Per Crate (dollars):				
Tomato	0.54	0.54	0.54	0.54
Bell pepper	0.94	0.94	0.94	0.94
Sweet corn	1.27	1.26	1.28	1.27
Spring cabbage	0.78	0.78	0.77	0.78
Fall cabbage	0.78	0.78	0.77	0.78

TABLE VI-9

FIVE VEGETABLES: TOTAL FIXED COST, TOTAL VARIABLE COST, AND TOTAL CRATES SOLD WHEN INTEREST RATE AND FINANCING ARE VARIED FROM BASE SOLUTION

Item	Base	Interest Rate 8 Percent	Interest Rate 12 Percent	Financing 80 Percent
		--percentage change from base-		
Total fixed cost (dollars)	236,409	-7	+7	-4
Total variable cost (dollars)	505,761	-7	+8	-4
Total crates sold	290,513	-7	+8	-4

A 10 percent reduction in crop yield required the number of crates to maintain the break-even level to increase 10 to 13 percent (Table VI-10). The reduction in yield exhibited no effect on per crate packing cost, average variable cost or average fixed cost.

When yield is reduced by 20 percent, acreage had to be increased 23 to 28 percent for the facility to maintain the operation at the break-even level. Per crate packing cost, average variable cost and average total cost were not effected by the 20 percent decline in yield.

When packing capacity was reduced from the base level of 70 to 50 percent, acreage had to be increased 37 percent for Irish potatoes, 47 percent for tomatoes and bell peppers and 41 percent for spring and fall cabbage. Packing cost per crate was reduced 4 percent for Irish potatoes and 2 percent for bell peppers when packout level was reduced to 50 percent. There was about a 3 percent increase in the per crate packing cost of tomatoes at the 50 percent packout level. The per crate packing

TABLE VI-10

FIVE VEGETABLES (WITHOUT HYDROCOOLER): ACREAGE REQUIRED TO BREAK EVEN AND CHANGES IN PACKING COST WHEN OPERATING LEVEL AND PACKING CHARGE ARE VARIED FROM BASE SOLUTION

Crop	Base	Yield		Operating Level		Adjusted Packing Charge[a]
		-10 Percent	-20 Percent	50 Percent	90 Percent	
		percentage change from base				
Break-even Acreage (acres):						
Irish potato	150	+13	+27	+37	-17	-20
Tomato	167	+10	+23	+47	-14	-16
Bell pepper	168	+13	+28	+47	-15	-24
Spring cabbage	170	+10	+24	+41	-15	-18
Fall cabbage	170	+10	+24	+41	-15	-18
Packing Cost Per Crate (dollars):						
Irish potato	2.23	0	0	-4	+3	+11
Tomato	2.24	0	0	+3	-1	+5
Bell pepper	2.38	0	0	-2	+1	+8
Spring cabbage	2.63	0	0	0	0	+7
Fall cabbage	2.63	0	0	0	0	+7
Variable Cost Per Crate (dollars):						
Irish potato	1.17	0	0	+19	-10	0
Tomato	1.70	0	0	+13	-8	0
Bell pepper	1.53	0	0	+14	-5	0
Spring cabbage	1.85	0	0	+12	-6	0
Fall cabbage	1.85	0	0	+12	-6	0
Fixed Cost Per Crate (dollars):						
Irish potato	1.06	0	0	-30	+18	+24
Tomato	0.54	0	0	-30	+19	+19
Bell pepper	0.85	0	0	-29	+18	+24
Spring cabbage	0.78	0	0	-29	+17	+22
Fall cabbage	0.78	0	0	-29	+17	+22

[a]Packing charges were changed to 10 cents above packing cost.

cost of spring and fall cabbage was not effected by the decline in packing level. Average variable cost for Irish potatoes increased by 19 percent, tomatoes increased 13 percent, bell peppers increased 14 percent and spring and fall cabbage increased 12 percent. The increase in the number of crates sold caused average fixed cost to decline 29 to 30 percent.

