# HATCHERY PRODUCED PACIFIC OYSTER SEED:

## economic feasibility on cultch in the Pacific Northwest

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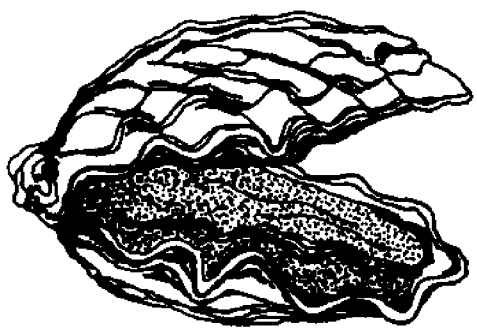

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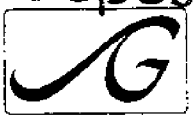



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Practical contributions to this report were aided through information from cooperating segments of the oyster industry and suppliers of utilities, equipment, and contracting services. Especially valuable capabilities, expressed as technical knowledge, access to production facilities, and support of cost evaluation were added by Dr. Vance P. Liporsky, Manager of the Hatchery Division of the Coast Oyster Company, and by Professor Wilbur P. Breese of the Department of Fisheries and Wildlife at the Marine Science Center, Oregon State University, Newport.

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## related publication

HATCHERY MANUAL FOR THE PACIFIC OYSTER, by Wilbur P. Breese and Robert E. Malouf. Publication no. ORESU-H-75-002.

Explains the tools and techniques tested and adopted at the Oregon State University Pilot Oyster Hatchery. It is a "how-to" manual covering all phases of raising oyster seed--from selecting and conditioning adult spawners, to feeding and raising larvae, to culturing algae for oyster food and preparing tanks for setting.

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CONTENTS

# ECONOMIC FEASIBILITY OF HATCHERY-PRODUCED PACIFIC OYSTER (*CRASSOSTREA GIGAS*) SEED ON CULTCH IN THE PACIFIC NORTHWEST

## INTRODUCTION

Oysters (all species combined), in terms of ex-vessel value, currently rank seventh largest among all seafood species landed in the United States, following shrimp, salmon, tuna, crab, lobster, and menhaden.

The supply of domestic hatchery seed for oyster propagation is not sufficient to meet the potential demand at current market prices. Oyster growers can not depend entirely on imported seed as a supplement to the natural seed, mainly because of high cost and uncertainty of seed supply. In the past, most of the Pacific oyster (*c. gigas*) seed has been imported from Japan at high cost and, often, with an extremely low survival rate.

The purpose of this study is to investigate the economic feasibility of producing hatchery seed in the Pacific Northwest, accommodating economic, technical, and biological factors that affect the cost of oyster seed production. In addition, costs are developed for five different levels of output that are within current practical commercial capacities. Also, for each level of production, costs are established for five methods of cultch preparation. These cost projections may serve as a guide for the analysis of costs of present or proposed oyster seed hatchery operations in the Pacific Northwest.

### Review of U.S. Oyster Supply

Oyster imports (mostly canned) have increased significantly, while domestic landings have decreased substantially during the last two and one-half decades, due primarily to high domestic production cost, pollution of oyster beds, and foreign competition. National oyster production, in meat-weight pounds produced per capita, has been .503, .333, .263, and .200 in 1950, 1960, 1970, and 1975, respectively, while oyster imports have been .003, .039, .074, and .058 pounds per capita, respectively, in those years.

The quantity of domestic landings has decreased by 23.7, 30.4, 31.8, and 32.4 percent in 1960, 1965, 1970, and 1975, respectively, compared to landings averaged over the 5 years 1950–1954. Conversely, for the same periods, the quantity of oyster imports has increased tremendously, by 821, 1,032, 1,874, and 1,532 percent, respectively. Nevertheless, in the same four comparative years the total supply of oysters for U.S. consumption has decreased from the 1950–54 average by 15.6, 20.3, 13.6, and 17.4 percent.

National oyster supply has not kept up with population growth. Table 1 shows the historical trend of U.S. population, oyster supply, and oyster consumption per capita for the last two and one-half decades. National oyster consumption, in terms of domestic landings plus imports, was .51, .37, .34, and .31 pounds per capita in 1950, 1960, 1970, and 1975, respectively.

## Objectives

This study identifies several realistic levels of oyster seed output, and determines capital requirements and profitability of each different output level. Specifically, the objectives are:

1. To estimate the variable and fixed costs;
2. to estimate the profit prospective of the hatchery;
3. to determine the average costs per case of seed on cultch;
4. to compare the investment alternatives; and
5. to investigate short-run and long-run cost functions.

## Source of Data

Data on labor input, equipment requirements, and technology were obtained through interviews with staff of leading commercial oyster seed hatcheries in the Pacific Northwest. Other sources of information were time and production studies, analysis of operating and accounting record data, and equipment inventories for the hatchery operation.

Construction cost estimates of the new hatchery building, including wiring and piping, were obtained through interviews with several contractors in Oregon and Washington. The present market values of proposed sizes of used buildings were obtained from industry.

Table 1. U.S. Oyster Supply and Consumption Per Capita

| Year | Population (resident) | Landings | Imports | Total supply[a/] | Consumption per capita |
|---|---|---|---|---|---|
| | million persons | million pounds | | | pounds |
| 1950... | 151.9 | 76.4 | 0.4 | 76.8 | .51 |
| 1951... | 154.0 | 73.0 | 1.0 | 74.0 | .48 |
| 1952... | 156.4 | 82.2 | 0.6 | 82.8 | .53 |
| 1953... | 159.0 | 79.7 | 0.7 | 80.4 | .51 |
| 1954... | 161.9 | 81.9 | 1.1 | 83.0 | .51 |
| 1955... | 165.1 | 77.5 | 1.5 | 79.0 | .48 |
| 1956... | 168.1 | 75.1 | 1.9 | 77.0 | .46 |
| 1957... | 171.2 | 71.7 | 2.7 | 74.4 | .43 |
| 1958... | 174.1 | 66.4 | 5.4 | 71.8 | .41 |
| 1959... | 177.1 | 64.7 | 6.0 | 70.7 | .40 |
| 1960... | 180.0 | 60.0 | 7.0 | 67.0 | .37 |
| 1962... | 185.8 | 56.0 | 7.8 | 63.8 | .34 |
| 1963... | 188.5 | 58.4 | 8.5 | 66.9 | .35 |
| 1964... | 191.1 | 60.5 | 8.0 | 68.5 | .36 |
| 1965... | 193.5 | 54.7 | 8.6 | 63.3 | .33 |
| 1966... | 195.6 | 51.2 | 12.0 | 63.2 | .32 |
| 1967... | 197.5 | 60.0 | 16.1 | 76.1 | .39 |
| 1968... | 199.4 | 61.9 | 14.5 | 76.4 | .38 |
| 1969... | 201.4 | 52.2 | 16.7 | 68.9 | .34 |
| 1970... | 203.8 | 53.6 | 15.0 | 68.6 | .34 |
| 1971... | 206.2 | 54.6 | 9.5 | 64.1 | .31 |
| 1972... | 208.2 | 52.5 | 20.8 | 73.3 | .35 |
| 1973... | 209.8 | 48.6 | 19.9 | 68.5 | .33 |
| 1974... | 211.4 | 44.9 | 16.0 | 60.9 | .29 |
| 1975... | 213.0 | 53.2 | 12.4 | 65.6 | .31 |

[a/] Total supply is not adjusted for beginning and ending stocks, exports, defense purchases, or shipments to U.S. Territories.

SOURCE: Compiled from Statistical Abstract of the U.S., and Fishery Statistics of the U.S., U.S. Department of Commerce, 1950-1975.

Further information on input-output relations, equipment costs, utility rates, and wage rates for 1976 were obtained from both industry and government sources.

Following a detailed study of the operating experience and cost estimates of the oyster hatchery, projections for various other output capacities were developed.

## Limitations and Methods

There are two methods of oyster seed production in hatcheries: spat (post-larval oyster) on cultch, and free or cultchless spat. In the cultch method, dealt with in this study, the spat attach themselves on whole pieces of oyster shell. Costs are not developed for producing cultchless seed, a system that is not currently employed on a commercial scale in the Pacific Northwest.

Production techniques and labor policies differ by hatcheries. Some commercial hatcheries operate nine months per year, and lay off operators during the winter months. However, in this study it was assumed that a core of regular employees (one manager, one supervisor, two operators, and one half-time bookkeeper) work on a year-round basis. They produce 15 batches per year: one batch in February, one and one-half batches each in March and April, two batches in each month from May through September, and only one batch during the winter period (October through January). During the winter months most labor is devoted to repairing and maintaining the facilities and equipment. Even though the business flow may not be sufficient at all times, especially during the winter months, to keep these operators working at capacity, it is necessary to employ them full-time in order to have these highly skilled operators available when they are needed. In this study, operator's wages are treated as part of a hatchery's fixed costs for the year.

Because of the variable production by seasons of the year, the cost analysis has been developed both month-by-month and on an annual basis in order to provide an idea of the gain or loss in each month, in addition to the annual average costs. In any event, either no production or low production in winter months will cause a loss of money because the fixed costs are uniform over all the months.

The basic model, referred to as Plant I in the cost analysis, was constructed to provide general information on building and equipment costs, labor inputs, and other costs incurred in producing oyster seed. Based on production costs for Plant I, which has a designed production capacity of 6,000 cases per year, costs for four other model plants, Plants II to V, were projected. Among the projected models, Plant II has an output capacity of 8,000 cases, Plant III 10,000 cases, Plant IV 12,000 cases, and Plant V 14,000 cases per year. Practices and technologies were assumed to be the same for the five plants.

To describe the production techniques, physical flow patterns were developed from both research and commercial types of oyster hatchery operations.

Total costs were developed by an economic-engineering approach,[1/] and analyzed for both short- and long-run conditions. In this study, "short-run" refers to the situation in which the plant's building and equipment are assumed to be invariant with respect to output, while the long-run situation permits changes in building and equipment levels with different output rates.

To provide decision-making assistance to those operating or contemplating the operation of a hatchery, 400 cumulative cost figures, as shown in Figure 1, were developed by capacity of plant, type of building, method of cultch preparation, type of cost, and season. Values for costs and returns were selected from those prevailing during the study, and are subject to change with time. Costs of

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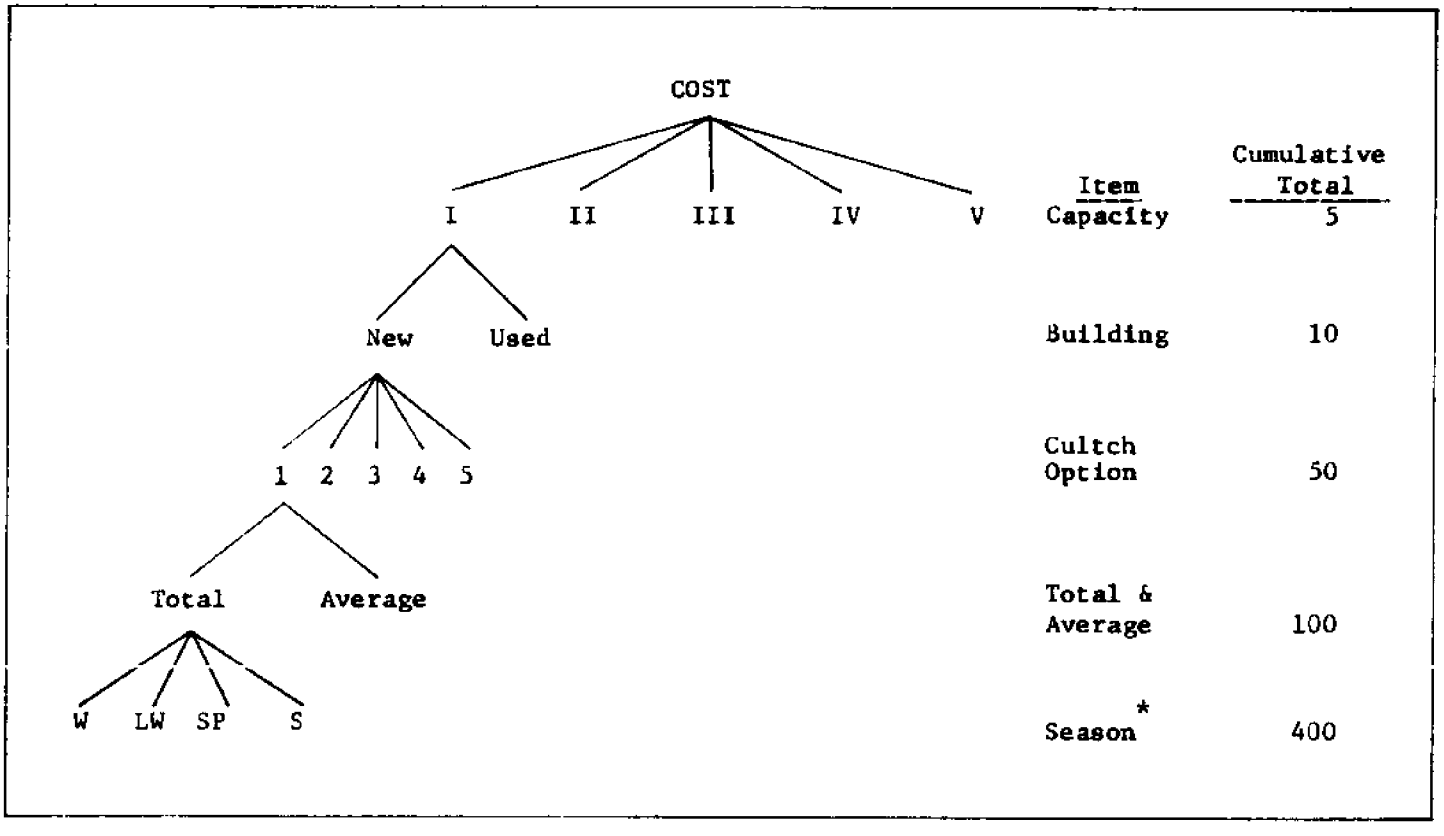
[1/] The explanation of the economic-engineering approach which is given by Madden [7] is that:

> In the economic-engineering or synthetic-firm approach, budgets are developed for hypothetical firms, using the best available estimates of the technical coefficients - resource requirements and expected yields - and charging market prices or opportunity costs for all resources. Hypothetical firms are developed in much the same way that an architect or engineer, bidding for a construction contract, designs a proposed factory or bridge, and estimates the performance and cost of the finished product.
>
> Economic-engineering or synthetic-firm analysis is an appropriate technique when either of two research questions is asked: (1) What is the average cost per unit of output or profit that firms of various sizes could potentially achieve, using modern or advanced technologies, or (2) what are the differences in average cost per unit of output attributable strictly to differences in size of firm.




*Operating seasons are winter (W), late winter (LW), spring (SP), and summer (S).

Figure 1. Schedule used for determining costs.

packaging, advertising, and transportation were not included in the average and total cost figures.

## OYSTER SEED HATCHERY STRUCTURES

### Operating Stages

Oyster seed production is dependent on 6 main stages of operation: (1) conditioning adult oysters for spawning; (2) spawning; (3) algal food production; (4) larval rearing; (5) larval setting; and (6) cultch preparation. Figure 2 relates these stages of an oyster hatchery system.

These six functions, though there may be some variation in how they are accomplished, are common to both research and commercial operations. The following description of hatchery operation stages is based on operating procedures of the Oregon State University pilot oyster hatchery. (For further information, see [1, 6]).

### Conditioning

Adult oysters are stored by suspending them in trays attached to rafts in the bay. The temperature of the water is too low to promote spawning. When needed for spawning, oysters are brought to the hatchery and placed in trays through which unfiltered sea water at 19°C is circulated. Prior to spawning, the oysters feed on natural food in the sea water for 4 or 5 weeks.

### Spawning

Conditioned adult oysters can be induced to spawn by placing them in spawning trays with running fresh sea water that has been filtered and sterilized by ultra-violet light. If necessary, sperm or eggs are added to the tray to stimulate spawning. Water temperature should be controllable to 30°C.

Oysters are placed into individual containers to collect eggs and sperm when they start spawning. An adult female Pacific oyster may release as many as 50 million eggs per spawning. Females are usually allowed to spawn out, but males are placed in cold water to stop their spawning before they spawn out, because only small volumes of sperm are required to fertilize a large number of eggs.

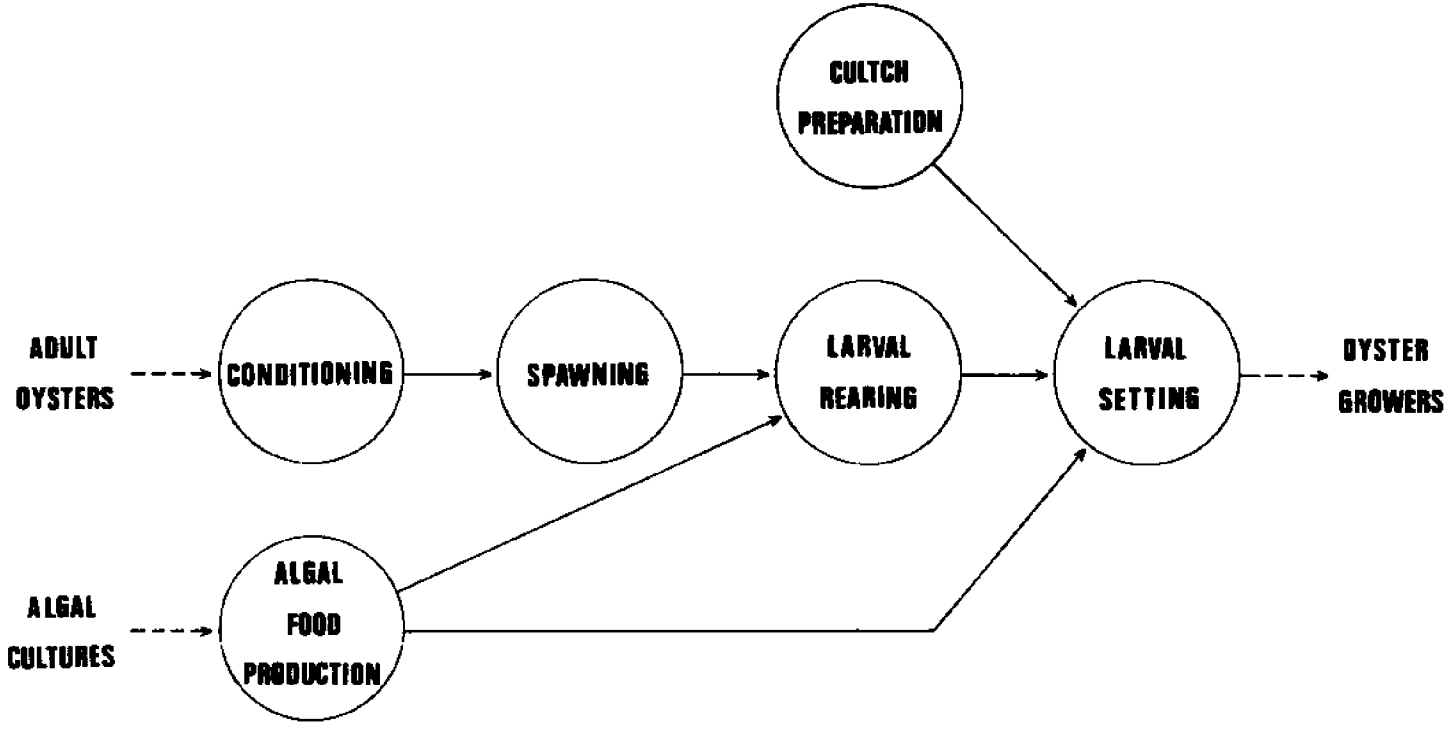



**Figure 2. Relationship between the six stages of oyster hatchery operation.**

## Algal Food Production

This stage, illustrated in some detail in Figure 3, may be considered as a separate operation from the growing of larvae. However, the availability of an adequate food supply is crucial for larval survival and growth.