The adjustment in packing charge resulted in a decrease in the required acres to maintain the break-even status. The acreage required to break even was reduced by 20 percent for Irish potatoes, 16 percent for tomatoes, 24 percent for bell peppers and 18 percent for spring and fall cabbage. The adjustment in the packing charge resulted in an increase in the per crate packing cost. Per crate packing cost increased 11 percent for Irish potatoes, 5 percent for tomatoes, 8 percent for bell peppers and 7 percent for spring and fall cabbage. Average variable cost was not effected by adjustments in packing charge, but average fixed cost increased 19 to 24 percent. Increasing packout level, from 70 to 90 percent, caused the number of required acres to fall 14 to 17 percent to maintain the break-even level of operation. The per crate packing cost of spring and fall cabbage did not change. Per crate packing cost increased 3 percent for Irish potatoes, 1 percent for bell peppers and declined 1 percent for tomatoes.

Total number of crates packed increased 43 percent to maintain the break-even level of operation when the packout level was reduced to 50 percent (Table VI-11). Total fixed cost was not influenced by an increase in the number of crates sold, but total variable cost was increased by 62 percent.

TABLE VI-11

FIVE VEGETABLES (WITHOUT HYDROCOOLER): TOTAL CRATES REQUIRED TO BREAK EVEN, TOTAL FIXED COST AND TOTAL VARIABLE COST WHEN OPERATING LEVEL AND PACKING CHARGE ARE VARIED FROM BASE SOLUTION

Item	Base	Operating Level		Adjusted Packing Charge[a]
		50 Percent	90 Percent	
		percentage change from base		
Total fixed cost (dollars)	212,460	0	0	0
Total variable cost (dollars)	472,626	+62	-21	-18
Total crates sold	282,080	+43	-15	-18

[a]Packing charges were changed to 10 cents above packing cost.

The change in packing capacity to 90 percent did not effect total fixed cost but did reduce total variable cost 21 percent and total crates sold 15 percent. The adjustment in packing charge exhibited no effect on total fixed cost but resulted in reducing total variable cost and total crates sold by 18 percent.

Results in Table VI-12 exhibit the effects of interest rate and financing on required acres and packing cost. When interest rate was reduced to 8 percent or raised to 10 percent per crate packing cost, average variable cost or average fixed cost were not effected. A change in interest rate changes the level of output due to the change in the payment on interest charges. When interest rates were reduced to 8 percent the required acreage was reduced 5 to 10 percent. An increase in interest rate to 12 percent required acreage to increase 5 to 9 percent to maintain the break-even level of operation.

TABLE VI-12

FIVE VEGETABLES (WITHOUT HYDROCOOLER): ACREAGE REQUIRED TO BREAK EVEN AND CHANGES IN PACKING COST WHEN INTEREST RATE AND FINANCING ARE VARIED FROM BASE SOLUTION

Crop	Base	Interest Rate		Financing
		8 Percent	12 Percent	80 Percent
Acres (percentage change from base):				
Irish potato	150	-10	+5	-5
Tomato	167	-7	+7	-4
Bell pepper	168	-5	+9	-1
Spring cabbage	170	-9	+6	-6
Fall cabbage	170	-9	+6	-6
Packing Cost Per Crate (dollars):				
Irish potato	2.23	2.24	2.24	2.24
Tomato	2.24	2.24	2.24	2.24
Bell pepper	2.38	2.39	2.38	2.38
Spring cabbage	2.63	2.64	2.63	2.64
Fall cabbage	2.63	2.64	2.63	2.64
Variable Cost Per Crate (dollars):				
Irish potato	1.17	1.17	1.17	1.17
Tomato	1.70	1.70	1.70	1.70
Bell pepper	1.53	1.53	1.53	1.53
Spring cabbage	1.85	1.85	1.85	1.85
Fall cabbage	1.85	1.85	1.85	1.85
Fixed Cost Per Crate (dollars):				
Irish potato	1.06	1.07	1.06	1.06
Tomato	0.54	0.55	0.55	0.54
Bell pepper	0.85	0.85	0.85	0.85
Spring cabbage	0.78	0.79	0.78	0.78
Fall cabbage	0.78	0.79	0.78	0.78

A reduction in the amount of financing from 90 to 80 percent exhibited no effect on per crate packing cost, average variable cost or average fixed cost. The reduction in the amount of capital borrowed reduced the required number of acres from 1 to 6 percent.