The time interval from the initiation of algae production to the availability of an adequate supply of algae for larval food requires from one to two weeks. Because of this production lag, a stock of algae is maintained at all times. The algae are started by inoculating the culture media in 250 mℓ flasks, and then transferred to progressively larger containers as the algae bloom.

## Larval Rearing

Fertilized eggs from the spawning stage are placed in 500 ℓ tanks which are filled with filtered sea water and maintained at a temperature of 27°C and aerated for 24 hours. If more than 80 percent of the larvae "shell up", the tanks are drained out through a 40 μ screen. This retains the veligers and discards the abnormal larvae and infertile eggs. The tanks are rinsed thoroughly and filled with warm filtered sea water until 1/3 full, at which time 2.5 million larvae are added. Each tank is then filled with warm filtered sea water.

Enough algae are added to the tank every day to maintain the proper level of nutrients. Every week, in addition, 25 g of Sulmet are added to each 500 ℓ tank. At the end of each week tanks are drained through 80 μ screen and rinsed thoroughly. Larvae are sampled, counted, and measured with the aid of a dissecting scope every week.

On the 14th day of rearing, a string of 3 scallop shells is placed in each tank and inspected every day until at least 50 spat are distributed among the 3 scallop shells.

## Larval Setting

When the larvae attain setting size, they are transferred to a setting tank. Sulmet, algae, and 1 million larvae are added to each tank, filled with warm filtered sea water. Two cases of clean cultch are added to each tank, and the temperature is maintained at 30°C.

Algae are added twice a day until one week after setting. Larvae set on the cultch within 3 days. From then until the spat are at least 3 mm in diameter, a size at which they can be placed in the bay or holding pond, the spat can be fed 100,000 to 150,000 algae cells/mℓ each day.

## Cultch Preparation

Cultch is the material (usually oyster shell) to which oyster larvae attach themselves and undergo metamorphosis to nonmotile "spat". This material, which is cleaned naturally in the ocean environment, must be cleaned by other means for use in a hatchery.

This stage is essentially a simple process that involves the cleaning of "dirty" oyster shells by tumbling them in a concrete mixer in which a continuous stream of water washes the shells. This stage, like algal food production, may be considered as a separate operation from growing the larvae.

## Variation in Production Practices

Even though the six main stages are common to both research and commercial type operations, each commercial oyster hatchery has variations of practices within stages. Water, for example, may be warmed by radiant heat, a heat exchanger, or by storing in tanks in a room that has the proper ambient temperature. Circulation of water at certain stages may differ, with some plants employing recirculation while others use a continuous flow of fresh sea water. Emptying larval rearing tanks for cleaning ranges, by practice, from once every 2 days to once a week. Agitation of algae cultures may be accomplished by bubbling air from lines immersed in the containers or simply by hand-shaking them a couple of times each day.

Each hatchery has its own recipe or formula for algae production. Also, the duration of larval setting varies, by technique, between 2 hours and 3 days. Larval density for setting differs with hatcheries, and ranges from 2 cases to 10 cases of cultch per million larvae.

The relationships among hatchery operation procedures are presented in Figures 3 to 6. Techniques at Oregon State University's Marine Science Center

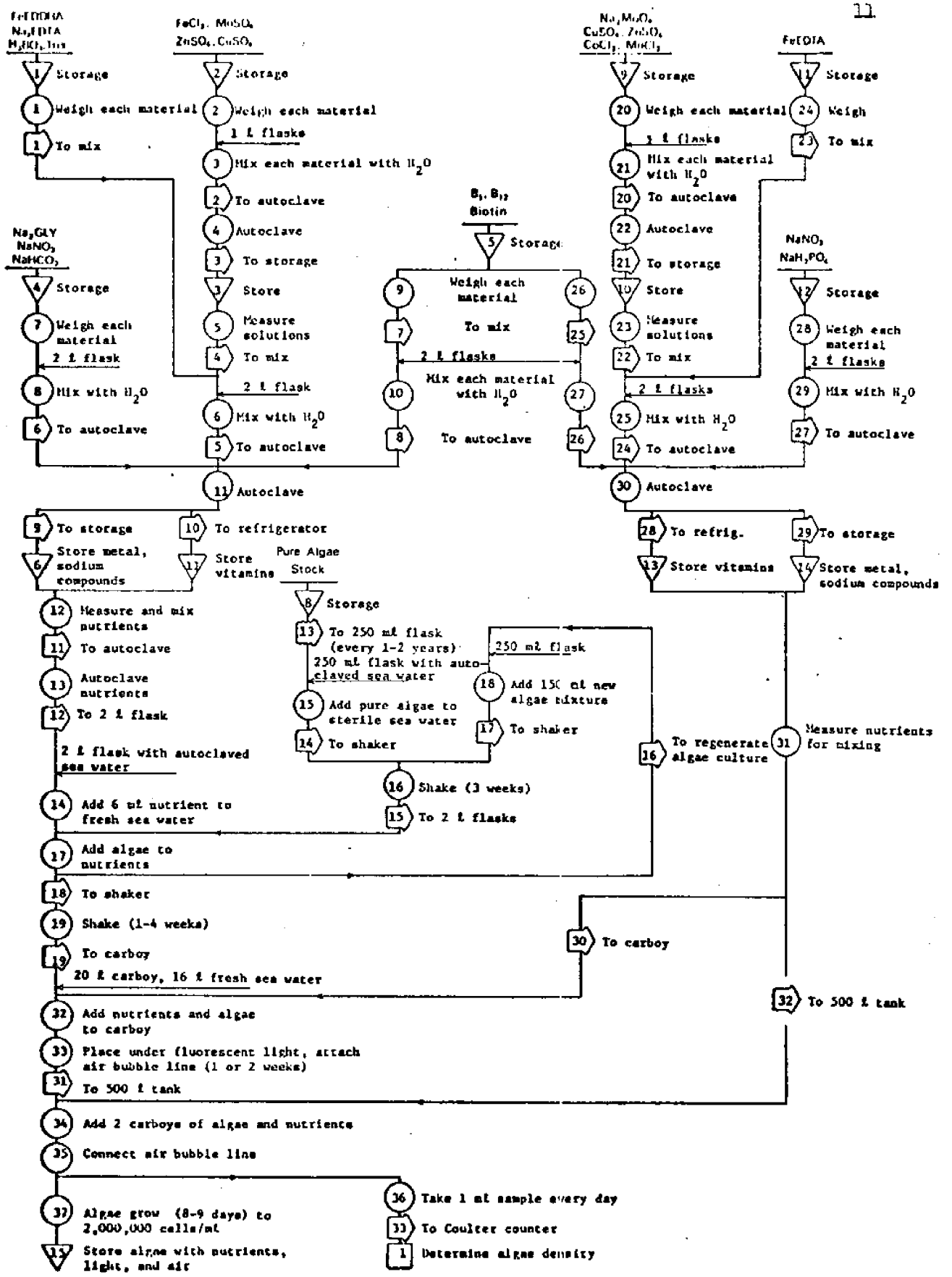



**Figure 3.** Simplified flow process chart of the present method of producing algal food at the Oregon State University, Marine Science Center.

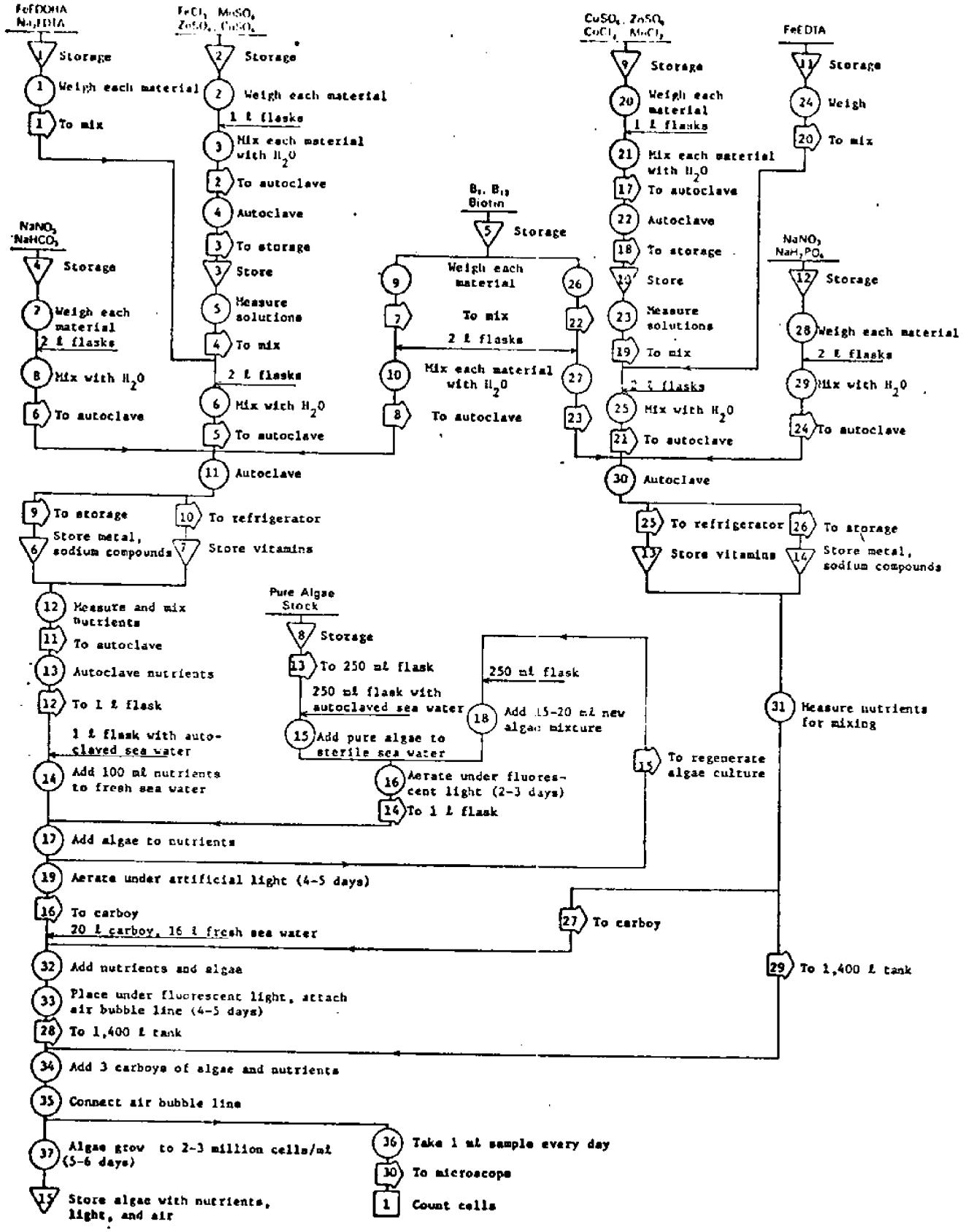



**Figure 4. Simplified flow process chart of a typical commercial method of producing algal food.**

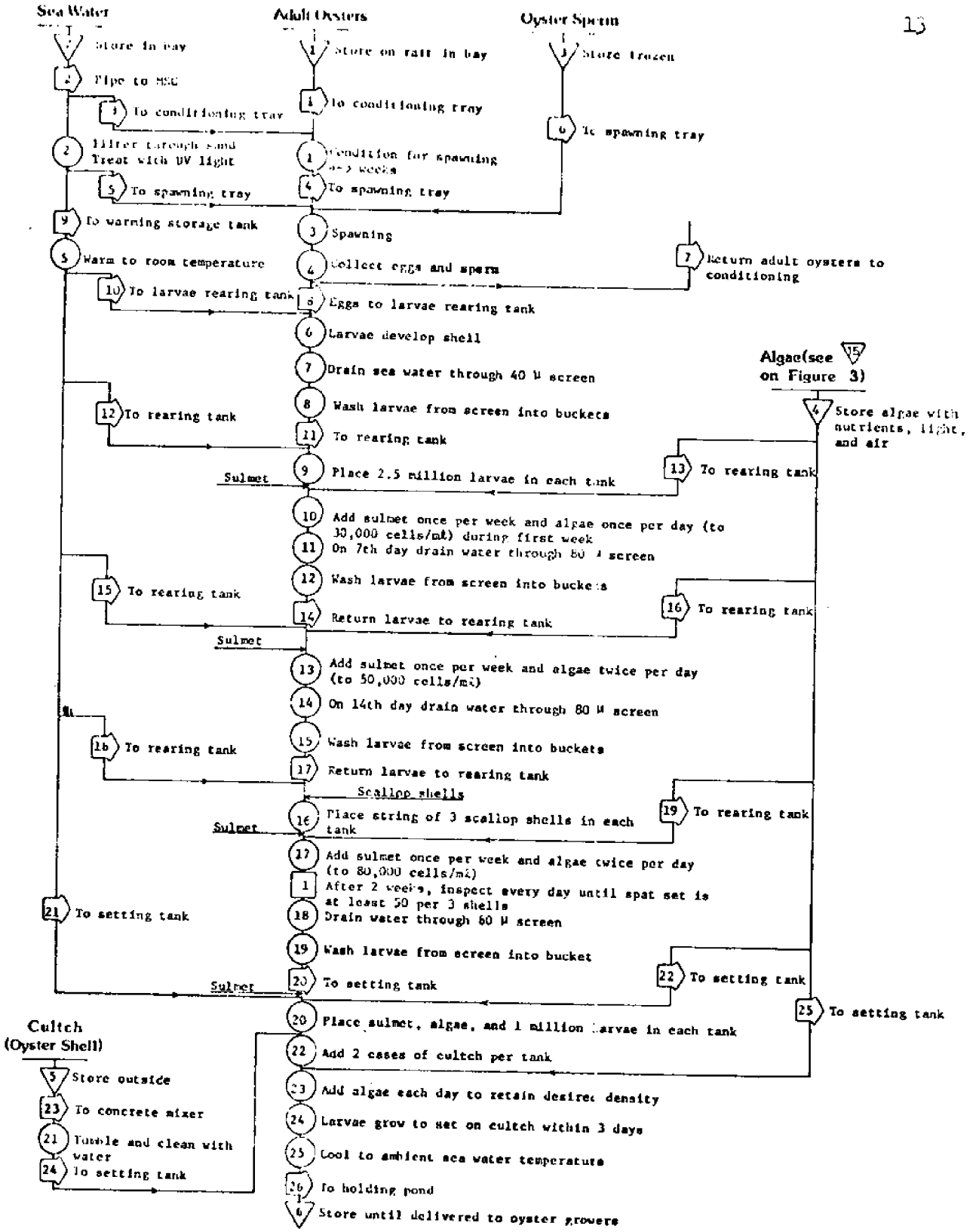



**Figure 5.** Simplified flow process chart of the present method of oyster seed production at the Oregon State University, Marine Science Center.

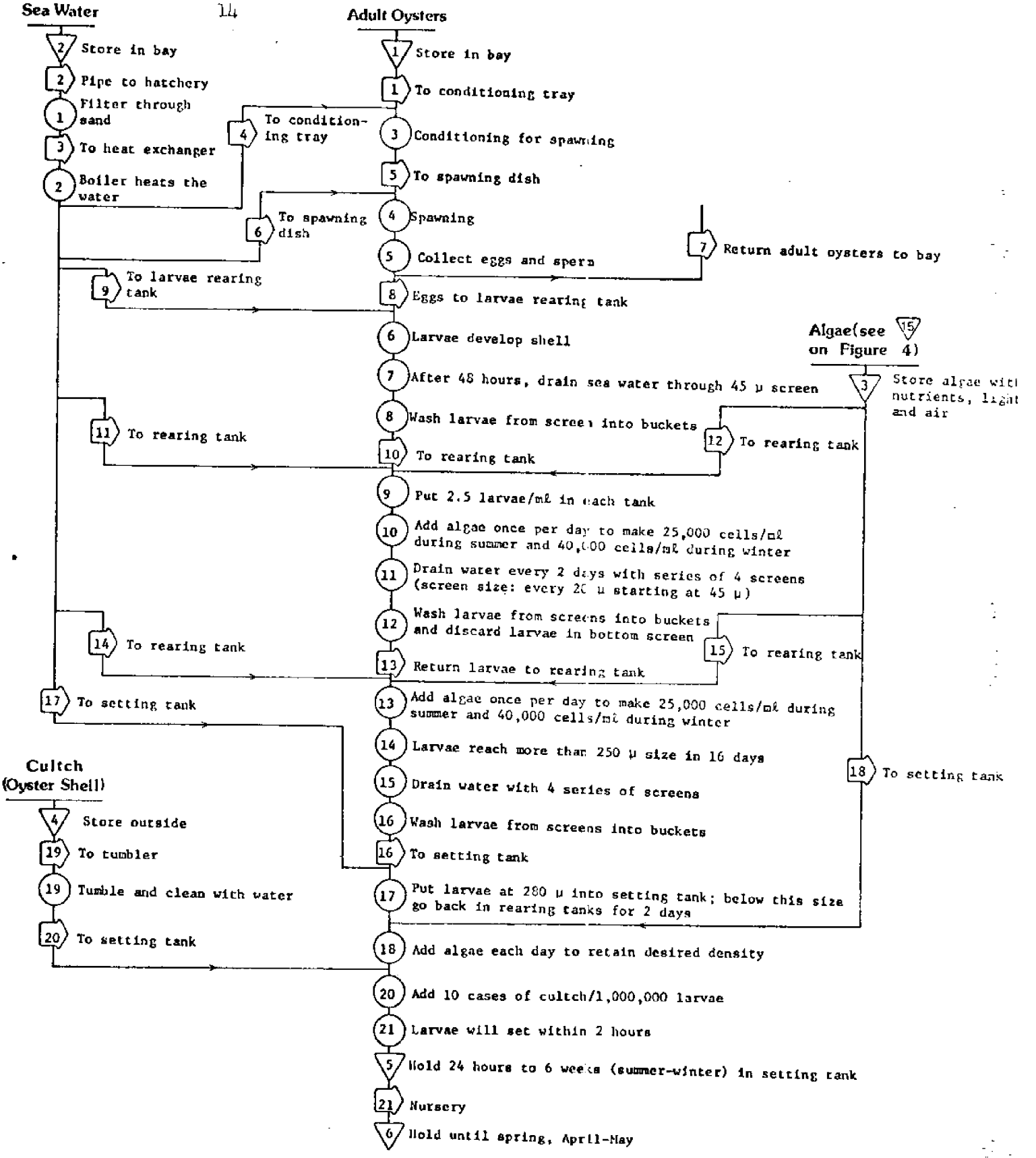



**Figure 6.** Simplified flow process chart of a typical method of producing oyster seed by a commercial hatchery.

are represented by Figures 3 and 5, and methods at a typical commercial oyster hatchery are shown in Figures 4 and 6. A flow-process chart or diagram is a graphical description which shows a picture of the over-all production process being studied. Each step of the process is identified, as to type of activity, by the following symbols:


## Sizes and Volume

The five model plant sizes had total output capacity (in cases of oyster seed) of: 6,000, 8,000, 10,000, 12,000, and 14,000 per year, or 400, 534, 666, 800, and 934 cases per each of 15 batches. These are designated as Plants I, II, III, IV, and V, respectively. Table 2 shows the space requirements for building, by plant and by stages of operation, and reveals that Plant I requires 5,770 square feet, while Plant V requires 8,955 square feet. Thus, a 133 percent increase in output capacity requires only a 55 percent increase in space. The main increase in space requirements is for larval rearing and algal food production. Table 3 shows the estimated production of oyster seed by plant and by month.

Table 2. Space Requirements for Building

| Stage | Plant I | II | III | IV | V |
|---|---|---|---|---|---|
| | | | square feet | | |
| Conditioning and spawning.... | 50 | 50 | 50 | 50 | 50 |
| Algal food production..... | 1,550 | 1,710 | 1,870 | 1,990 | 2,150 |
| Larval rearing..... | 1,940 | 2,677 | 3,227 | 3,778 | 4,425 |
| Larval setting..... | 1,620 | 1,620 | 1,620 | 1,620 | 1,620 |
| Other[a/] ..... | 610 | 610 | 610 | 710 | 710 |
| TOTAL..... | 5,770 | 6,667 | 7,377 | 8,148 | 8,955 |

a/ Includes spaces for office, 330; restroom, 30; boiler and sand filters, 150; and storage, 100 and 200.

Table 3. Estimated Production of Oyster Seed, by Month

| Month | Plant I | II | III | IV | V |
|---|---|---|---|---|---|
| | | | cases[a] | | |
| January | 100 | 134 | 166 | 200 | 234 |
| February | 400 | 534 | 666 | 800 | 934 |
| March | 600 | 800 | 1,000 | 1,200 | 1,400 |
| April | 600 | 800 | 1,000 | 1,200 | 1,400 |
| May | 800 | 1,066 | 1,334 | 1,600 | 1,866 |
| June | 800 | 1,066 | 1,334 | 1,600 | 1,866 |
| July | 800 | 1,066 | 1,334 | 1,600 | 1,866 |
| August | 800 | 1,066 | 1,334 | 1,600 | 1,866 |
| September | 800 | 1,066 | 1,334 | 1,600 | 1,866 |
| October | 100 | 134 | 166 | 200 | 234 |
| November | 100 | 134 | 166 | 200 | 234 |
| December | 100 | 134 | 166 | 200 | 234 |
| TOTAL | 6,000 | 8,000 | 10,000 | 12,000 | 14,000 |

[a] One case is equivalent to 2 1/2 bushels, and will contain approximately 1,000 to 1,500 pieces of oyster shell, broken and unbroken, with an average spat count of 20 spat per shell.

Figure 7 shows more precisely what the monthly production pattern is. During the winter months production is extremely low, and during summer months it reaches its peak.

## ESTIMATION OF COSTS

### Initial Investment Costs

Initial investment costs consist mainly of land, building, and equipment.

#### Land

Cost of initial investment in land is highly variable in relation to location and site, and was omitted in this study. This is not a major item affecting the cost of production.

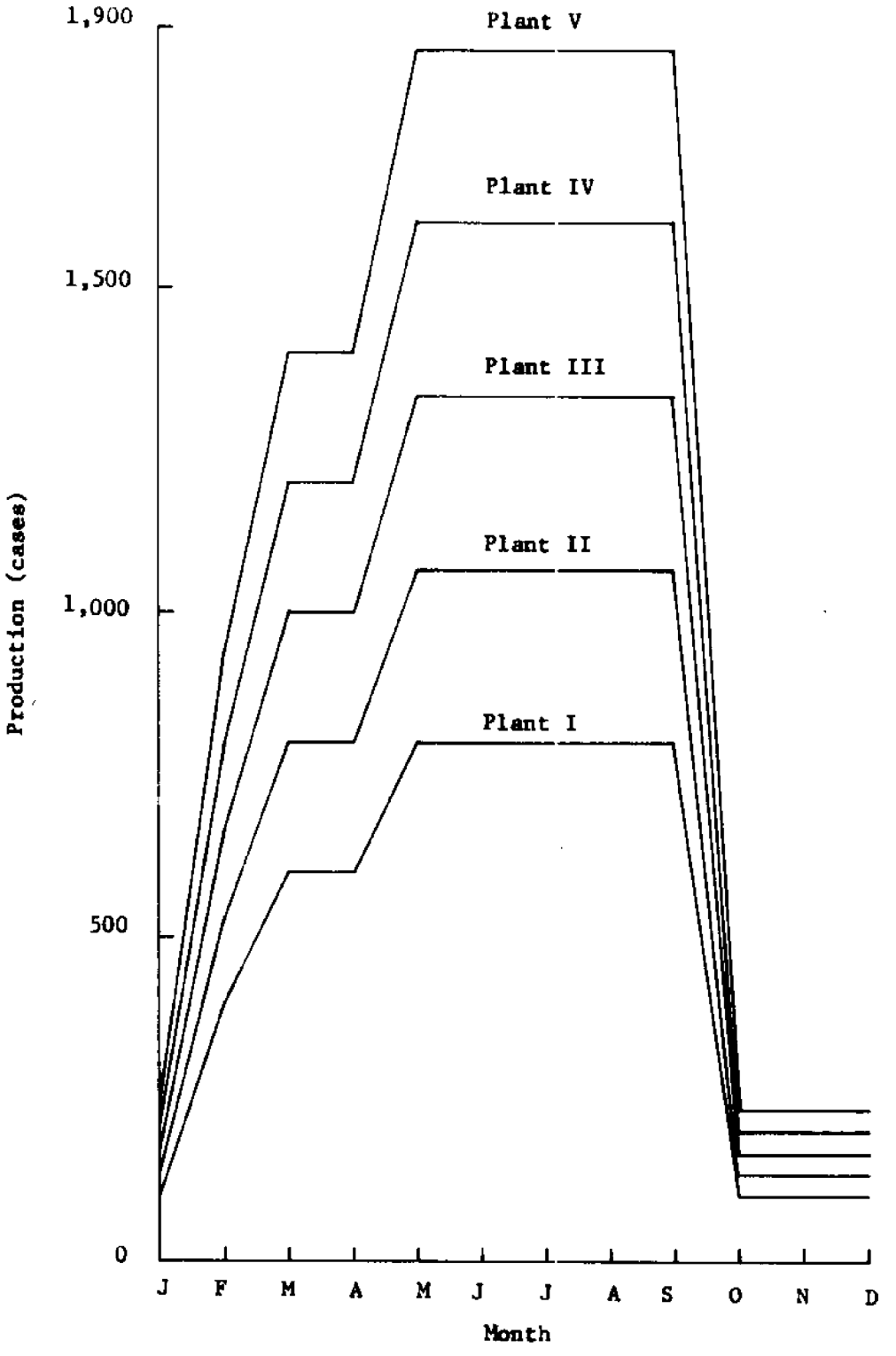



Figure 7. Production cycle by plant.

## Building

Initial investment costs for the oyster hatchery building were estimated on the basis of space requirements needed for equipment and processing. The projected space requirements for various levels of output capacity are shown in Table 2.

Two types of buildings - new and used - were considered in this study. Initial investment costs for a new building, including piping and wiring, were estimated, at current prices, to be $25 per square foot, and those of a used building were estimated to be $10 per square foot. Table 4 shows these figures.

Table 4. Initial Investment Costs for Building

| Type of building | Plant I | II | III | IV | V |
|---|---|---|---|---|---|
| | | | dollars | | |
| New..... | 144,250 | 166,675 | 184,425 | 203,700 | 223,875 |
| Used..... | 57,700 | 66,670 | 73,770 | 81,480 | 89,550 |

## Equipment

The number of equipment items, kind, size, and type required for each plant, are synthesized from input-output relationships and presented in Table 5. Initial investment costs for equipment vary with methods (options) of cultch preparation. Five different methods of cultch preparation are analyzed in this study, and are designated by Option 1, Option 2, Option 3, Option 4, and Option 5, which are used throughout the report. The description of the options follows:

Option 1 - Pump salt water with city power.
Option 2 - Pump salt water with own generated power.
Option 3 - Use city water and power.
Option 4 - Use city water with own generated power.
Option 5 - Buy already-cleaned cultch from a local dealer.

Selection of the cultch preparation option will be influenced by conditions at the site of a specific hatchery.

Table 5. Equipment Requirements, by Stages of Operation

| Stages and equipment items | Capacity | Unit cost | Plant I | II | III | IV | V |
|---|---|---|---|---|---|---|---|
| | | dollars | units required | | | | |
| 1. Conditioning: | | | | | | | |
| Trough | 2'x8' (100 oysters) | 20 | 3 | 3 | 3 | 3 | 3 |
| Little pump (to recycle water) | 1/10 hp. 50 gal/hr. | 20 | 1 | 1 | 1 | 1 | 1 |
| 2. Spawning: | | | | | | | |
| Dish | — | 2 | 12 | 15 | 18 | 21 | 24 |
| Bucket | 5 gal. | 5 | 3 | 4 | 5 | 6 | 7 |
| 3. Algae production: | | | | | | | |
| Flask | 250 ml | 1 | 9 | 12 | 15 | 18 | 21 |
| Carboy | 1 gal. | 9 | 25 | 34 | 42 | 50 | 59 |
| Carboy | 5 gal. | 25 | 15 | 20 | 25 | 30 | 35 |
| Tank (fiberglas) | 1,600 l | 130 | 11 | 15 | 19 | 22 | 26 |
| Plastic valve (for tank) | — | 12 | 11 | 15 | 19 | 22 | 26 |
| Light meter (optical density) | spectronic 20 | 425 | 1 | 1 | 1 | 1 | 1 |
| Autoclave | 2.5 kw | 650 | 1 | 1 | 1 | 1 | 1 |
| Top loading balance | — | 25 | 1 | 1 | 1 | 1 | 1 |
| Refrigerator | -- | 350 | 1 | 1 | 1 | 1 | 1 |
| Water distiller | 5.2 kw 2 gal/hr. | 500 | 1 | 1 | 1 | 1 | 1 |
| Hand cart | -- | 55 | 1 | 1 | 1 | 2 | 2 |
| Refrigeration unit | 1.5 hp | 500 | 1 | 1 | 1 | 1 | 1 |
| Fluorescent light (for tank & bottle) | 40 w | 1 | 142 | 186 | 230 | 273 | 317 |
| Air compressor | 1/3 hp | 132 | 2 | 2 | 2 | 2 | 2 |
| PH meter | — | 200 | 1 | 1 | 1 | 1 | 1 |
| PH meter | — | 325 | 1 | 1 | 1 | 1 | 1 |
| 4. Larval rearing: | | | | | | | |
| Tank (fiberglas) | 6,500 gal. | 1,900 | 3 | 5 | 7 | 9 | 10 |
| Tank (fiberglas) | 3,500 gal. | 1,400 | 3 | 4 | 4 | 4 | 6 |
| Tank (fiberglas) | 1,000 gal. | 250 | 11 | 11 | 11 | 11 | 11 |
| Plastic valve (for 3,500 gal. tank) | — | 24 | 3 | 4 | 4 | 4 | 6 |
| PVC screen (14 different sizes) | 45 μ - 240 μ | 30 | 15 | 16 | 17 | 17 | 18 |
| Dissecting scope | -- | 160 | 1 | 1 | 1 | 1 | 1 |
| Compound scope | -- | 200 | 1 | 1 | 1 | 1 | 1 |
| Compound scope | -- | 1,500 | 1 | 1 | 1 | 1 | 1 |
| Bucket | 5 gal. | 5 | 10 | 12 | 14 | 16 | 18 |
| Electric heater | 3 kw | 190 | 1 | 1 | 1 | 2 | 2 |
| Air compressor (1 for spare) | 1/3 hp | 132 | 2 | 2 | 2 | 2 | 2 |
| 5. Larval setting: | | | | | | | |
| Tank (concrete) | 1,000 gal. 20 cases ea. | 175 | 14 | 14 | 14 | 14 | 14 |
| Air compressor (1 for spare) | 2 hp | 450 | 2 | 2 | 2 | 2 | 2 |
| Electric heater | 3 kw | 190 | 1 | 1 | 1 | 1 | 1 |
| Forklift (propane gas) | 1/2 ton | 4,800 | 1 | 1 | 1 | 1 | 1 |
| 6. Cultch preparation[a/]: | | | | | | | |
| Shell washer tumbler | 2 hp | 2,000 | 1 | 1 | 1 | 1 | 1 |
| Conveyor (waste shell) | 2 hp | 1,000 | 1 | 1 | 1 | 1 | 1 |
| Conveyor (bagging tube) | 2 hp | 1,500 | 1 | 1 | 1 | 1 | 1 |
| Bay pump | 30 hp | 1,300 | 1 | 1 | 1 | 1 | 1 |
| Generator (diesel) | 100 kw | 4,000 | 1 | 1 | 1 | 1 | 1 |
| Bulldozer (gasoline) | 1 ton | 3,000 | 1 | 1 | 1 | 1 | 1 |
| Truck | 1.5 ton | 2,000 | 1 | 1 | 1 | 1 | 1 |
| 7. Other: | | | | | | | |
| Bay pump (1 for spare) | 5 hp. 100 gal/min. | 475 | 2 | 2 | 2 | 2 | 2 |
| Inside pump | 3 hp | 400 | 1 | 1 | 1 | 1 | 1 |
| Sand filter | 60 gal/min. | 664 | 2 | 2 | 2 | 2 | 2 |
| Boiler (diesel) | 3/4 hp 1,000,000 BTU 9 GPH oil | 2,000 | 1 | 1 | 1 | 1 | 1 |
| Diesel fuel storage tank | 1,000 gal. | 500 | 2 | 2 | 2 | 2 | 2 |
| Heat exchanger | — | 1,800 | 2 | 2 | 2 | 2 | 2 |
| Office heater | 1.5 kw | 30 | 1 | 1 | 1 | 1 | 1 |

[a/] The equipment listed in this heading is for a plant which pumps salt water with own generated power, for cultch preparation.

The estimated initial investment costs for equipment, by option, are presented in Table 6. The costs for Option 5 are the lowest because, under this option, no equipment is needed for cultch preparation. Total initial investment costs for building and equipment are presented in Table 7.

Table 6. Initial Investment Costs for Equipment, by Option

| Cultch preparation method | Plant | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| | dollars | | | | |
| Option 1..... | 51,622 | 57,948 | 62,806 | 67,755 | 73,595 |
| Option 2..... | 55,622 | 61,948 | 66,806 | 71,755 | 77,595 |
| Option 3..... | 50,322 | 56,648 | 61,506 | 66,455 | 72,295 |
| Option 4..... | 54,322 | 60,648 | 65,506 | 70,455 | 76,295 |
| Option 5..... | 40,322 | 46,648 | 51,506 | 56,455 | 62,295 |

The respective total initial investment costs for building and equipment varied from $98,022 to $199,872 for Plant I, and from $151,845 to $301,470 for Plant V. Initial investment costs for the building alone accounted for up to 51 to 78 percent of the total.

## Fixed Costs

Fixed costs are not a function of the level of output, but are incurred regardless of output level. Costs considered in this study as being fixed include depreciation, interest on investment, insurance and taxes, repair and maintenance charges for building and equipment, and administration, supervision, and full-time labor costs. Travel expenses for the manager and other personnel are also considered to be fixed. The following procedures and values were used in estimating fixed costs.

### Depreciation

Depreciation was calculated using the straight-line method, assuming no

Table 7. Total Initial Investment Costs for Building and Equipment

| Type of building | Cultch preparation method | Plant I | Plant II | Plant III | Plant IV | Plant V |
|---|---|---|---|---|---|---|
| | | | | dollars | | |
| New | Option 1..... | 195,872 | 224,623 | 247,231 | 271,455 | 297,470 |
| | Option 2..... | 199,872 | 228,623 | 251,231 | 275,455 | 301,470 |
| | Option 3..... | 194,572 | 223,323 | 245,931 | 270,155 | 296,170 |
| | Option 4..... | 198,572 | 227,323 | 249,931 | 274,155 | 300,170 |
| | Option 5..... | 184,572 | 213,323 | 235,931 | 260,155 | 286,170 |
| Used | Option 1..... | 109,322 | 124,618 | 136,576 | 149,235 | 163,145 |
| | Option 2..... | 113,322 | 128,618 | 140,576 | 153,235 | 167,145 |
| | Option 3..... | 108,022 | 123,318 | 135,276 | 147,935 | 161,845 |
| | Option 4..... | 112,022 | 127,318 | 139,276 | 151,935 | 165,845 |
| | Option 5..... | 98,022 | 113,318 | 125,276 | 137,935 | 151,845 |

salvage value, on the basis of 10 years for equipment, 30 years for new building, and 15 years for used building.

## Interest on Investment

Interest on investment was calculated at 12 percent of undepreciated balance on building and equipment, i.e., 6.6 percent on equipment, 6.2 percent on new building, and 6.4 percent on used building, according to the following formula:

$$\text{Average interest} = \frac{i}{2}\left(\frac{n+1}{n}\right),$$

where: $i$ = interest rate, estimated as 12 percent, and

$n$ = number of useful years.

## Insurance and Taxes

Insurance and taxes equal to 1.0 and 1.6 percent, respectively, of the total initial investment costs.

Repair and Maintenance Charges

Regardless of whether equipment and buildings are being used, their maintenance and repair are necessary in order to retain their productive ability. Three main factors - age, type of construction, and foundation - affect repair and maintenance charges for a building. The allocated proportion of repair and maintenance charges are 1.5 percent each of the total initial investment costs for the new building and equipment, and 3 percent for the used building.

Supervision, Administration, and Full-Time Labor

Four and one-half employees were considered to be sufficient for Plants I through V as fixed labor: 1 manager, 1 supervisor, 2 operators, and one half-time bookkeeper. The estimated wages and salaries are as follows:

| | |
|---|---|
| Manager..... | $14,210 |
| Supervisor..... | 9,470 |
| Two operators..... | 17,595 |
| Half-time bookkeeper..... | 3,420 |
| TOTAL..... | $44,695 |

Wages for the operators were computed at $4 per hour for 40 hours per week, and 52 weeks per year. One of the operators, assigned only to algae production, is assumed to work overtime for 4 hours per week during the winter months and 8 hours per week the rest of the year. It is advantageous for management to pay overtime for the few extra hours of work needed for algae production rather than to obtain and train a part-time operator for the additional work. The estimated wages for two operators included this overtime work with a time and one-half rate.