Changes in interest rate affected total fixed cost, total variable cost and total crates sold (Table VI-13). When interest rate was reduced to 8 percent, total variable cost was reduced 7 percent and total variable cost and total crates sold were reduced 8 percent. Total fixed cost, total variable cost and total crates sold increased 7 percent when interest rate was increased to 12 percent. Reducing financing to 80 percent decreased total fixed cost by 4 percent, and total variable cost and total crates sold declined 5 percent.

TABLE VI-13

FIVE VEGETABLES (WITHOUT HYDROCOOLER): TOTAL FIXED COST, TOTAL VARIABLE COST AND TOTAL CRATES SOLD WHEN INTEREST RATE AND FINANCING ARE VARIED FROM BASE SOLUTION

Item	Base	Interest Rate 8 Percent	Interest Rate 12 Percent	Financing 80 Percent
		--percentage change from base-		
Total fixed cost (dollars)	212,460	-7	+7	-4
Total variable cost (dollars)	472,626	-8	+7	-5
Total crates sold	282,080	-8	+7	-5

E. ANALYSIS OF FACILITY PACKING FOUR VEGETABLES

Sweet corn was eliminated to reduce the amount of required capital by $125,000 because the hydrocooler was omitted. The four vegetables packed in this model were tomatoes, bell peppers, spring and fall cabbage.

A reduction in the crop yield exhibited no effect on per crate packing cost, average variable cost and average fixed cost (Table VI-14). To maintain the packing facility at the break-even level of operation, the acreage was increased 10 to 12 percent when yield declined 10 percent, and the acreage was increased 25 percent when yield declined 20 percent.

When the packout level decreased from the base level of 70 to 50 percent, the required acreage to break even increased 35 percent for tomatoes, 41 percent for bell peppers and 38 percent for spring and fall cabbage. Per crate packing cost of tomatoes increased by 2 percent, bell peppers declined 3 percent and spring and fall cabbage declined 1 percent when the packing level was 50 percent. Average variable cost increased 12 to 14 percent, and average fixed cost decreased 28 percent at 50 percent packing capacity.

Acreage was reduced 12 to 15 percent to maintain the break-even level of operation when the packing level was increased to 90 percent. An increase in packing level reduced average variable cost 6 to 8 percent and increased average fixed cost 14 to 16 percent.

Acreage was reduced when the packing charges were adjusted. The required acreage for tomatoes was reduced 19 percent, 20 percent for

TABLE VI-14

FOUR VEGETABLES: ACREAGE REQUIRED TO BREAK EVEN AND CHANGES IN PACKING COST WHEN YIELD, OPERATING LEVEL AND PACKING CHARGE VARIED FROM BASE SOLUTION

Crop	Base	Yield		Operating Level		Adjusted Packing Charge[a]
		-10 Percent	-20 Percent	50 Percent	90 Percent	
		percentage change from base				
Break-even Acreage (acres):						
Tomato	173	+10	+25	+35	-12	-19
Bell pepper	172	+12	+25	+41	-15	-20
Spring cabbage	172	+11	+25	+38	-13	-15
Fall cabbage	172	+11	+25	+38	-13	-15
Packing Cost Per Crate (dollars):						
Tomato	2.33	0	0	+2	-1	+6
Bell pepper	2.57	0	0	-3	+2	+9
Spring cabbage	2.75	0	0	-1	0	+7
Fall cabbage	2.75	0	0	-1	0	+7
Variable Cost Per Crate (dollars):						
Tomato	1.70	0	0	+13	-8	0
Bell pepper	1.53	0	0	+14	-8	0
Spring cabbage	1.85	0	0	+12	-6	0
Fall cabbage	1.85	0	0	+12	-6	0
Fixed Cost Per Crate (dollars):						
Tomato	0.64	0	0	-28	+14	+21
Bell pepper	1.04	0	0	-28	+15	+21
Spring cabbage	0.90	0	0	-28	+16	+20
Fall cabbage	0.90	0	0	-28	+16	+20

[a]Packing charges were changed to 10 cents above packing cost.

bell peppers and 15 percent for spring and fall cabbage. Packing cost per crate increased 6 to 9 percent when the packing charge was adjusted but exhibited no effect on average variable cost. Average fixed cost increased 21 percent for tomatoes and bell peppers and increased 20 percent for spring and fall cabbage when packing charges were adjusted.