Hourly wage rates and fringe benefits vary considerably with the state and individual plant policy. Fringe benefits, in general, include allowance for Social Security Tax, unemployment insurance, health and accident insurance, workmen's compensation insurance, and other fringe costs to the employer. In addition to these, full-time employees normally receive 2 weeks' paid vacation and 8 to 10 paid holidays per year. In this study, 14 and 10 percent of wages and salaries were applied for fringe benefits, respectively, to the full-time employees and part-time workers. The total estimated wages and salaries, including fringe benefits, are $50,815.

### Travel Expenses

Business travel expense by the manager and other employees was assumed to be $1,000 per year.

Table 8 shows the annual fixed costs, by plant and option. Fixed costs varied from $80,000 to $83,000 for Plant I, and from $95,000 to $98,000 for Plant V, associated with new buildings, and from $71,000 to $74,000 for Plant I and from $81,000 to $85,000 for Plant V, associated with used buildings.

## Variable Costs

Variable costs used in this study include such items as wages of part-time labor, costs of utilities, materials, and supplies, and other expenses directly related to oyster seed production. All costs are analyzed on a monthly basis. Some items such as electrical demand charges, water and sewer charges, oil for boiler, garbage, and telephone, are semi-fixed on a monthly basis, regardless of output level.

### Part-Time Labor

In addition to full-time laborers, part-time laborers are required for cultch preparation. With the designed model and technology, 4 part-time workers are required to clean 200 cases of oyster shell per day. The labor requirements vary, month by month, with plants and options chosen. Also, 2 additional part-time workers, working 4 days per week for 5 months (May through September), are necessary for Plants IV and V, to support full-time workers. Wage rates for these workers, including fringe benefits, are estimated at $3.64 per hour. Table 9 shows the variable labor costs, by months. Labor costs for cultch preparation are considered to be proportional with output, and Options 1 through 4 have the same cost figures in each month. In Option 5, however, there is no variable labor costs for cultch preparation, because cultch is purchased from local dealers.

### Utilities, Materials, and Supplies

Electricity - Operating time for each item of electrical equipment was estimated, to determine the total KWH usage per month for power and light. Costs of electricity are derived from light and power usage. For example, a 1-hp motor

Table 8. Annual Fixed Costs, by Plant and Option

PLANT I:

| Building[a/] | New | | | | | Used | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Option | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| | dollars | | | | | dollars | | | | |
| Depreciation | 9,922 | 10,322 | 9,792 | 10,192 | 8,792 | 9,009 | 9,409 | 8,879 | 9,279 | 7,879 |
| Interest on investment | 12,351 | 12,615 | 12,265 | 12,529 | 11,605 | 7,100 | 7,364 | 7,014 | 7,278 | 6,354 |
| Insurance & taxes | 5,093 | 5,197 | 5,059 | 5,163 | 4,799 | 2,842 | 2,946 | 2,809 | 2,913 | 2,549 |
| Repair & maintenance | 2,938 | 2,998 | 2,919 | 2,979 | 2,769 | 2,505 | 2,565 | 2,468 | 2,546 | 2,336 |
| Travel expense | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Fixed labor | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 |
| Total | 82,119 | 82,947 | 81,850 | 82,678 | 79,780 | 73,271 | 74,099 | 73,003 | 73,831 | 70,933 |

PLANT II:

| Building[a/] | New | | | | | Used | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Option | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| | dollars | | | | | dollars | | | | |
| Depreciation | 11,295 | 11,695 | 11,165 | 11,565 | 10,165 | 10,239 | 10,639 | 10,109 | 10,509 | 9,109 |
| Interest on investment | 14,159 | 14,423 | 14,073 | 14,337 | 13,413 | 8,091 | 8,355 | 8,006 | 8,270 | 7,346 |
| Insurance & taxes | 5,840 | 5,944 | 5,806 | 5,910 | 5,546 | 3,240 | 3,344 | 3,206 | 3,310 | 2,946 |
| Repair & maintenance | 3,369 | 3,429 | 3,350 | 3,410 | 3,200 | 2,869 | 2,929 | 2,850 | 2,910 | 2,700 |
| Travel expense | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Fixed labor | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 |
| Total | 86,478 | 87,306 | 86,209 | 87,037 | 84,139 | 76,254 | 77,082 | 75,986 | 76,814 | 73,916 |

PLANT III:

| Building[a/] | New | | | | | Used | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Option | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| | dollars | | | | | dollars | | | | |
| Depreciation | 12,367 | 12,767 | 12,237 | 12,637 | 11,237 | 11,199 | 11,599 | 11,069 | 11,469 | 10,069 |
| Interest on investment | 15,579 | 15,843 | 15,493 | 15,757 | 14,833 | 8,866 | 9,130 | 8,781 | 9,045 | 8,121 |
| Insurance & taxes | 6,428 | 6,532 | 6,394 | 6,498 | 6,134 | 3,551 | 3,655 | 3,517 | 3,621 | 3,257 |
| Repair & maintenance | 3,708 | 3,768 | 3,689 | 3,749 | 3,539 | 3,155 | 3,215 | 3,136 | 3,196 | 2,986 |
| Travel expenses | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Fixed labor | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 |
| Total | 89,897 | 90,725 | 89,628 | 90,456 | 87,558 | 78,586 | 79,414 | 78,318 | 79,146 | 76,248 |

(continued)

Table 8. Annual Fixed Costs, by Plant and Option (continued)

PLANT IV:

| Building[a/] | New | | | | | Used | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Option | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| | dollars | | | | | dollars | | | | |
| Depreciation | 13,497 | 13,897 | 13,367 | 13,767 | 12,367 | 12,207 | 12,607 | 12,077 | 12,477 | 11,077 |
| Interest on investment | 17,101 | 17,365 | 17,015 | 17,279 | 16,355 | 9,687 | 9,951 | 9,601 | 9,865 | 8,941 |
| Insurance & taxes | 7,058 | 7,162 | 7,024 | 7,128 | 6,764 | 3,880 | 3,984 | 3,846 | 3,950 | 3,586 |
| Repair & maintenance | 4,072 | 4,132 | 4,052 | 4,112 | 3,902 | 3,461 | 3,521 | 3,441 | 3,501 | 3,291 |
| Travel expense | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Fixed labor | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 |
| Total | 93,543 | 94,371 | 93,273 | 94,101 | 91,203 | 81,050 | 81,878 | 80,780 | 81,608 | 78,710 |

PLANT V:

| Building[a/] | New | | | | | Used | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Option | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| | dollars | | | | | dollars | | | | |
| Depreciation | 14,744 | 15,147 | 14,617 | 15,017 | 13,617 | 13,330 | 13,730 | 13,200 | 13,600 | 12,200 |
| Interest on investment | 18,737 | 19,001 | 18,651 | 18,915 | 17,991 | 10,588 | 10,852 | 10,503 | 10,767 | 9,843 |
| Insurance & taxes | 7,734 | 7,838 | 7,700 | 7,804 | 7,440 | 4,242 | 4,346 | 4,208 | 4,312 | 3,948 |
| Repair & maintenance | 4,462 | 4,522 | 4,443 | 4,503 | 4,293 | 3,790 | 3,850 | 3,771 | 3,831 | 3,621 |
| Travel expense | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Fixed labor | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 | 50,815 |
| Total | 97,495 | 98,323 | 97,226 | 98,054 | 95,156 | 83,765 | 84,593 | 83,497 | 84,325 | 81,427 |

[a/] "New" and "used" refer to the costs associated with a new building at $25 per square foot, and a used building at $10 equivalent per square foot, respectively.

Table 9. Monthly and Annual Variable Labor Costs, by Plant and Option

| Plant | Cultch preparation method | Costs of each month, by season | | | | |
|---|---|---|---|---|---|---|
| | | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| | | dollars | | | | |
| I | Options 1-4..... | 58 | 233 | 349 | 466 | 3,494 |
| | Option 5..... | -- | -- | -- | -- | -- |
| II | Options 1-4..... | 78 | 311 | 466 | 621 | 4,659 |
| | Option 5..... | -- | -- | -- | -- | -- |
| III | Options 1-4..... | 97 | 388 | 582 | 777 | 5,824 |
| | Option 5..... | -- | -- | -- | -- | -- |
| IV | Options 1-4..... | 117 | 466 | 699 | 1,930 | 11,981 |
| | Option 5..... | -- | -- | -- | 998 | 4,992 |
| V | Options 1-4..... | 136 | 544 | 815 | 2,085 | 13,146 |
| | Option 5..... | -- | -- | -- | 998 | 4,992 |

consumes 746 watts of electricity per hour of operation. Twenty percent of total KWH usage is added for allowance to the total cost figures.

The following rate schedule is applied in estimating monthly charges for electric power:

Billing demand:

No charge for the first 20 kw

$1.25/kw for the remainder.

Energy charges:

$5 minimum for less than 100 KWH

2¢ per KWH for the next 400 KWH

1.7¢ per KWH for the next 4,500 KWH

0.7¢ per KWH for the next 35,000 KWH

.48¢ per KWH for the next 40,000 KWH.

Table 10 shows the example of light and power usage for Option 1 of Plant I. Tables of light and power usage for other plants and options have been eliminated.

Table 11 shows the monthly power demand and charges, by plant. Demand charges range from $6.30 to $40 per month for Plant I, and from $10 to $43.80 for Plant V.

Table 12 shows the costs of electricity, including demand charges, by plant. These costs varied from $142 to $210 per month for Plant I, and $190 to $279 per month for Plant V.

Fresh Water - The major use of fresh water is for cultch preparation. It varies directly with the amount of cultch required. Either fresh or salt water can be used for cultch preparation, depending on the option chosen. In general, 210,000 gallons of water, including a 40 percent allowance for cleaning and waste, is used to clean 200 cases of oyster shell. Very little water is used in algal food production. It was assumed that fresh water usage in the restroom and lunch room, and for algae production, including 40 percent for waste and other personal use, averages 40 gallons per day per person. The following rate schedule was applied in estimating monthly charges for fresh water:

Water Rates:

$9 minimum for less than 6,000 gallons
.095¢ per gallon for the next 14,000 gallons
.090¢ per gallon for the next 20,000 gallons
.080¢ per gallon for the next 40,000 gallons
.065¢ per gallon for the next 120,000 gallons
.050¢ per gallon for the next 800,000 gallons
.030¢ per gallon for the remainder.

Table 13 shows the fresh water usage and costs, by month. Options 1, 2, and 5 do not use fresh water in preparing cultch, and have a minimum charge of $9 per month, except for summer months (May through September), in Plants IV and V. Options 3 and 4 use fresh water in cleaning cultch, and have a water cost up to $840 per month during summer, in Plant V.

Sewer and Garbage Disposal - The sewer charge considered here is based on the

Table 10. Monthly and Annual Light and Power Usage for Plant I, Option 1

| Item[a] by operation stage | Capacity | Usage each month, by season: Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
|---|---|---|---|---|---|---|
| | | kilowatt hours | | | | |
| **Conditioning & spawning** | | | | | | |
| Little pump (1)..... | 1/10 hp | 54 | 54 | 54 | -- | 376 |
| **Algal production** | | | | | | |
| Autoclave (1)..... | 2.5 kw | 10 | 10 | 32 | 32 | 274 |
| Refrigerator (1)..... | 400 w | 146 | 146 | 146 | 146 | 1,752 |
| Water generator (1)..... | 5.2 kw | 13 | 13 | 26 | 26 | 247 |
| Refrigeration unit (1)..... | 1.1 kw | 396 | 396 | 396 | 396 | 4,752 |
| Fluorescent light (142)..... | 40 w | 4,090 | 4,090 | 4,090 | 4,090 | 49,075 |
| Air compressor (1)..... | 1/3 hp | 179 | 179 | 179 | 179 | 2,152 |
| **Larval rearing** | | | | | | |
| Light (19)..... | 40 w | 186 | 202 | 240 | 403 | 3,440 |
| Heater (1)..... | 3 kw | 2,160 | 2,160 | 1,080 | -- | 12,960 |
| Air compressor (1)..... | 1/3 hp | 179 | 179 | 179 | 179 | 2,152 |
| **Larval setting** | | | | | | |
| Light (14)..... | 40 w | 45 | 67 | 101 | 134 | 1,120 |
| Air compressor (1)..... | 1.5 kw | 155 | 387 | 580 | 774 | 6,037 |
| Heater (1)..... | 3 kw | 2,160 | 2,160 | 1,080 | -- | 12,960 |
| **Cultch preparation** | | | | | | |
| Shell tumbler (1)..... | 2 hp | 5 | 21 | 31 | 42 | 313 |
| Conveyor (2)..... | 2 hp | 10 | 42 | 62 | 84 | 626 |
| Bay pump (1)..... | 30 hp | 78 | 313 | 470 | 627 | 4,700 |
| **Other** | | | | | | |
| Bay pump (1)..... | 5 hp | 2,686 | 2,686 | 2,686 | 2,686 | 32,232 |
| Inside pump (1)..... | 3 hp | 528 | 528 | 528 | 528 | 6,336 |
| Office heater (1)..... | 1.5 kw | 360 | -- | -- | -- | 1,440 |
| Light (10)..... | 40 w | 96 | 96 | 96 | 96 | 1,152 |
| Total..... | | 13,536 | 13,729 | 12,056 | 10,422 | 144,096 |
| 20% allowance..... | | 2,707 | 2,746 | 2,411 | 2,084 | 28,819 |
| GRAND TOTAL..... | | 16,243 | 16,475 | 14,467 | 12,506 | 172,915 |

[a] Numbers in parentheses indicate the required units.

Table 11. Monthly Power Demand and Charges, by Plant

| Item | Cultch preparation method | | | | |
|---|---|---|---|---|---|
| | Option 1 | Option 2 | Option 3 | Option 4 | Option 5 |
| | kilowatts | | | | |
| Demand | | | | | |
| Plant I..... | 52 | 25 | 30 | 25 | 25 |
| Plant II..... | 52 | 25 | 30 | 25 | 25 |
| Plant III..... | 52 | 25 | 30 | 25 | 25 |
| Plant IV..... | 55 | 28 | 33 | 28 | 28 |
| Plant V..... | 55 | 28 | 33 | 28 | 28 |
| | dollars | | | | |
| Charges | | | | | |
| Plant I..... | 40.0 | 6.3 | 12.5 | 6.3 | 6.3 |
| Plant II..... | 40.0 | 6.3 | 12.5 | 6.3 | 6.3 |
| Plant III..... | 40.0 | 6.3 | 12.5 | 6.3 | 6.3 |
| Plant IV..... | 43.8 | 10.0 | 16.3 | 10.0 | 10.0 |
| Plant V..... | 43.8 | 10.0 | 16.3 | 10.0 | 10.0 |

Table 12. Monthly and Annual Costs of Electricity (Including Demand Charges), by Plant and Option

| Plant | Cultch preparation method | Costs each month, by season | | | | |
|---|---|---|---|---|---|---|
| | | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| | | dollars | | | | |
| I | Option 1..... | 208 | 210 | 196 | 182 | 2,344 |
| | Options 2,4,5. | 174 | 173 | 157 | 142 | 1,892 |
| | Option 3..... | 180 | 180 | 164 | 149 | 1,975 |
| II | Option 1..... | 219 | 222 | 208 | 195 | 2,492 |
| | Options 2,4,5. | 185 | 184 | 168 | 153 | 2,025 |
| | Option 3..... | 191 | 191 | 176 | 161 | 2,109 |
| III | Option 1..... | 230 | 234 | 221 | 208 | 2,638 |
| | Options 2,4,5. | 195 | 195 | 179 | 164 | 2,155 |
| | Option 3..... | 202 | 202 | 187 | 172 | 2,243 |
| IV | Option 1..... | 263 | 267 | 246 | 225 | 2,936 |
| | Options 2,4,5. | 228 | 227 | 203 | 178 | 2,435 |
| | Option 3..... | 234 | 234 | 211 | 187 | 2,527 |
| V | Option 1..... | 274 | 279 | 259 | 238 | 3,083 |
| | Options 2,4,5. | 238 | 238 | 214 | 190 | 2,568 |
| | Option 3..... | 245 | 245 | 222 | 198 | 2,661 |

Table 13. Monthly and Annual Fresh Water Usage and Costs, by Plant and Option

| Item and plant | Cultch preparation method | Usage and costs each month, by season | | | | |
|---|---|---|---|---|---|---|
| | | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| | | | | gallons | | |
| Usage: | | | | | | |
| I | Options 1,2,5 | 4,080 | 4,320 | 4,480 | 4,640 | 52,800 |
| | Options 3,4 | 109,080 | 424,320 | 634,480 | 844,640 | 6,352,800 |
| II | Options 1,2,5, | 4,107 | 4,427 | 4,640 | 4,853 | 54,400 |
| | Options 3,4 | 144,807 | 565,127 | 844,640 | 1,124,153 | 8,454,400 |
| III | Options 1,2,5 | 4,133 | 4,533 | 4,800 | 5,067 | 56,000 |
| | Options 3,4 | 178,433 | 703,833 | 1,054,800 | 1,405,767 | 10,556,000 |
| IV | Options 1,2,5 | 4,160 | 4,640 | 4,960 | 6,650 | 64,450 |
| | Options 3,4 | 214,160 | 844,640 | 1,264,960 | 1,686,650 | 12,664,450 |
| V | Options 1,2,5 | 4,187 | 4,747 | 5,120 | 6,863 | 66,050 |
| | Options 3,4 | 249,887 | 985,447 | 1,475,120 | 1,966,163 | 14,766,050 |
| | | | | dollars | | |
| Costs: | | | | | | |
| I | Options 1,2,5 | 9 | 9 | 9 | 9 | 108 |
| | Options 3,4 | 91 | 262 | 367 | 473 | 3,725 |
| II | Options 1,2,5 | 9 | 9 | 9 | 9 | 108 |
| | Options 3,4 | 114 | 333 | 473 | 588 | 4,674 |
| III | Options 1,2,5 | 9 | 9 | 9 | 9 | 108 |
| | Options 3,4 | 136 | 402 | 567 | 672 | 5,440 |
| IV | Options 1,2,5 | 9 | 9 | 9 | 10 | 112 |
| | Options 3,4 | 157 | 473 | 630 | 756 | 6,143 |
| V | Options 1,2,5 | 9 | 9 | 9 | 10 | 112 |
| | Options 3,4 | 175 | 543 | 693 | 840 | 6,830 |

fresh water used by the hatchery, excluding the fresh water for cultch preparation. Following is the rate schedule applied in estimating monthly sewer charges:

Sewer rates:

$6 minimum for less than 6,000 gallons
.06¢ per gallon for the next 14,000 gallons
.04¢ per gallon for the next 20,000 gallons
.025¢ per gallon for the remainder.

According to this schedule, sewer charges per month are $6 for each plant, except for the summer months, in Plants IV and V. During the summer months, the monthly sewer charges are $6.39 and $6.52 for Plant IV and Plant V, respectively. Rates for garbage disposal are assigned $20 per month for each plant.

Nutrients and Material - Algal food requirements in Plant I are 700 gallons per day during summer, and 250 gallons per day during winter. Food requirements, by months and by plants, are shown in Table 14. A 50 percent allowance is made for waste and emergency purposes. Food requirements are proportional with output level.

Algae medium costs are estimated at 1¢ per gallon. Because of a 50 percent allowance above the normal food requirements, the cost of algae medium at 1¢ per gallon allows for the use of the vitamins and metal compounds needed for algae production, and also for other chemicals used in the hatchery. These costs varied from $113 to $315 per month for Plant I, and from $262 to $735 per month for Plant V.

The highest material cost is for cultch preparation. A one-bushel size meshed bag costs 30¢, and one bushel of oyster shell costs 30¢. In estimating material costs for uncleaned cultch, a 20 percent allowance is made for waste shell too small to be used for setting. For example, 125 cases (312.5 bushels) of uncleaned oyster shell and 250 meshed bags are needed to get 100 cases (250 bushels) of cleaned cultch. Therefore, the material costs for 100 cases of cleaned cultch are 562.5 x $0.30, or $168.75.

Estimated material costs for cultch preparation are presented in Table 15. These costs are proportional with output level, and the values are the same for

Table 14. Monthly and Annual Algal Food Requirements, by Plant, Options 1 through 5

| Plant | Food requirements each month, by season | | | | |
|---|---|---|---|---|---|
| | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| | gallons | | | | |
| I | 11,250 | 19,900 | 25,715 | 31,500 | 273,830 |
| II | 14,990 | 26,520 | 34,265 | 41,975 | 364,885 |
| III | 18,760 | 33,185 | 42,880 | 52,530 | 456,635 |
| IV | 22,500 | 39,800 | 51,430 | 63,000 | 547,660 |
| V | 26,240 | 46,420 | 59,980 | 73,475 | 638,715 |

Table 15. Monthly and Annual Material Costs for Cultch Preparation, by Plant and Option

| Plant | Cultch preparation method | Costs each month, by season | | | | |
|---|---|---|---|---|---|---|
| | | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| | | dollars | | | | |
| I | Options 1-4 | 169 | 675 | 1,012 | 1,350 | 10,125 |
| | Option 5 | 450 | 1,800 | 2,700 | 3,600 | 27,000 |
| II | Options 1-4 | 226 | 901 | 1,350 | 1,799 | 13,500 |
| | Option 5 | 603 | 2,403 | 3,600 | 4,797 | 36,000 |
| III | Options 1-4 | 280 | 1,124 | 1,688 | 2,251 | 16,875 |
| | Option 5 | 747 | 2,997 | 4,500 | 6,003 | 45,000 |
| IV | Options 1-4 | 338 | 1,350 | 2,025 | 2,700 | 20,250 |
| | Option 5 | 900 | 3,600 | 5,400 | 7,200 | 54,000 |
| V | Options 1-4 | 395 | 1,576 | 2,362 | 3,149 | 23,625 |
| | Option 5 | 1,053 | 4,203 | 6,300 | 8,397 | 63,000 |

Options 1 through 4 for each plant. These costs ranged from $169 per month during the winter months to $1,350 per month during the summer months for Plant I, and from $395 per month during the winter months to $3,150 per month during the summer months for Plant V. Current market price (as of April 1976) of already-cleaned cultch (oyster shell in meshed bag) is $4.50 per case. The material costs for Option 5 in each plant are in proportion to output level. In Table 15 the material costs for Option 5 varied from $450 per month during the winter months to $3,600 per month during the summer months for Plant I, and from $1,053 per month during the winter months to $8,397 per month during the summer months for Plant V.

Fuel and Oil - Major use of fuel and oil is for the boiler (diesel), forklift (propane), truck (gasoline), bulldozer (gasoline), and generator (diesel). Fuel consumption for the boiler, using data provided by the industry, varied from 450 gallons per month during the summer months to 800 gallons per month during the winter months. The estimated fuel consumption for forklift, truck, bulldozer, and generator was 2, 3, 2, and 4 gallons per hour of operation, respectively. The approximate fuel prices per gallon were 40¢ for diesel, 60¢ for gasoline, and 50¢ for propane gas.

The forklift is used for the larval setting stage, and the operating hours for this machine are about 40 minutes (in and out) for every 20 cases of oyster seed. In the cultch preparation stage for Options 2 and 4, truck, bulldozer, and generator are used, and the operating hours for these machines are 1, 3, and 7 hours, respectively, to clean 200 cases of oyster shell. No generator is used for Options 1 and 3. Fuel costs for Option 5 are the lowest among the options, because there is no cultch preparation stage in this option. Estimated fuel and oil costs in Table 16 vary from $207 to $332 per month for Plant I, and from $242 to $403 per month for Plant V.

Telephone - Telephone usage varies widely from plant to plant. The estimated annual telephone costs, including sales expenses, were $1,200, $1,320, $1,440, $1,560, and $1,680 for Plants I, II, III, IV, and V, respectively.

Office Supplies - The annual costs of office supplies were estimated to be

Table 16. Monthly and Annual Fuel and Oil Costs, by Plant and Option

| Plant | Cultch preparation method | Costs each month, by season | | | | |
|---|---|---|---|---|---|---|
| | | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| | | dollars | | | | |
| I | Options 1,3 | 326 | 304 | 276 | 228 | 3,301 |
| | Options 2,4 | 332 | 326 | 310 | 273 | 3,638 |
| | Option 5 | 323 | 293 | 260 | 207 | 3,140 |
| II | Options 1,3 | 328 | 312 | 288 | 244 | 3,422 |
| | Options 2,4 | 336 | 342 | 333 | 304 | 3,870 |
| | Option 5 | 324 | 298 | 267 | 215 | 3,206 |
| III | Options 1,3 | 330 | 320 | 300 | 260 | 3,543 |
| | Options 2,4 | 339 | 358 | 356 | 335 | 4,103 |
| | Option 5 | 326 | 302 | 273 | 224 | 3,273 |
| IV | Options 1,3 | 332 | 328 | 312 | 277 | 3,664 |
| | Options 2,4 | 343 | 373 | 380 | 366 | 4,336 |
| | Option 5 | 327 | 307 | 280 | 233 | 3,340 |
| V | Options 1,3 | 334 | 336 | 324 | 293 | 3,784 |
| | Options 2,4 | 347 | 389 | 403 | 397 | 4,568 |
| | Option 5 | 328 | 311 | 287 | 242 | 3,406 |

$600, $660, $720, $780, and $840, corresponding to Plants I, II, III, IV, and V. This includes bookkeeping supplies and other materials to be used in the office.

The costs of office supplies and telephone must vary, month by month, among plants, but it is impossible to predict month-by-month variations for these costs. Therefore, the estimated annual costs for office supplies and telephone were averaged to estimate monthly costs to be used for each plant.

## Variable Repairs and Maintenance

In addition to having fixed costs associated with repairs and maintenance, some machinery requires maintenance which varies with length of usage. The variable repairs and maintenance costs for machinery were estimated at 0.5 percent of the initial investment costs for that machinery per 100 hours of operation.

Table 17 shows the estimated costs of variable repairs and maintenance for machinery, by plant and option.

Table 17. Monthly and Annual Costs of Variable Repairs and Maintenance for Machinery, by Plant and Option

| Plant | Cultch preparation method | Costs each month, by season | | | | |
|---|---|---|---|---|---|---|
| | | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| | | dollars | | | | |
| I | Option 1 | 69 | 78 | 77 | 75 | 885 |
| | Option 2 | 70 | 81 | 81 | 80 | 927 |
| | Option 3 | 69 | 77 | 76 | 73 | 871 |
| | Option 4 | 70 | 80 | 80 | 79 | 913 |
| | Option 5 | 68 | 73 | 70 | 65 | 807 |
| II | Option 1 | 70 | 81 | 81 | 80 | 926 |
| | Option 2 | 71 | 84 | 87 | 88 | 982 |
| | Option 3 | 70 | 80 | 80 | 78 | 908 |
| | Option 4 | 71 | 83 | 85 | 85 | 964 |
| | Option 5 | 68 | 74 | 71 | 67 | 823 |
| III | Option 1 | 71 | 84 | 87 | 86 | 968 |
| | Option 2 | 72 | 88 | 93 | 95 | 1,038 |
| | Option 3 | 70 | 82 | 83 | 83 | 945 |
| | Option 4 | 72 | 87 | 90 | 92 | 1,015 |
| | Option 5 | 69 | 75 | 73 | 69 | 839 |
| IV | Option 1 | 78 | 93 | 93 | 92 | 1,051 |
| | Option 2 | 80 | 99 | 102 | 103 | 1,135 |
| | Option 3 | 78 | 91 | 90 | 88 | 1,024 |
| | Option 4 | 79 | 97 | 99 | 99 | 1,108 |
| | Option 5 | 76 | 83 | 78 | 71 | 896 |
| V | Option 1 | 79 | 96 | 97 | 97 | 1,093 |
| | Option 2 | 81 | 103 | 107 | 110 | 1,191 |
| | Option 3 | 79 | 94 | 94 | 93 | 1,061 |
| | Option 4 | 80 | 100 | 104 | 106 | 1,159 |
| | Option 5 | 76 | 84 | 79 | 73 | 912 |

Others

Other variable costs included interest on operating capital and other miscellaneous expenses directly related to the production of oyster seed. These costs were allocated at 5 percent of the total variable costs (Appendix Table I).

## Total Costs

Total costs and costs per case for Plants I through V are presented in Appendix Tables I-1 through I-5. These costs, including fixed costs and variable costs, are expressed in terms of monthly as well as an annual basis. Total costs vary with options, months of the year, and size of plant.

In Options 1 through 4 for the 5 different plants, the proportion of fixed costs to the total falls between the range of 60 to 76 percent for a new building, and 57 to 74 percent for a used building; but, in Option 5 for those plants, the proportion drops to the range of 52 to 67 percent for a new building, and 48 to 64 percent for a used building.

Labor costs are the major component affecting the cost of production, ranging from 39 to 50 percent of the total in Options 1 through 4 for most plants associated with a new building, and 44 to 56 percent of the total associated with a used building. But, in Option 5, these proportions varied from 30 to 43 percent and 33 to 47 percent for those plants associated with a new building and a used building, respectively.

Utilities, materials, and supplies are the next major component affecting the cost of production, ranging from 19 to 29 percent of the total in Options 1 through 4 for all plants associated with a new building, and 21 to 32 percent for those associated with a used building. But, in Option 5, these proportions varied from 31 to 43 percent and 34 to 47 percent for those plants associated with a new building and a used building, respectively.

Figure 8 shows these relationships. Costs of labor as a percentage of the total decreases as plant size increases, but the reverse is true on utilities, materials, and supplies. Costs other than labor, utilities, materials, and supplies as a percentage of the total are relatively stable throughout all options and plants.

Average costs per case are estimated by taking total costs and dividing by cases produced. As can be seen in Appendix Tables I-1 through I-5, average costs vary with options, plants, and also with months of the year. During the

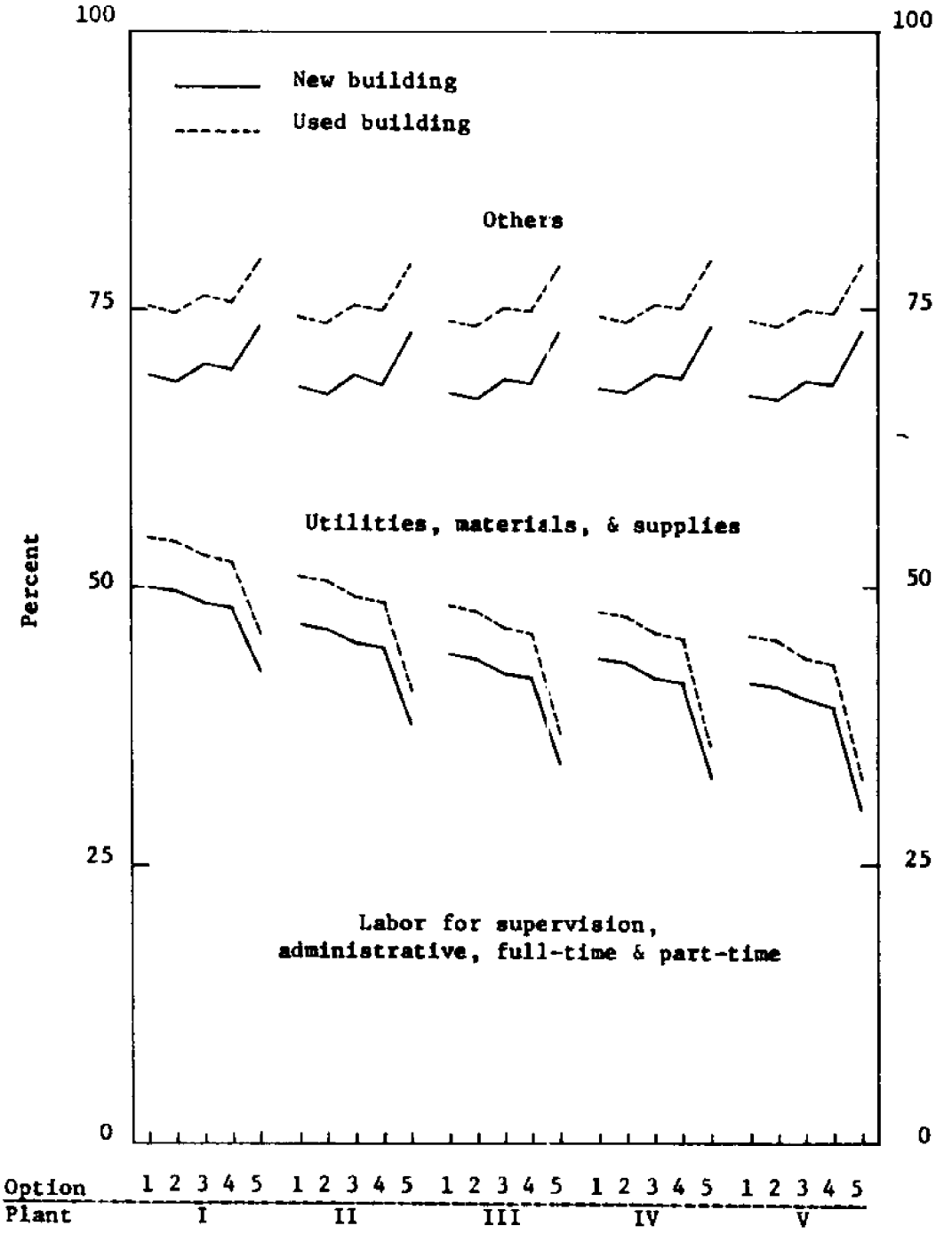



Figure 8. Cost categories as a percentage of total costs per case.

winter months, October through January, average costs for Plant I are around $80 and $73 per case for each option associated with a new and a used building, respectively. During the summer months, May through September, these costs for Plant I, associated with a new and a used building, vary between $11 and $14, depending on options. The range of average costs between summer and winter months narrowed by increased output capacities. Figures 9 and 10 show the range of average costs through the year for each option and plant. Annual average costs for Plant I, associated with a new building and a used building, ranged from $18 to $20 and $16 to $18, respectively, and those costs for Plant V ranged from $11 to $13 and from $10 to $12. Figures 11 through 14 graphically demonstrate these variations for Plants I and V.

## Returns

In this section, the influence of seasonability of production on expected monthly flow of returns and costs is identified. Price received per case of seed was assumed to be $23, and to remain constant through the year. Tables 18 and 19 show the figures for production, total receipts, total costs, and net returns, by month, for each plant and option.

"Net returns" refer to the total receipts after deducting all costs incurred to the production of oyster seed. In general, winter months, October through January, are the only months which have a negative net returns. The net returns continue to increase, and reach their peak during the summer months.

Table 20 shows the efficiency between net returns and total costs, based on over-all annual performance. This table gives some idea of how much average net returns would be created by a dollar of total costs for each option and plant. For example, in Option 1 for Plant I, associated with a new building, average net returns would be 27¢ per $1 of total costs. Figures 15 and 16 reveal the proportion of total costs and net returns to the total receipts.

The estimated average net returns per case are presented in Table 21. The bigger the plant, the more net returns per case. The reader should remember that this provides only an estimate, and he should be aware of the limitations of this study because changes may occur over time.

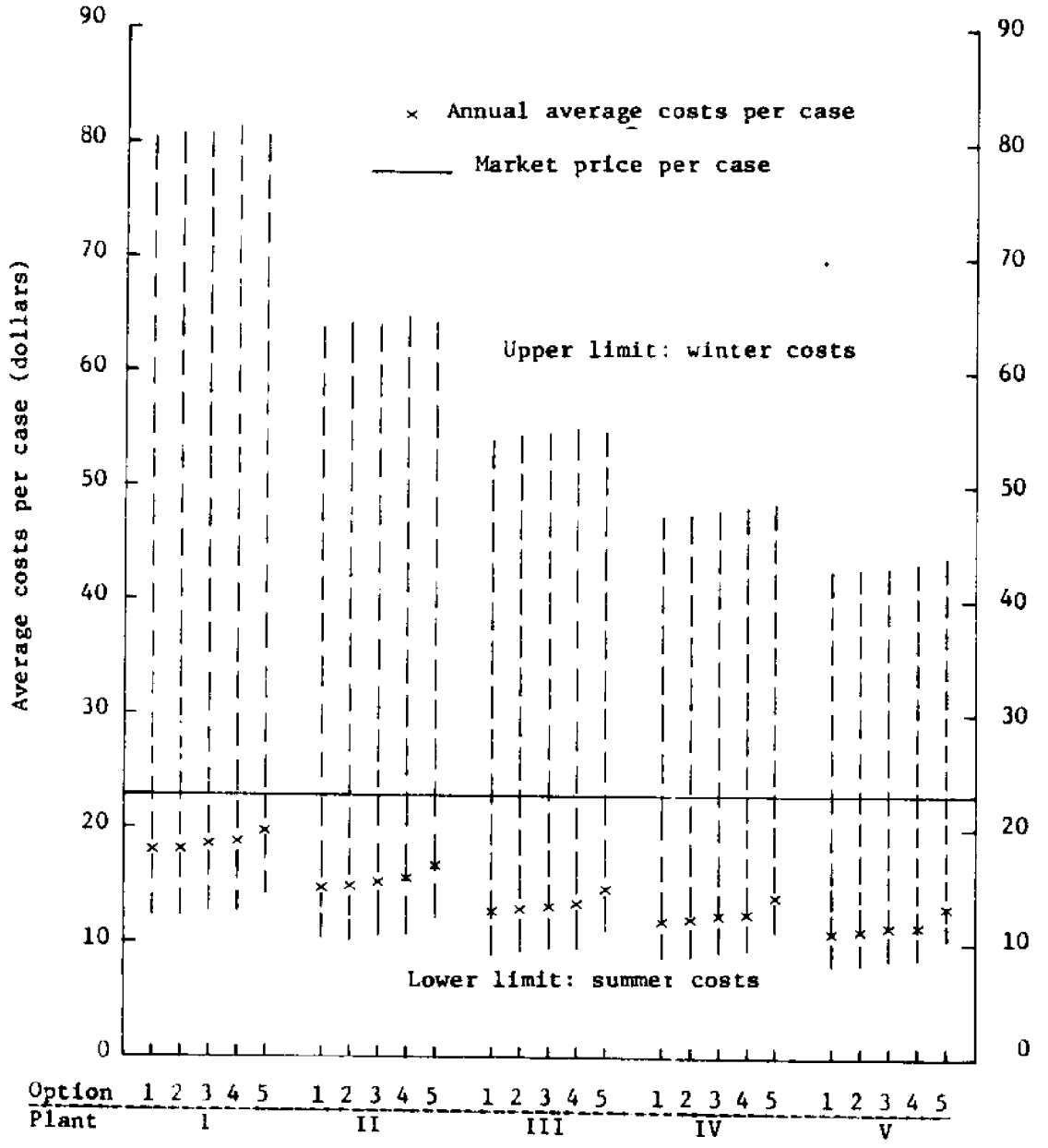



Figure 9. Range of average costs per case, through the year, for each option and plant associated with new building.