Total fixed cost was not affected by reducing packout level to 50 percent, but total variable cost increased 55 percent and total crates sold increased 37 percent (Table VI-15). Total variable cost declined 19 percent, and total crates sold declined 13 percent when the packing level was increased to 90 percent. Total variable cost and total crates sold declined 17 percent at the 90 percent packing level.

TABLE VI-15

FOUR VEGETABLES: TOTAL CRATES REQUIRED FOR PACKINGHOUSE TO BREAK EVEN, TOTAL FIXED COST AND TOTAL VARIABLE COST WHEN OPERATING LEVEL AND PACKING CHARGE ARE VARIED FROM BASE SOLUTION

Item	Base	Operating Level		Adjusted Packing Charge[a]
		50 Percent	90 Percent	
		percentage change from base		
Total fixed cost (dollars)	212,460	0	0	0
Total variable cost (dollars)	442,340	+55	-19	-17
Total crates sold	253,760	+37	-13	-17

[a]Packing charges were changed to 10 cents above packing cost.

When interest rates were changed to 8 and 12 percent, acreage declined 7 to 8 percent and increased 7 to 8 percent, respectively (Table VI-16). Changes in interest rate exhibited no effect on per crate packing cost, average variable cost or average fixed cost. A reduction in the financing from 90 to 80 percent resulted in reducing acreage 3 to 5 percent, but per crate packing cost, average variable cost and average fixed cost were not effected.

Total fixed cost, total variable cost and total crates sold declined 7 percent when interest rate was changed to 8 percent and increased 7 percent when interest rate was changed to 12 percent (Table VI-17). Total fixed cost, total variable cost and total crates sold declined 4 percent when financing was reduced to 80 percent.

TABLE VI-16

FOUR VEGETABLES: ACREAGE REQUIRED TO BREAK EVEN AND CHANGES IN PACKING COST WHEN INTEREST RATE AND FINANCING ARE VARIED FROM BASE SOLUTION

Crop	Base	Interest Rate		Financing
		8 Percent	12 Percent	80 Percent
Acres (percentage change from base):				
Tomato	173	-7	+7	-5
Bell pepper	172	-8	+8	-4
Spring cabbage	172	-7	+7	-3
Fall cabbage	172	-7	+7	-3
Packing Cost Per Crate (dollars):				
Tomato	2.33	2.33	2.33	2.33
Bell pepper	2.57	2.57	2.57	2.57
Spring cabbage	2.75	2.76	2.75	2.75
Fall cabbage	2.75	2.76	2.75	2.75
Variable Cost Per Crate (dollars):				
Tomato	1.70	1.70	1.70	1.70
Bell pepper	1.53	1.53	1.53	1.53
Spring cabbage	1.85	1.85	1.85	1.85
Fall cabbage	1.85	1.85	1.85	1.85
Fixed Cost Per Crate (dollars):				
Tomato	0.64	0.63	0.64	0.64
Bell pepper	1.04	1.04	1.04	1.04
Spring cabbage	0.90	0.91	0.90	0.90
Fall cabbage	0.90	0.91	0.90	0.90

TABLE VI-17

FOUR VEGETABLES: TOTAL FIXED COST, TOTAL VARIABLE COST AND TOTAL CRATES SOLD WHEN INTEREST RATE AND FINANCING ARE VARIED FROM BASE SOLUTION

Item	Base	Interest Rate 8 Percent	Interest Rate 12 Percent	Financing 80 Percent
		--percentage change from base-		
Total fixed cost (dollars)	212,460	-7	+7	-4
Total variable cost (dollars)	442,340	-7	+7	-4
Total crates sold	253,760	-7	+7	-4