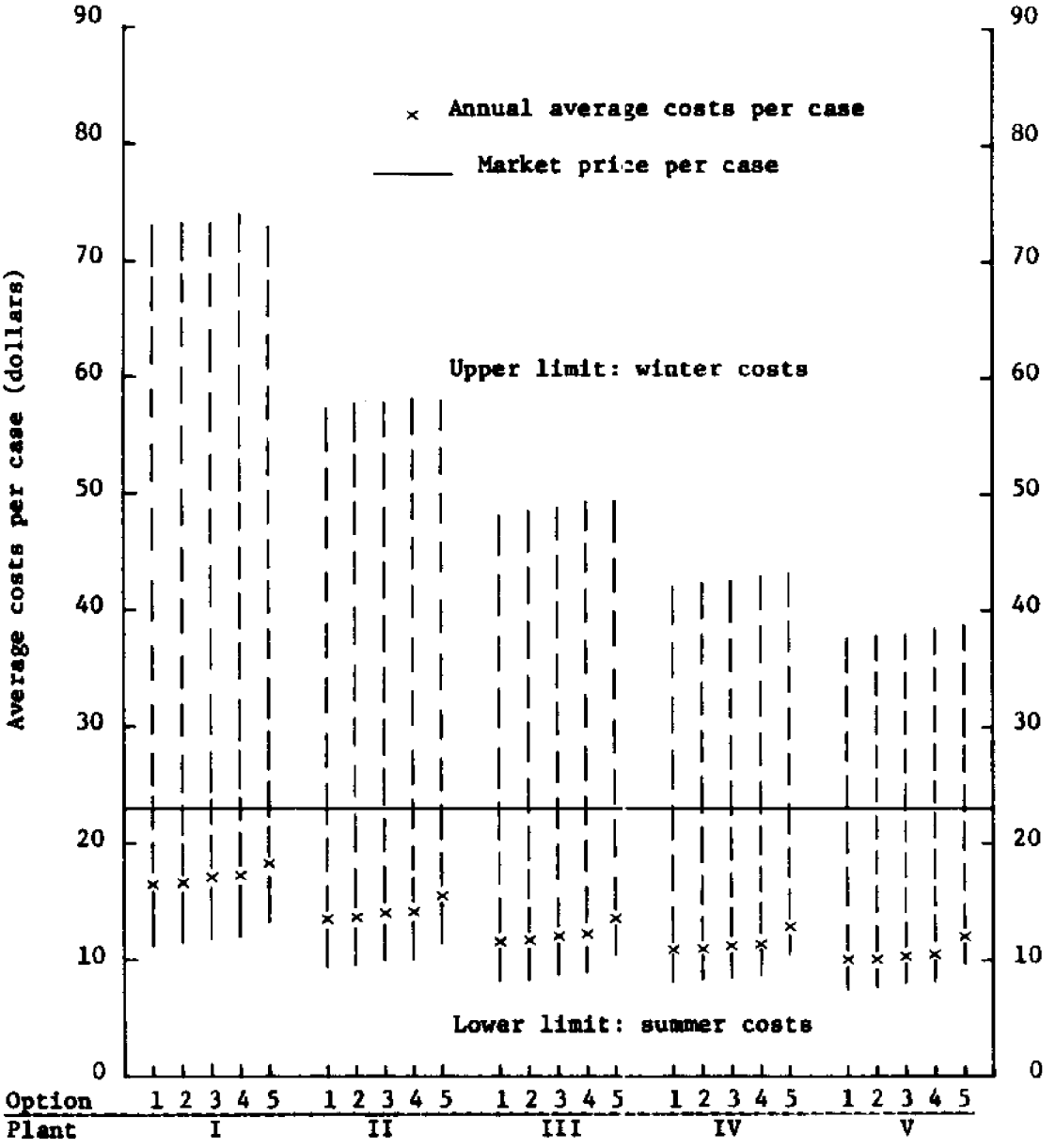



Figure 10. Range of average costs per case, through the year, for each option and plant associated with used building.

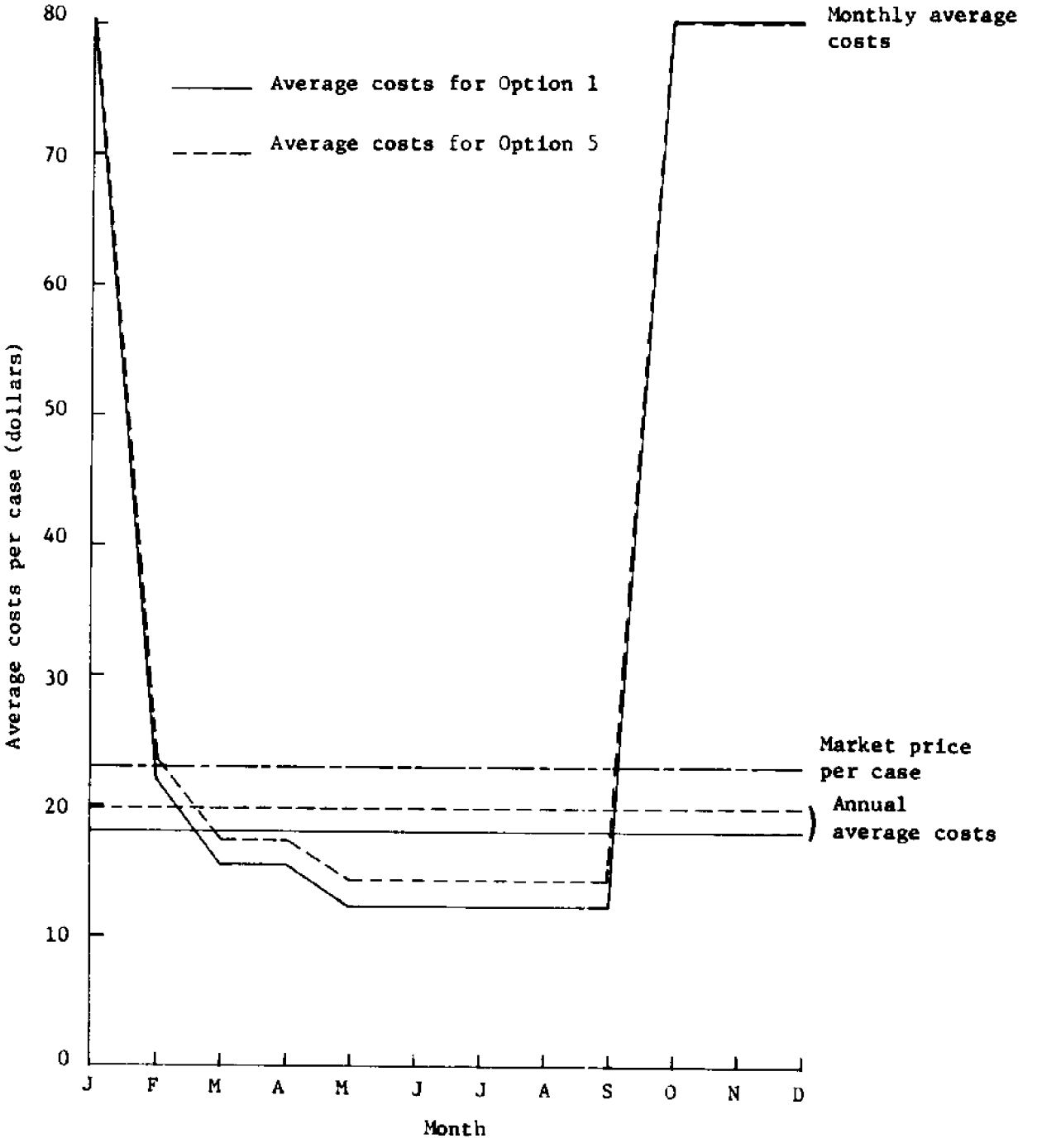



Figure 11. Fluctuation of average costs per case, by month, for Plant I associated with new building.

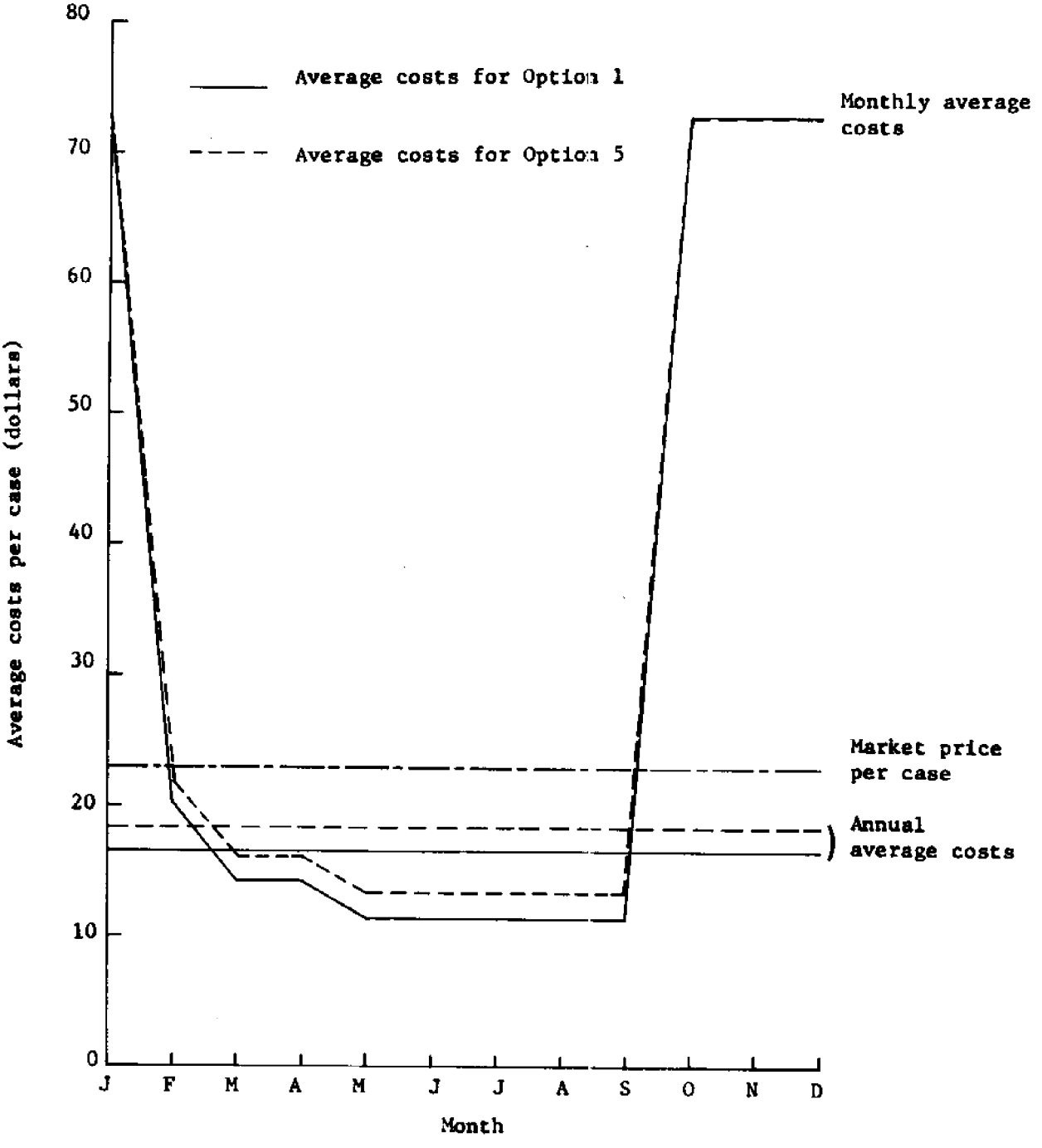



Figure 12. Fluctuation of average costs per case, by month, for Plant I associated with used building.

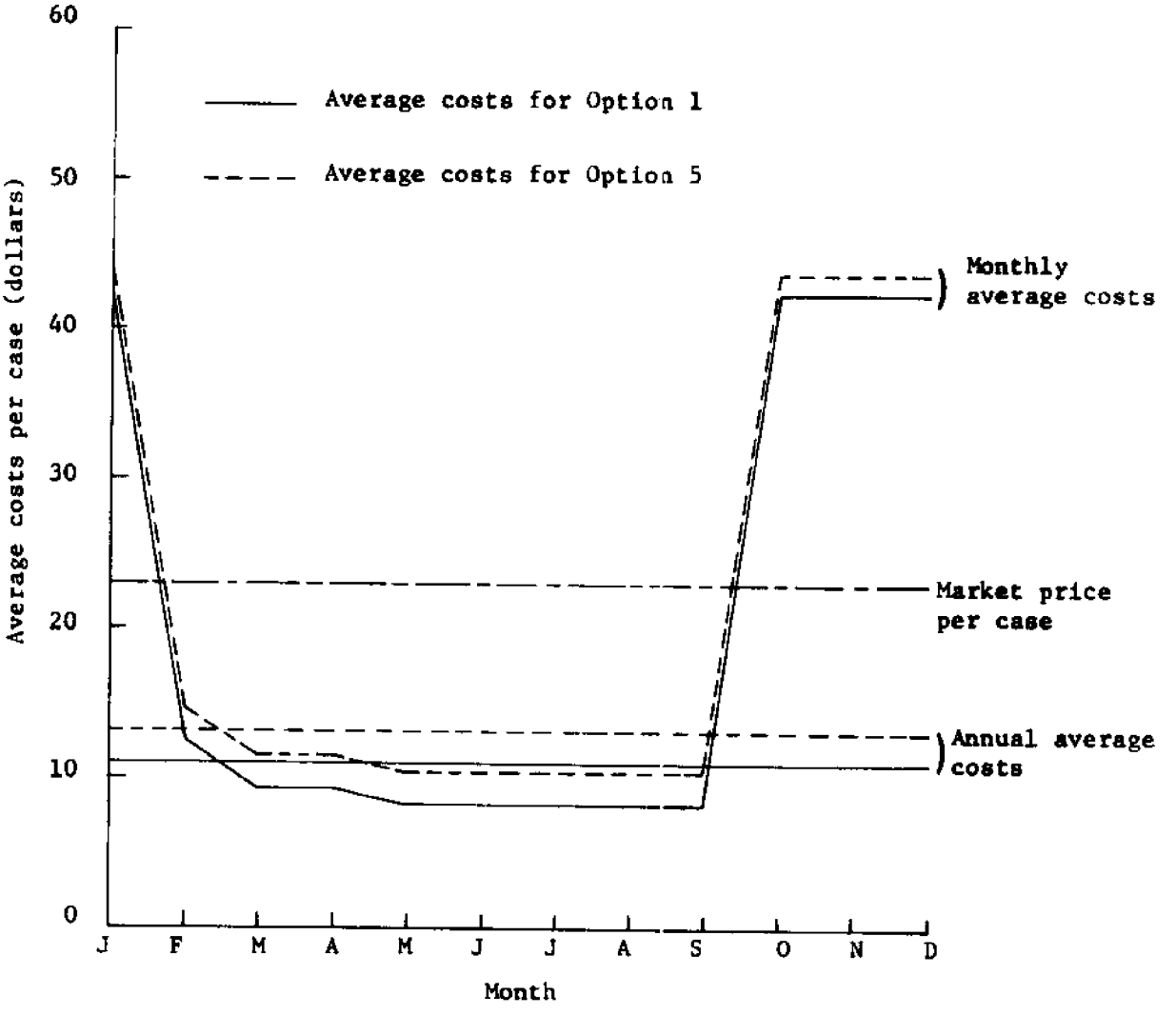



Figure 13. Fluctuation of average costs per case, by month, for Plant V associated with new building.

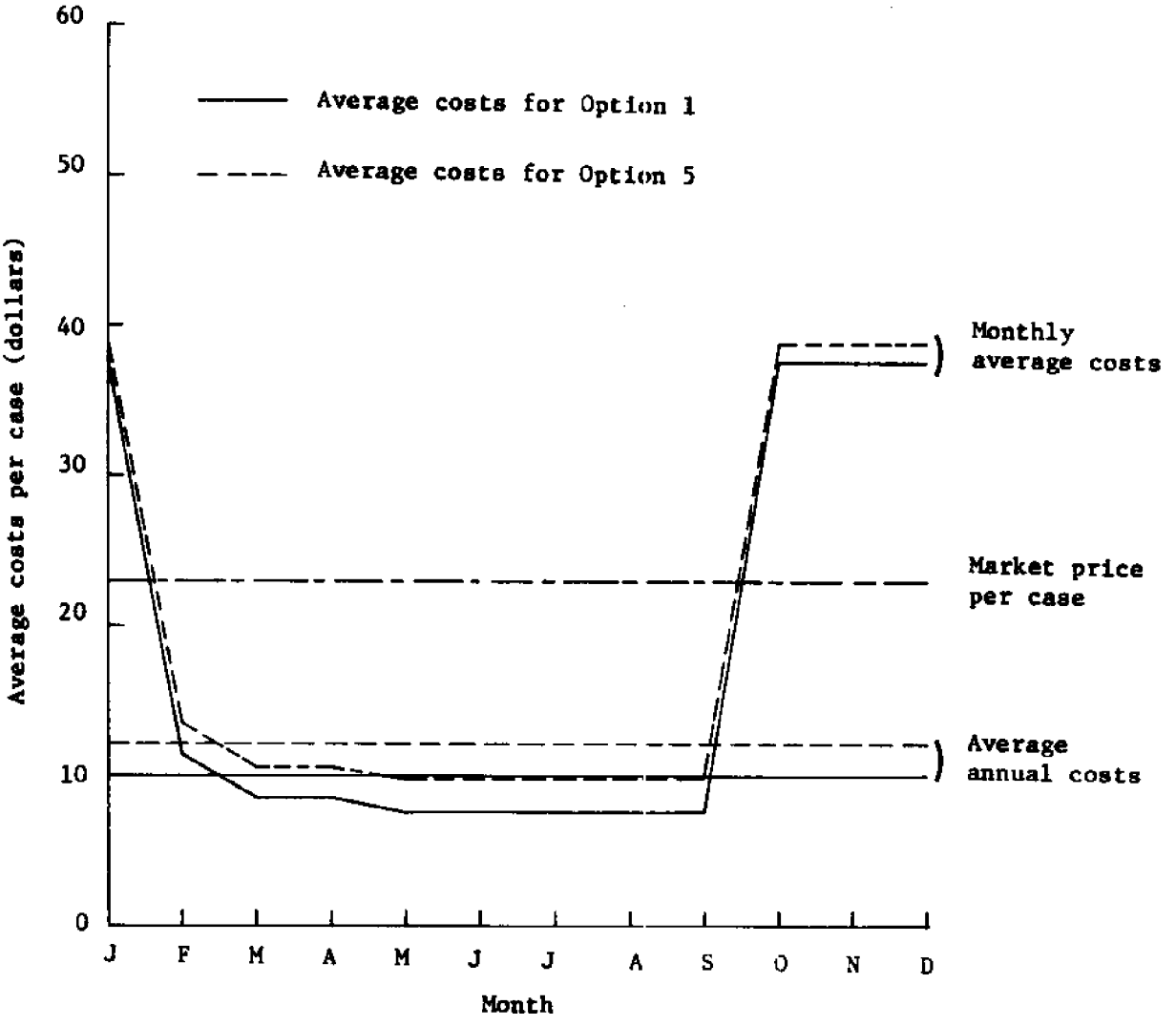



Figure 14. Fluctuation of average costs per case, by month, for Plant V associated with used building

Table 18. Flow of Return and Costs, by Month, Associated with New Building for Planned Capacity

| Item | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PLANT I: | | | | | | | | | | | | | |
| Production (cases) | 100 | 400 | 600 | 600 | 800 | 800 | 800 | 800 | 800 | 100 | 100 | 100 | 6,000 |
| | | | | | | | dollars | | | | | | |
| Total receipts | 2,300 | 9,200 | 13,800 | 13,800 | 18,400 | 18,400 | 18,400 | 18,400 | 18,400 | 2,300 | 2,300 | 2,300 | 138,000 |
| Option 1: | | | | | | | | | | | | | |
| Total costs | 8,028 | 8,821 | 9,314 | 9,314 | 9,784 | 9,784 | 9,784 | 9,784 | 9,784 | 8,028 | 8,028 | 8,028 | 108,483 |
| Return | -5,728 | 379 | 4,486 | 4,486 | 8,616 | 8,616 | 8,616 | 8,616 | 8,616 | -5,728 | -5,728 | -5,728 | -- |
| Accumulated return | -5,728 | -5,349 | -863 | 3,623 | 12,239 | 20,855 | 29,471 | 38,087 | 46,703 | 40,975 | 35,247 | 29,519 | 29,517 |
| Option 2: | | | | | | | | | | | | | |
| Total costs | 8,067 | 8,878 | 9,383 | 9,383 | 9,864 | 9,864 | 9,864 | 9,864 | 9,864 | 8,067 | 8,067 | 8,067 | 109,233 |
| Return | -5,767 | 322 | 4,417 | 4,417 | 8,536 | 8,536 | 8,536 | 8,536 | 8,536 | -5,767 | -5,767 | -5,767 | -- |
| Accumulated return | -5,767 | -5,445 | -1,028 | 3,389 | 11,925 | 20,461 | 28,997 | 37,533 | 46,069 | 40,302 | 34,535 | 28,768 | 28,767 |
| Option 3: | | | | | | | | | | | | | |
| Total costs | 8,062 | 9,033 | 9,634 | 9,634 | 10,213 | 10,213 | 10,213 | 10,213 | 10,213 | 8,062 | 8,062 | 8,062 | 111,610 |
| Return | -5,762 | 167 | 4,166 | 4,166 | 8,187 | 8,187 | 8,187 | 8,187 | 8,187 | -5,762 | -5,762 | -5,762 | -- |
| Accumulated return | -5,762 | -5,595 | -1,429 | 2,737 | 10,924 | 19,111 | 27,298 | 35,485 | 43,672 | 37,910 | 32,148 | 26,386 | 26,390 |
| Option 4: | | | | | | | | | | | | | |
| Total costs | 8,131 | 9,121 | 9,735 | 9,735 | 10,327 | 10,327 | 10,327 | 10,327 | 10,327 | 8,131 | 8,131 | 8,131 | 112,748 |
| Return | -5,831 | 79 | 4,065 | 4,065 | 8,073 | 8,073 | 8,073 | 8,073 | 8,073 | -5,831 | -5,831 | -5,831 | -- |
| Accumulated return | -5,831 | -5,752 | -1,687 | 2,378 | 10,451 | 18,524 | 26,597 | 34,670 | 42,743 | 36,912 | 31,081 | 25,250 | 25,252 |
| Option 5: | | | | | | | | | | | | | |
| Total costs | 8,026 | 9,508 | 10,459 | 10,459 | 11,387 | 11,387 | 11,387 | 11,387 | 11,387 | 8,026 | 8,026 | 8,026 | 119,467 |
| Return | -5,726 | -308 | 3,341 | 3,341 | 7,013 | 7,013 | 7,013 | 7,013 | 7,013 | -5,726 | -5,726 | -5,726 | -- |
| Accumulated return | -5,726 | -6,034 | -2,693 | 648 | 7,661 | 14,674 | 21,687 | 28,700 | 35,713 | 29,987 | 24,261 | 18,535 | 18,533 |
| PLANT II: | | | | | | | | | | | | | |
| Production (cases) | 134 | 534 | 800 | 800 | 1,066 | 1,066 | 1,066 | 1,066 | 1,066 | 134 | 134 | 134 | 8,000 |
| | | | | | | | dollars | | | | | | |
| Total receipts | 3,082 | 12,282 | 18,400 | 18,400 | 24,518 | 24,518 | 24,518 | 24,518 | 24,518 | 3,082 | 3,082 | 3,082 | 184,000 |
| Option 1: | | | | | | | | | | | | | |
| Total costs | 8,542 | 9,613 | 10,290 | 10,290 | 10,944 | 10,944 | 10,944 | 10,944 | 10,944 | 8,542 | 8,542 | 8,542 | 119,079 |
| Return | -5,460 | 2,669 | 8,110 | 8,110 | 13,574 | 13,574 | 13,574 | 13,574 | 13,574 | -5,460 | -5,460 | -5,460 | -- |
| Accumulated return | -5,460 | -2,791 | 5,319 | 13,429 | 27,003 | 40,577 | 54,151 | 67,725 | 81,299 | 75,839 | 70,379 | 64,919 | 64,921 |
| Option 2: | | | | | | | | | | | | | |
| Total costs | 8,583 | 9,677 | 10,370 | 10,370 | 11,039 | 11,039 | 11,039 | 11,039 | 11,039 | 8,583 | 8,583 | 8,583 | 119,945 |
| Return | -5,501 | 2,605 | 8,030 | 8,030 | 13,479 | 13,479 | 13,479 | 13,479 | 13,479 | -5,501 | -5,501 | -5,501 | -- |
| Accumulated return | -5,501 | -2,896 | 5,134 | 13,164 | 26,643 | 40,122 | 53,601 | 67,080 | 80,559 | 75,058 | 69,557 | 64,056 | 64,055 |
| Option 3: | | | | | | | | | | | | | |
| Total costs | 8,600 | 9,897 | 10,718 | 10,718 | 11,490 | 11,490 | 11,490 | 11,490 | 11,490 | 8,600 | 8,600 | 8,600 | 123,183 |
| Return | -5,518 | 2,385 | 7,682 | 7,682 | 13,028 | 13,028 | 13,028 | 13,028 | 13,028 | -5,518 | -5,518 | -5,518 | -- |
| Accumulated return | -5,518 | -3,133 | 4,549 | 12,231 | 25,259 | 38,287 | 51,315 | 64,343 | 77,371 | 71,853 | 66,335 | 60,817 | 60,817 |
| Option 4: | | | | | | | | | | | | | |
| Total costs | 8,671 | 9,994 | 10,832 | 10,832 | 11,622 | 11,622 | 11,622 | 11,622 | 11,622 | 8,671 | 8,671 | 8,671 | 124,451 |
| Return | -5,589 | 2,288 | 7,568 | 7,568 | 12,896 | 12,896 | 12,896 | 12,896 | 12,896 | -5,589 | -5,589 | -5,589 | -- |
| Accumulated return | -5,589 | -3,301 | 4,267 | 11,835 | 24,731 | 37,627 | 50,523 | 63,419 | 76,315 | 70,726 | 65,137 | 59,548 | 59,549 |
| Option 5: | | | | | | | | | | | | | |
| Total costs | 8,618 | 10,607 | 11,893 | 11,893 | 13,156 | 13,156 | 13,156 | 13,156 | 13,156 | 8,618 | 8,618 | 8,618 | 134,646 |
| Return | -5,536 | 1,675 | 6,507 | 6,507 | 11,362 | 11,362 | 11,362 | 11,362 | 11,362 | -5,536 | -5,536 | -5,536 | -- |
| Accumulated return | -5,536 | -3,861 | 2,646 | 9,153 | 20,515 | 31,877 | 43,239 | 54,601 | 65,963 | 60,427 | 54,891 | 49,355 | 49,354 |

(continued)

Table 13. Flow of Return and Costs, by Month, Associated with New Building for Planned Capacity (continued)

| Item | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PLANT III: | | | | | | | | | | | | | |
| Production (cases)..... | 166 | 666 | 1,000 | 1,000 | 1,334 | 1,334 | 1,334 | 1,334 | 1,334 | 166 | 166 | 166 | 10,000 |
| | | | | | | | dollars | | | | | | |
| Total receipts..... | 3,818 | 15,318 | 23,000 | 23,000 | 30,682 | 30,682 | 30,682 | 30,682 | 30,682 | 3,818 | 3,818 | 3,818 | 230,000 |
| Option 1: | | | | | | | | | | | | | |
| Total costs..... | 8,972 | 10,322 | 11,188 | 11,188 | 12,031 | 12,031 | 12,031 | 12,031 | 12,031 | 8,972 | 8,972 | 8,972 | 128,742 |
| Return..... | -5,154 | 4,996 | 11,812 | 11,812 | 18,651 | 18,651 | 18,651 | 18,651 | 18,651 | -5,154 | -5,154 | -5,154 | — |
| Accumulated return..... | -5,154 | -158 | 11,654 | 23,466 | 42,117 | 60,768 | 79,419 | 98,070 | 116,721 | 111,567 | 106,413 | 101,259 | 101,258 |
| Option 2: | | | | | | | | | | | | | |
| Total costs..... | 9,016 | 10,394 | 11,279 | 11,279 | 12,141 | 12,141 | 12,141 | 12,141 | 12,141 | 9,016 | 9,016 | 9,016 | 129,723 |
| Return..... | -5,198 | 4,924 | 11,721 | 11,721 | 18,541 | 18,541 | 18,541 | 18,541 | 18,541 | -5,198 | -5,198 | -5,198 | -- |
| Accumulated return..... | -5,198 | -274 | 11,447 | 23,168 | 41,709 | 60,250 | 78,791 | 97,332 | 115,873 | 110,675 | 105,477 | 100,279 | 100,277 |
| Option 3: | | | | | | | | | | | | | |
| Total costs..... | 9,053 | 10,678 | 11,713 | 11,713 | 12,663 | 12,663 | 12,663 | 12,663 | 12,663 | 9,053 | 9,053 | 9,053 | 133,633 |
| Return..... | -5,235 | 4,640 | 11,287 | 11,287 | 18,019 | 18,019 | 18,019 | 18,019 | 18,019 | -5,235 | -5,235 | -5,235 | -- |
| Accumulated return..... | -5,235 | -595 | 10,692 | 21,979 | 39,998 | 58,017 | 76,036 | 94,055 | 112,074 | 106,839 | 101,604 | 96,369 | 96,367 |
| Option 4: | | | | | | | | | | | | | |
| Total costs..... | 9,127 | 10,783 | 11,840 | 11,840 | 12,812 | 12,812 | 12,812 | 12,812 | 12,812 | 9,127 | 9,127 | 9,127 | 135,030 |
| Return..... | -5,309 | 4,535 | 11,160 | 11,160 | 17,870 | 17,870 | 17,870 | 17,870 | 17,870 | -5,309 | -5,309 | -5,309 | — |
| Accumulated return..... | -5,309 | -774 | 10,386 | 21,546 | 39,416 | 57,286 | 75,156 | 93,026 | 110,896 | 105,587 | 100,278 | 94,969 | 94,970 |
| Option 5: | | | | | | | | | | | | | |
| Total costs..... | 9,123 | 11,618 | 13,249 | 13,249 | 14,857 | 14,857 | 14,857 | 14,857 | 14,857 | 9,123 | 9,123 | 9,123 | 148,892 |
| Return..... | -5,305 | 3,700 | 9,751 | 9,751 | 15,825 | 15,825 | 15,825 | 15,825 | 15,825 | -5,305 | -5,305 | -5,305 | — |
| Accumulated return..... | -5,305 | -1,605 | 8,146 | 17,897 | 33,722 | 49,547 | 65,372 | 81,197 | 97,022 | 91,717 | 86,412 | 81,107 | 81,108 |
| PLANT IV: | | | | | | | | | | | | | |
| Production (cases)..... | 200 | 800 | 1,200 | 1,200 | 1,600 | 1,600 | 1,600 | 1,600 | 1,600 | 200 | 200 | 200 | 12,000 |
| | | | | | | | dollars | | | | | | |
| Total receipts..... | 4,600 | 18,400 | 27,600 | 27,600 | 36,800 | 36,800 | 36,800 | 36,800 | 36,800 | 4,600 | 4,600 | 4,600 | 276,000 |
| Option 1: | | | | | | | | | | | | | |
| Total costs..... | 9,457 | 11,084 | 12,121 | 12,121 | 14,184 | 14,184 | 14,184 | 14,184 | 14,184 | 9,457 | 9,457 | 9,457 | 144,072 |
| Return..... | -4,857 | 7,316 | 15,479 | 15,479 | 22,616 | 22,616 | 22,616 | 22,616 | 22,616 | -4,857 | -4,857 | -4,857 | — |
| Accumulated return..... | -4,857 | 2,459 | 17,938 | 33,417 | 56,033 | 78,649 | 101,265 | 123,881 | 146,497 | 141,640 | 136,783 | 131,926 | 131,928 |
| Option 2: | | | | | | | | | | | | | |
| Total costs..... | 9,502 | 11,164 | 12,224 | 12,224 | 14,310 | 14,310 | 14,310 | 14,310 | 14,310 | 9,502 | 9,502 | 9,502 | 145,168 |
| Return..... | -4,902 | 7,236 | 15,376 | 15,376 | 22,490 | 22,490 | 22,490 | 22,490 | 22,490 | -4,902 | -4,902 | -4,902 | — |
| Accumulated return..... | -4,902 | 2,334 | 17,710 | 33,086 | 55,576 | 78,066 | 100,556 | 123,046 | 145,536 | 140,634 | 135,732 | 130,830 | 130,832 |
| Option 3: | | | | | | | | | | | | | |
| Total costs..... | 9,559 | 11,513 | 12,710 | 12,710 | 14,902 | 14,902 | 14,902 | 14,902 | 14,902 | 9,559 | 9,559 | 9,559 | 149,678 |
| Return..... | -4,959 | 6,887 | 14,890 | 14,890 | 21,898 | 21,898 | 21,898 | 21,898 | 21,898 | -4,959 | -4,959 | -4,959 | — |
| Accumulated return..... | -4,959 | 1,928 | 16,818 | 31,708 | 53,606 | 75,504 | 97,402 | 119,300 | 141,198 | 136,239 | 131,280 | 126,321 | 126,322 |
| Option 4: | | | | | | | | | | | | | |
| Total costs..... | 9,635 | 11,627 | 12,850 | 12,850 | 15,067 | 15,067 | 15,067 | 15,067 | 15,067 | 9,635 | 9,635 | 9,635 | 151,203 |
| Return..... | -5,035 | 6,773 | 14,750 | 14,750 | 21,733 | 21,733 | 21,733 | 21,733 | 21,733 | -5,035 | -5,035 | -5,035 | — |
| Accumulated return..... | -5,035 | 1,738 | 16,488 | 31,238 | 52,971 | 74,704 | 96,437 | 118,170 | 139,903 | 134,868 | 129,833 | 124,798 | 124,797 |
| Option 5: | | | | | | | | | | | | | |
| Total costs..... | 9,684 | 12,687 | 14,640 | 14,640 | 17,618 | 17,618 | 17,618 | 17,618 | 17,618 | 9,684 | 9,684 | 9,684 | 168,793 |
| Return..... | -5,084 | 5,713 | 12,960 | 12,960 | 19,182 | 19,182 | 19,182 | 19,182 | 19,182 | -5,084 | -5,084 | -5,084 | — |
| Accumulated return..... | -5,084 | 629 | 13,589 | 26,549 | 45,731 | 64,913 | 84,095 | 103,277 | 122,459 | 117,375 | 112,291 | 107,207 | 107,202 |

(continued)

Table 18. Flow of Return and Costs, by Month, Associated with New Building for Planned Capacity (continued)

| Item | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PLANT V: | | | | | | | | | | | | | |
| Production (cases) | 234 | 934 | 1,400 | 1,400 | 1,866 | 1,866 | 1,866 | 1,866 | 1,866 | 234 | 234 | 234 | 14,000 |
| | | | | | | | dollars | | | | | | |
| Total receipts | 5,382 | 21,482 | 32,200 | 32,200 | 42,918 | 42,918 | 42,918 | 42,918 | 42,918 | 5,382 | 5,382 | 5,382 | 322,000 |
| Option 1: | | | | | | | | | | | | | |
| Total costs | 9,936 | 11,842 | 13,063 | 13,063 | 15,310 | 15,310 | 15,310 | 15,310 | 15,310 | 9,936 | 9,936 | 9,936 | 154,263 |
| Return | -4,554 | 9,640 | 19,137 | 19,137 | 27,608 | 27,608 | 27,608 | 27,608 | 27,608 | -4,554 | -4,554 | -4,554 | — |
| Accumulated return | -4,554 | 5,086 | 24,223 | 43,360 | 70,968 | 98,576 | 126,184 | 153,792 | 181,400 | 176,846 | 172,292 | 167,738 | 167,737 |
| Option 2: | | | | | | | | | | | | | |
| Total costs | 9,984 | 11,930 | 13,177 | 13,177 | 15,451 | 15,451 | 15,451 | 15,451 | 15,451 | 9,984 | 9,984 | 9,984 | 155,476 |
| Return | -4,602 | 9,552 | 19,023 | 19,023 | 27,467 | 27,467 | 27,467 | 27,467 | 27,467 | -4,602 | -4,602 | -4,602 | — |
| Accumulated return | -4,602 | 4,950 | 23,973 | 42,996 | 70,463 | 97,930 | 125,397 | 152,864 | 180,331 | 175,729 | 171,127 | 166,525 | 166,524 |
| Option 3: | | | | | | | | | | | | | |
| Total costs | 10,058 | 12,343 | 13,716 | 13,716 | 16,113 | 16,113 | 16,113 | 16,113 | 16,113 | 10,058 | 10,058 | 10,058 | 160,571 |
| Return | -4,676 | 9,139 | 18,484 | 18,484 | 26,805 | 26,805 | 26,805 | 26,805 | 26,805 | -4,676 | -4,676 | -4,676 | — |
| Accumulated return | -4,676 | 4,463 | 22,947 | 41,431 | 68,236 | 95,041 | 121,846 | 148,651 | 175,456 | 170,780 | 166,104 | 161,428 | 161,429 |
| Option 4: | | | | | | | | | | | | | |
| Total costs | 10,135 | 12,466 | 13,870 | 13,870 | 16,296 | 16,296 | 16,296 | 16,296 | 16,296 | 10,135 | 10,135 | 10,135 | 162,227 |
| Return | -4,753 | 9,016 | 18,330 | 18,330 | 26,622 | 26,622 | 26,622 | 26,622 | 26,622 | -4,753 | -4,753 | -4,753 | — |
| Accumulated return | -4,753 | 4,263 | 22,593 | 40,923 | 67,545 | 94,167 | 120,789 | 147,411 | 174,033 | 169,280 | 164,527 | 159,774 | 159,773 |
| Option 5: | | | | | | | | | | | | | |
| Total costs | 10,242 | 13,752 | 16,040 | 16,040 | 19,354 | 19,354 | 19,354 | 19,354 | 19,354 | 10,242 | 10,242 | 10,242 | 183,571 |
| Return | -4,860 | 7,730 | 16,160 | 16,160 | 23,564 | 23,564 | 23,564 | 23,564 | 23,564 | -4,860 | -4,860 | -4,860 | — |
| Accumulated return | -4,860 | 2,870 | 19,030 | 35,190 | 58,754 | 82,318 | 105,882 | 129,446 | 153,010 | 148,150 | 143,290 | 138,430 | 138,429 |

NOTE: Sum of individual items may not be equal to the total because of rounding.