CHAPTER VII

SUMMARY AND IMPLICATIONS

The Packing Simulation (PACKSIM) model was used in this analysis to determine the effects that variations in product prices, crop yields, operating level, interest rate, financing and packing charges have on the operation of a fresh vegetable packing facility. The initial analysis consisted of 15 vegetables (spring and fall broccoli, cantaloupe, cucumber, okra, Irish potatoes, sweet potatoes, tomatoes, bell peppers, fall greens, sweet corn, squash, pole beans and spring and fall cabbage). The initial specifications were that product prices were based on a five-year average of Atlanta wholesale prices, crop yields were based on the 1988 Extension vegetable budgets, operating level was set at 70 percent of rated capacity, packing charges were obtained from several sources and 90 percent of the total capital was financed at 10 percent interest. In the analysis, product prices were varied 25 percent above and below the Atlanta wholesale prices, crop yields were reduced 10 and 20 percent below budget levels, operating level was set at 50 and 90 percent of rated capacity, packing charges were adjusted to 10 cents above packing cost, interest rates were changed to 8 and 12 percent, and the total amount financed was changed to 80 percent.

Analysis of the facility packing 15 vegetables revealed that several vegetables had packing cost greater than their packing charge. Larry Snell, Manager of Cumberland Farm Products in Monticello, Kentucky, suggested that it would be impractical for a facility to attempt to pack 15 different vegetables.

The analysis was also conducted on several combinations of vegetables taken from the original 15. In these models, changes in product prices exhibited no effect on the break-even analysis of the facility due to the design of the program. Because changes in product prices did not affect the break-even level of operation in these models, product prices were omitted from further examination.

This study revealed that decreases in yield by 10 and 20 percent required that acreage be increased about 10 percent and 25 percent, respectively, for all the facilities analyzed to maintain the break-even level of operation. Change in yield had no effect on packing cost per crate, average variable cost, average fixed cost and total fixed cost.

A decrease in packing level to 50 percent of rated capacity resulted in a range of 37 to 49 percent increase in required acreage and an increase of rated capacity to 90 percent decreased required acreage in a range of 12 to 17 percent. Average variable cost decreased 12 to 19 percent at the 50 percent packout level and increased 6 to 10 percent at the 90 percent packout level. Average fixed cost declined 29 to 32 percent at the 50 percent packout level and increased 14 to 19 percent at the 90 percent packout level. Total fixed cost was not affected by changes in packing level. Total variable cost increased 43 to 62 percent at the 50 percent packout level and decreased 13 to 21 percent at the 90 percent packout level.

The required acreage to maintain the break-even level of operation declined in a range of 13 to 19 percent when packing charges were adjusted to 10 cents above packing cost. Packing cost per crate increased in a range of 5 to 10 percent, average fixed cost increased in

a range of 19 to 25 percent, total variable cost declined in a range of 17 to 18 percent and total crates sold declined in a range of 17 to 18 percent. Average variable cost and total fixed cost were not effected by the change in packing cost.

Changes in interest rates exhibited no effect on packing cost per crate, average variable cost and average fixed cost. Required acreage to maintain the breakeven level of operation was reduced in a range of 6 to 10 percent at 8 percent interest and increased in a range of 5 to 11 percent at 12 percent interest. Total fixed cost, total variable cost and total crates sold decreased in a range of 7 to 8 percent at 8 percent interest and increased 7 to 8 percent at 12 percent interest.

Financing at the 80 percent level resulted in the required acreage to decline in a range of 3 to 9 percent to maintain the break-even level of operation. The change in financing exhibited no effect on packing cost per crate, average variable cost and average fixed cost. Total fixed cost declined 4 percent, total variable cost declined in a range of 4 to 5 percent and total crates sold declined in a range of 4 to 5 percent.

These results indicate that the change in packing level had the greatest effect on the facilities maintaining a break-even level of operation. Adjustments in the packing charge exhibited the second largest effect. Changes in crop yield, interest rate and financing exhibited the smallest effect on required acreage, packing cost, fixed cost and variable cost.

The analysis suggests that the 15-crop facility would have the most difficulty in maintaining the break-even level of operation.

Several problems would need to be overcome for the 15-crop facility to maintain a break-even level of operation. One problem is the difference in packing charge and packing cost. Eight of the 15 vegetables had packing a cost that exceeded the packing charge. A second problem would be the distribution of capital investments such as the ice machine and hydrocooler over a very few crops. A third problem would be managing a facility that would packout 15 vegetables. Problems in coordinating harvest, delivery to the facility and changes on the assembly line as the vegetables are graded and packed would have to be considered.

The facilities designed to packout six vegetables, five vegetables, five vegetables (with hydrocooler) or four vegetables would be more manageable than the 15-vegetable facility. These facilities would be able to packout Irish potatoes, tomatoes and bell peppers on the weight sizer and packout sweet corn and cabbage on the conveyor line (using the hydrocooler for the sweet corn).

The analysis of the six-vegetable, five-vegetable, five-vegetable with hydrocooler and four-vegetable facilities revealed that the major determining factor was the specified operating level as a percentage of rated capacity. The affects of changes in crop yield, packing charges, interest rate, financing and operating at the 90 percent of rated capacity level were all similar among four packinghouse models. But, when the facilities operated at the 50 percent packout level, the four-vegetable and five-vegetable (with hydrocooler) models performed better than the five- or six-vegetable facility. The four-vegetable facility required that acreage increase in a range of 35 to 41 percent per vegetable, total variable cost increased 55 percent and total crates

sold increased 37 percent to maintain the break-even level of operation. The five-vegetable (with hydrocooler) facility at the 50 percent packout level had to increase acreage per vegetable 38 to 43 percent, total variable cost increased 58 percent and total crates sold increased 40 percent to maintain the break-even level of operation. The six-vegetable and five-vegetable facilities had to increase acreage in a range of 44 to 49 percent and 37 to 47 percent, increase total variable cost in a range of 66 and 62 percent and increase total crates sold in a range of 46 and 43 percent, respectively, when operating at the 50 percent packout level, to maintain the break-even level of operation.

When forced to operate at 50 percent of rated capacity, the four-vegetable facility and the five-vegetable (with hydrocooler) facility required smaller increases in required acreage, total variable cost and total crates sold to maintain the break-even level of operation than the five- or six-vegetable facility. Otherwise, it seems that the six-vegetable, five-vegetable, five-vegetable (with hydrocooler) and four-vegetable facilities were affected about the same when there were changes in crop yield, packing charge, interest or financing or operating at 90 percent of rated capacity.

Another determining factor will be which vegetables are marketable in the chosen area. If demand for sweet corn is low, the decision should be to build the five-vegetable or four-vegetable facility. The five-vegetable (with hydrocooler) facility would be the better choice if there is a demand for sweet corn and the producers are good managers.

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APPENDIX

TABLE A-1

SPECIFIED COST OF LABOR, PACKING MATERIALS, FIXED OVERHEAD, ADMINISTRATIVE SALARIES, GENERAL EXPENSES, BUILDING AND EQUIPMENT AND LAND FOR MODEL PACKINGHOUSE

Labor:		
Forklift operator		$4.00/hour
Dumper		$3.35/hour
Culling		$3.35/hour
Packing		$3.35/hour
Crate former		$3.35/hour
Storage		$3.35/hour
Secretary		$3.35/hour
State unemployment		2.7% of first $7,000
Federal unemployment[a]		0.8% of first $7,000
Packing Materials:		
Irish potato	(50-pound bag)	$0.44
Sweet potato	(50-pound crate)	$0.76
Bell peppers	(1 1/9 bushel waxed)	$0.80
Tomato	(20-pound cardboard)	$0.95
Cabbage	(50-pound cardboard)	$1.10
Broccoli	(20-pound cardboard)	$1.00
Fall greens	(20-pound cardboard)	$0.48
Cantaloupe	(50-pound crate)	$1.05
Sweet corn	(4 1/2 dozen, wire)	$0.94
Squash	(1 1/9 bushel)	$0.80
Okra	(1/2 bushel crate)	$0.73
Pole beans	(30-pound bushel, wire)	$1.35
Cucumber	(1 1/9 bushel crate)	$0.80
Pallets		$7.00
Bands	(broccoli)	$0.18
Ice		$0.50
Fixed Overhead:		
Annual insurance on building		$ 4,200.00
Annual maintenance and repair on building		$10,000.00
Annual insurance on machinery and equipment		2%
Annual maintenance and repair on machinery and equipment		2%
Administrative Salaries:		
Secretary	($5.00/hour, 40 hours/week)	$10,400.00
Manager		$24,000.00
Inspector	($500/week for 16 weeks)	$ 8,000.00

TABLE A-1 (continued)

General Expenses:		
Utilities		$11,100.00
Telephone		$10,500.00
Office supplies		$ 3,420.00
Property taxes		$ 65.00
Postage		$ 2,040.00
Office furniture and equipment -		
Furniture (reception area, manager's office and meeting room)		$ 5,538.00
Computer system		$ 4,080.00
Copy machine		$ 2,000.00
Check writer		$ 359.00
Time clock		$ 435.00
Air conditioning/heating units		$ 1,790.00
Building and Equipment:		
Building	(25,000 square feet)	$500,000.00
Equipment	(weight sizer)	$134,717.00
Hydrocooler		$125,000.00
Refrigeration units	(2 40' X 40', 5-ton units)	$ 20,000.00
Ice machine	(15-ton unit, 30-ton storage)	$115,000.00
Forklift	(electric)	$ 18,500.00
Hand forklift	(manual, 4 at $500)	$ 2,000.00
Return flow belt	(conveyor)	$ 6,692.00
Field crates	(7,500 at $6.00)	$ 45,000.00
Bulk bins	(1,000 at $40.00)	$ 40,000.00
Truck scales		$ 30,000.00
Land:		
Current value	(3 acres at $1,500/acre)	$4,500.00

[a]The tax rate is 6.2 percent, but if the employer pays the state tax on time, he is allowed a 5.4 percent credit and pays only 0.8 percent.

Source: Synthesis of information obtained from managers of vegetable packing facilities in Henegar, Alabama, Monticello and Russell Springs, Kentucky, and Ripley and Tazewell, Tennessee.

TABLE A-2

PRODUCT PRICES USED FOR MODEL PACKINGHOUSE

Crop	Month	Quality[a]			Selling Price in Dollars[b]		
		#1	#2	#3	#1	#2	#3
		----percent----					
Spring broccoli	May	100			8.28		
	June	100			9.34		
Fall broccoli	October	100			9.06		
	November	100			9.11		
Cantaloupe[c]	July	20	50	30	8.23	5.49	2.74
	August	20	50	30	6.99	4.66	2.33
	September	20	50	30	6.33	4.22	2.11
Cucumber[d]	June	20	50	30	9.98	6.65	3.33
	July	20	50	30	11.75	7.83	3.92
	August	20	50	30	8.17	5.80	2.90
	September	20	50	30	9.28	6.19	3.09
Okra	July	100			7.46		
	August	100			6.61		
	September	100			8.63		
	October	100			7.94		
Irish potato	July	100			6.15		
Sweet potato[e]	August	35	65		8.10	4.05	
	September	35	65		7.59	3.80	
Tomato[f]	July	40	40	20	7.47	7.47	3.72
	August	40	40	20	7.15	7.15	3.75
	September	40	40	20	6.38	6.38	3.19
Bell pepper[g]	July	15	85		11.40	9.12	
	August	15	85		9.01	7.21	
	September	15	85		11.17	8.94	
	October	15	85		9.51	7.61	
Fall greens	October	100			5.63		
	November	100			4.63		
Sweet corn	June	100			6.15		
	July	100			5.89		

TABLE A-2 (continued)

Crop	Month	Quality[a]			Selling Price in Dollars[b]		
		#1	#2	#3	#1	#2	#3
		----percent----					
Squash	June	100			7.23		
	July	100			9.55		
	August	100			10.55		
	September	100			11.04		
Pole beans	June	100			13.27		
	July	100			9.49		
	August	100			9.74		
	September	100			10.18		
	October	100			12.68		
Spring cabbage	June	100			7.34		
	July	100			6.36		
Fall cabbage	October	100			4.95		
	November	100			4.93		
	December	100			5.90		

[a]Distribution of packout by grade categories obtained from Rutledge and Jenkins.

[b]Alanta Fresh Fruit and Vegetable Wholesale Market Price, 1982, 1983, 1985, 1986. Average price adjusted for transportation expense from packinghouse study area.

[c]Medium two-thirds price of No. 1; Small one-half price of Medium (No. 2).

[d]Medium two-thirds price of No. 1; Small one-half price of Medium (No. 2).

[e]No. 2 one-half price of Jumbo (No. 1).

[f]No. 3 one-half price of No. 1.

[g]No. 2 four-fifths of Fancy price (No. 1).

TABLE A-3

FREIGHT AND BROKERAGE FEES FOR MODEL PACKINGHOUSE

Crop	Transportation[a]	Broker Fee[a]
	----------dollars----------	
Spring broccoli	0.12	0.25
Fall broccoli	0.12	0.25
Cantaloupe	0.30	0.15
Cucumber	0.30	0.25
Okra	0.12	0.25
Irish potato	0.30	0.10
Sweet potato	0.30	0.25
Tomato	0.12	0.25
Bell pepper	0.24	0.25
Fall greens	0.12	0.25
Sweet corn	0.18	0.25
Squash	0.30	0.25
Pole beans	0.18	0.15
Spring cabbage	0.30	0.15
Fall cabbage	0.30	0.15

[a]Obtained from Leroy Neely, local fruit and vegetable broker in Knoxville, Tennessee.

TABLE A-4

CROP YIELDS FOR MODEL PACKINGHOUSE[a]

Crop	Pounds Per Crate	Crates Per Acre	Percent Packed
Spring broccoli	23	225	75
Fall broccoli	23	225	75
Cantaloupe	38	222	100
Cucumber	50	263	100
Okra	18	333	90
Irish potato	50	300	75
Sweet potato	50	300	90
Tomato	20	1,000	70
Bell pepper	40	356	75
Fall greens	25	350	90
Sweet corn	42	200	75
Squash	55	270	90
Pole beans	30	340	80
Spring cabbage	50	450	80
Fall cabbage	50	450	80

[a]Information obtained from Rutledge and Jenkins.

TABLE A-5

WORKERS REQUIRED PER STATION FOR MODEL PACKINGHOUSE[a]

Crop	DC	FL	DP	UL	GR	PK	CF	HI	ST	RC
Spring broccoli	2	1	2	2	6	20	4	3	3	1
Fall broccoli	2	1	2	2	6	20	4	3	3	1
Cantaloupe	2	1	2	2	6	20	4	0	3	1
Cucumber	2	1	2	2	6	20	4	0	3	1
Okra	2	1	2	2	6	20	4	0	3	1
Irish potato	2	1	2	0	6	20	4	0	3	1
Sweet potato	2	1	2	2	6	20	4	0	3	1
Tomato	2	1	2	0	6	20	4	0	3	1
Bell pepper	2	1	2	0	6	20	4	0	3	1
Fall greens	2	1	2	2	6	20	4	3	3	1
Sweet corn	2	1	2	2	6	20	4	2	3	1
Squash	2	1	2	2	6	20	4	0	3	1
Pole beans	2	1	2	2	6	20	4	0	3	1
Spring cabbage	2	1	2	2	6	20	4	0	3	1
Fall cabbage	2	1	2	2	6	20	4	0	3	1

[a]DC = Dumper Culls; FL = Forklift; DP = Dumper; UL = Unloading; GR = Grader; PK = Packer; CF = Crate Former; HI = Hydrocooler and Ice; ST = Storage; and RC = Records.

VITA

Robert Mason Ball was born in Davidson County, Tennessee, on April 16, 1952. He attended the public schools in Nashville, Tennessee, and graduated from Isaac Litton High School in 1970. He received a Bachelor of Science degree in Agriculture from the University of Tennessee at Martin in August, 1974.

He entered Graduate School at Abilene Christian University in Abilene, Texas, in September, 1974, and received the Master of Science degree with a major in Ministry and Evangelism in May, 1976. After graduation he worked with churches of Christ in Whitney, Texas, and Somerville, Texas.

He entered Graduate School at Texas A&M University in College Station, Texas, in January, 1978. He received the Master of Science degree with a major in Animal Science in December, 1980.

He worked with the Mississippi Cooperative Extension Service as 4-H agent in Greenville, Mississippi, from June, 1981, to June, 1984. He transferred to Fulton, Mississippi, and worked as 4-H agent from June, 1984, to July, 1986.

He entered Graduate School at the University of Tennessee at Knoxville in September, 1986, and received the Master of Science degree with a major in Agricultural Economics in August, 1988. In May, 1988, he accepted a position teaching Agricultural Economics at Freed-Hardeman College in Henderson, Tennessee.