**Table 19. Flow of Return and Costs, by Month, Associated with Used Building for Planned Capacity**

| Item | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PLANT I: | | | | | | | | | | | | | |
| Production (cases) | 100 | 400 | 600 | 600 | 800 | 800 | 800 | 800 | 800 | 100 | 100 | 100 | 6,000 |
| | | | | | | | dollars | | | | | | |
| Total receipts | 2,300 | 9,200 | 13,800 | 13,800 | 18,400 | 18,400 | 18,400 | 18,400 | 18,400 | 2,300 | 2,300 | 2,300 | 138,000 |
| Option 1: | | | | | | | | | | | | | |
| Total costs | 7,291 | 8,084 | 8,577 | 8,577 | 9,047 | 9,047 | 9,047 | 9,047 | 9,047 | 7,291 | 7,291 | 7,291 | 99,635 |
| Return | -4,991 | 1,116 | 5,223 | 5,223 | 9,353 | 9,353 | 9,353 | 9,353 | 9,353 | -4,991 | -4,991 | -4,991 | — |
| Accumulated return | -4,991 | -3,875 | 1,348 | 6,571 | 15,924 | 25,277 | 34,630 | 43,983 | 53,336 | 48,345 | 43,354 | 38,363 | 38,365 |
| Option 2: | | | | | | | | | | | | | |
| Total costs | 7,330 | 8,141 | 8,645 | 8,645 | 9,127 | 9,127 | 9,127 | 9,127 | 9,127 | 7,330 | 7,330 | 7,330 | 100,385 |
| Return | -5,030 | 1,059 | 5,155 | 5,155 | 9,273 | 9,273 | 9,273 | 9,273 | 9,273 | -5,030 | -5,030 | -5,030 | — |
| Accumulated return | -5,030 | -3,971 | 1,184 | 6,339 | 15,612 | 24,885 | 34,158 | 43,431 | 52,704 | 47,674 | 42,644 | 37,614 | 37,615 |
| Option 3: | | | | | | | | | | | | | |
| Total costs | 7,325 | 8,295 | 8,897 | 8,897 | 9,475 | 9,475 | 9,475 | 9,475 | 9,475 | 7,325 | 7,325 | 7,325 | 102,763 |
| Return | -5,025 | 905 | 4,903 | 4,903 | 8,925 | 8,925 | 8,925 | 8,925 | 8,925 | -5,025 | -5,025 | -5,025 | — |
| Accumulated return | -5,025 | -4,120 | 783 | 5,686 | 14,611 | 23,536 | 32,461 | 41,386 | 50,311 | 45,286 | 40,261 | 35,236 | 35,237 |
| Option 4: | | | | | | | | | | | | | |
| Total costs | 7,394 | 8,384 | 8,998 | 8,998 | 9,590 | 9,590 | 9,590 | 9,590 | 9,590 | 7,394 | 7,394 | 7,394 | 103,901 |
| Return | -5,094 | 816 | 4,802 | 4,802 | 8,810 | 8,810 | 8,810 | 8,810 | 8,810 | -5,094 | -5,094 | -5,094 | — |
| Accumulated return | -5,094 | -4,278 | 524 | 5,326 | 14,136 | 22,946 | 31,756 | 40,566 | 49,376 | 44,282 | 39,188 | 34,094 | 34,099 |
| Option 5: | | | | | | | | | | | | | |
| Total costs | 7,289 | 8,770 | 9,721 | 9,721 | 10,650 | 10,650 | 10,650 | 10,650 | 10,650 | 7,289 | 7,289 | 7,289 | 110,620 |
| Return | -4,989 | 430 | 4,079 | 4,079 | 7,750 | 7,750 | 7,750 | 7,750 | 7,750 | -4,989 | -4,989 | -4,989 | — |
| Accumulated return | -4,989 | -4,559 | -480 | 3,599 | 11,349 | 19,099 | 26,849 | 34,599 | 42,349 | 37,360 | 32,371 | 27,382 | 27,380 |
| PLANT II: | | | | | | | | | | | | | |
| Production (cases) | 134 | 534 | 800 | 800 | 1,066 | 1,066 | 1,066 | 1,066 | 1,066 | 134 | 134 | 134 | 8,000 |
| | | | | | | | dollars | | | | | | |
| Total receipts | 3,082 | 12,282 | 18,400 | 18,400 | 24,518 | 24,518 | 24,518 | 24,518 | 24,518 | 3,082 | 3,082 | 3,082 | 184,000 |
| Option 1: | | | | | | | | | | | | | |
| Total costs | 7,690 | 8,761 | 9,438 | 9,438 | 10,092 | 10,092 | 10,092 | 10,092 | 10,092 | 7,690 | 7,690 | 7,690 | 108,855 |
| Return | -4,608 | 3,521 | 8,962 | 8,962 | 14,426 | 14,426 | 14,426 | 14,426 | 14,426 | -4,608 | -4,608 | -4,608 | — |
| Accumulated return | -4,608 | -1,087 | 7,875 | 16,837 | 31,263 | 45,689 | 60,115 | 74,541 | 88,967 | 84,359 | 79,751 | 75,143 | 75,145 |
| Option 2: | | | | | | | | | | | | | |
| Total costs | 7,731 | 8,825 | 9,518 | 9,518 | 10,187 | 10,187 | 10,187 | 10,187 | 10,187 | 7,731 | 7,731 | 7,731 | 109,721 |
| Return | -4,649 | 3,457 | 8,802 | 8,882 | 14,331 | 14,331 | 14,331 | 14,331 | 14,331 | -4,649 | -4,649 | -4,649 | — |
| Accumulated return | -4,649 | -1,192 | 7,690 | 16,572 | 30,903 | 45,234 | 59,565 | 73,896 | 88,227 | 83,578 | 78,929 | 74,280 | 74,279 |
| Option 3: | | | | | | | | | | | | | |
| Total costs | 7,748 | 9,045 | 9,866 | 9,866 | 10,638 | 10,638 | 10,638 | 10,638 | 10,638 | 7,748 | 7,748 | 7,748 | 112,960 |
| Return | -4,666 | 3,237 | 8,534 | 8,534 | 13,880 | 13,880 | 13,880 | 13,880 | 13,880 | -4,666 | -4,666 | -4,666 | — |
| Accumulated return | -4,666 | -1,429 | 7,105 | 15,639 | 29,519 | 43,399 | 57,279 | 71,159 | 85,039 | 80,373 | 75,707 | 71,041 | 71,040 |
| Option 4: | | | | | | | | | | | | | |
| Total costs | 7,819 | 9,142 | 9,980 | 9,980 | 10,770 | 10,770 | 10,770 | 10,770 | 10,770 | 7,819 | 7,819 | 7,819 | 114,228 |
| Return | -4,737 | 3,140 | 8,420 | 8,420 | 13,748 | 13,748 | 13,748 | 13,748 | 13,748 | -4,737 | -4,737 | -4,737 | — |
| Accumulated return | -4,737 | -1,597 | 6,823 | 15,243 | 28,991 | 42,739 | 56,487 | 70,235 | 83,983 | 79,246 | 74,509 | 69,772 | 69,772 |
| Option 5: | | | | | | | | | | | | | |
| Total costs | 7,767 | 9,755 | 11,041 | 11,041 | 12,304 | 12,304 | 12,304 | 12,304 | 12,304 | 7,767 | 7,767 | 7,767 | 124,423 |
| Return | -4,685 | 2,527 | 7,359 | 7,359 | 12,214 | 12,214 | 12,214 | 12,214 | 12,214 | -4,685 | -4,685 | -4,685 | — |
| Accumulated return | -4,685 | -2,158 | 5,201 | 12,560 | 24,774 | 36,988 | 49,202 | 61,416 | 73,630 | 68,945 | 64,260 | 59,575 | 59,577 |

(continued)

Table 19. Flow of Return and Costs, by Month, Associated with Used Building for Planned Capacity (continued)

| Item | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PLANT III: | | | | | | | | | | | | | |
| Production (cases) | 166 | 666 | 1,000 | 1,000 | 1,334 | 1,334 | 1,334 | 1,334 | 1,334 | 166 | 166 | 166 | 10,000 |
| | | | | | | | dollars | | | | | | |
| Total receipts | 3,818 | 15,318 | 23,000 | 23,000 | 30,682 | 30,682 | 30,682 | 30,682 | 30,682 | 3,818 | 3,818 | 3,818 | 230,000 |
| Option 1: | | | | | | | | | | | | | |
| Total costs | 8,030 | 9,380 | 10,245 | 10,245 | 11,088 | 11,088 | 11,088 | 11,088 | 11,088 | 8,030 | 8,030 | 8,030 | 117,431 |
| Return | -4,212 | 5,938 | 12,755 | 12,755 | 19,594 | 19,594 | 19,594 | 19,594 | 19,594 | -4,212 | -4,212 | -4,212 | — |
| Accumulated return | -4,212 | 1,726 | 14,481 | 27,236 | 46,830 | 66,424 | 86,018 | 105,612 | 125,206 | 120,994 | 116,782 | 112,570 | 112,569 |
| Option 2: | | | | | | | | | | | | | |
| Total costs | 8,073 | 9,452 | 10,337 | 10,337 | 11,199 | 11,199 | 11,199 | 11,199 | 11,199 | 8,073 | 8,073 | 8,073 | 118,412 |
| Return | -4,255 | 5,866 | 12,663 | 12,663 | 19,483 | 19,483 | 19,483 | 19,483 | 19,483 | -4,255 | -4,255 | -4,255 | — |
| Accumulated return | -4,255 | 1,611 | 14,274 | 26,937 | 46,420 | 65,903 | 85,386 | 104,869 | 124,352 | 120,097 | 115,842 | 111,587 | 111,588 |
| Option 3: | | | | | | | | | | | | | |
| Total costs | 8,111 | 9,735 | 10,771 | 10,771 | 11,721 | 11,721 | 11,721 | 11,721 | 11,721 | 8,111 | 8,111 | 8,111 | 122,323 |
| Return | -4,293 | 5,583 | 12,229 | 12,229 | 18,961 | 18,961 | 18,961 | 18,961 | 18,961 | -4,293 | -4,293 | -4,293 | — |
| Accumulated return | -4,293 | 1,290 | 13,519 | 25,748 | 44,709 | 63,670 | 82,631 | 101,592 | 120,553 | 116,260 | 111,967 | 107,674 | 107,677 |
| Option 4: | | | | | | | | | | | | | |
| Total costs | 8,184 | 9,841 | 10,898 | 10,898 | 11,870 | 11,870 | 11,870 | 11,870 | 11,870 | 8,184 | 8,184 | 8,184 | 123,720 |
| Return | -4,366 | 5,477 | 12,102 | 12,102 | 18,812 | 18,812 | 18,812 | 18,812 | 18,812 | -4,366 | -4,366 | -4,366 | — |
| Accumulated return | -4,366 | 1,111 | 13,213 | 25,315 | 44,127 | 62,939 | 81,751 | 100,563 | 119,375 | 115,009 | 110,643 | 106,277 | 106,280 |
| Option 5: | | | | | | | | | | | | | |
| Total costs | 8,180 | 10,675 | 12,306 | 12,306 | 13,915 | 13,915 | 13,915 | 13,915 | 13,915 | 8,180 | 8,180 | 8,180 | 137,582 |
| Return | -4,362 | 4,643 | 10,694 | 10,694 | 16,767 | 16,767 | 16,767 | 16,767 | 16,767 | -4,362 | -4,362 | -4,362 | — |
| Accumulated return | -4,362 | 281 | 10,975 | 21,669 | 38,436 | 55,203 | 71,970 | 88,737 | 105,504 | 101,142 | 96,780 | 92,418 | 92,418 |
| PLANT IV: | | | | | | | | | | | | | |
| Production (cases) | 200 | 800 | 1,200 | 1,200 | 1,600 | 1,600 | 1,600 | 1,600 | 1,600 | 200 | 200 | 200 | 12,000 |
| | | | | | | | dollars | | | | | | |
| Total receipts | 4,600 | 18,400 | 27,600 | 27,600 | 36,800 | 36,800 | 36,800 | 36,800 | 36,800 | 4,600 | 4,600 | 4,600 | 276,000 |
| Option 1: | | | | | | | | | | | | | |
| Total costs | 8,416 | 10,043 | 11,080 | 11,080 | 13,143 | 13,143 | 13,143 | 13,143 | 13,143 | 8,416 | 8,416 | 8,416 | 131,579 |
| Return | -3,816 | 8,357 | 16,520 | 16,520 | 23,657 | 23,657 | 23,657 | 23,657 | 23,657 | -3,816 | -3,816 | -3,816 | — |
| Accumulated return | -3,816 | 4,541 | 21,061 | 37,581 | 61,238 | 84,895 | 108,552 | 132,209 | 155,866 | 152,050 | 148,234 | 144,418 | 144,421 |
| Option 2: | | | | | | | | | | | | | |
| Total costs | 8,461 | 10,123 | 11,183 | 11,183 | 13,269 | 13,269 | 13,269 | 13,269 | 13,269 | 8,461 | 8,461 | 8,461 | 132,675 |
| Return | -3,861 | 8,277 | 16,417 | 16,417 | 23,531 | 23,531 | 23,531 | 23,531 | 23,531 | -3,861 | -3,861 | -3,861 | — |
| Accumulated return | -3,861 | 4,416 | 20,833 | 37,250 | 60,781 | 84,312 | 107,843 | 131,374 | 154,905 | 151,044 | 147,183 | 143,322 | 143,325 |
| Option 3: | | | | | | | | | | | | | |
| Total costs | 8,518 | 10,472 | 11,669 | 11,669 | 13,861 | 13,861 | 13,861 | 13,861 | 13,861 | 8,518 | 8,518 | 8,518 | 137,185 |
| Return | -3,918 | 7,928 | 15,931 | 15,931 | 22,939 | 22,939 | 22,939 | 22,939 | 22,939 | -3,918 | -3,918 | -3,918 | — |
| Accumulated return | -3,918 | 4,010 | 19,941 | 35,872 | 58,811 | 81,750 | 104,689 | 127,628 | 150,567 | 146,649 | 142,731 | 138,813 | 138,815 |
| Option 4: | | | | | | | | | | | | | |
| Total costs | 8,594 | 10,586 | 11,809 | 11,809 | 14,026 | 14,026 | 14,026 | 14,026 | 14,026 | 8,594 | 8,594 | 8,594 | 138,710 |
| Return | -3,994 | 7,814 | 15,791 | 15,791 | 22,774 | 22,774 | 22,774 | 22,774 | 22,774 | -3,994 | -3,994 | -3,994 | — |
| Accumulated return | -3,994 | 3,820 | 19,611 | 35,402 | 58,176 | 80,950 | 103,724 | 126,498 | 149,272 | 145,278 | 141,284 | 137,290 | 137,290 |
| Option 5: | | | | | | | | | | | | | |
| Total costs | 8,643 | 11,646 | 13,599 | 13,599 | 16,577 | 16,577 | 16,577 | 16,577 | 16,577 | 8,643 | 8,643 | 8,643 | 156,305 |
| Return | -4,043 | 6,754 | 14,001 | 14,001 | 20,223 | 20,223 | 20,223 | 20,223 | 20,223 | -4,043 | -4,043 | -4,043 | — |
| Accumulated return | -4,043 | 2,711 | 16,712 | 30,713 | 50,936 | 71,159 | 91,382 | 111,605 | 131,828 | 127,785 | 123,742 | 119,699 | 119,695 |

(continued)

Table 19. Flow of Return and Costs, by Month, Associated with Used Building for Planned Capacity (continued)

| Item | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PLANT V: | | | | | | | | | | | | | |
| Production (cases) | 234 | 934 | 1,400 | 1,400 | 1,866 | 1,866 | 1,866 | 1,866 | 1,866 | 234 | 234 | 234 | 14,000 |
| | | | | | | | dollars | | | | | | |
| Total receipts | 5,382 | 21,482 | 32,000 | 32,000 | 42,918 | 42,918 | 42,918 | 42,918 | 42,918 | 5,382 | 5,382 | 5,382 | 322,000 |
| Option 1: | | | | | | | | | | | | | |
| Total costs | 8,792 | 10,698 | 11,919 | 11,919 | 14,166 | 14,166 | 14,166 | 14,166 | 14,166 | 8,792 | 8,792 | 8,792 | 140,533 |
| Return | -3,410 | 10,784 | 20,281 | 20,281 | 28,752 | 28,752 | 28,752 | 28,752 | 28,752 | -3,410 | -3,410 | -3,410 | — |
| Accumulated return | -3,410 | 7,374 | 27,655 | 47,936 | 76,688 | 105,440 | 134,192 | 162,944 | 191,696 | 188,286 | 184,876 | 181,466 | 181,467 |
| Option 2: | | | | | | | | | | | | | |
| Total costs | 8,840 | 10,786 | 12,033 | 12,033 | 14,307 | 14,307 | 14,307 | 14,307 | 14,307 | 8,840 | 8,840 | 8,840 | 141,746 |
| Return | -3,458 | 10,696 | 20,167 | 20,167 | 28,611 | 28,611 | 28,611 | 28,611 | 28,611 | -3,458 | -3,458 | -3,458 | — |
| Accumulated return | -3,458 | 7,238 | 27,405 | 47,572 | 76,183 | 104,794 | 133,405 | 162,016 | 190,627 | 187,169 | 183,711 | 180,253 | 180,254 |
| Option 3: | | | | | | | | | | | | | |
| Total costs | 8,914 | 11,199 | 12,572 | 12,572 | 14,969 | 14,969 | 14,969 | 14,969 | 14,969 | 8,914 | 8,914 | 8,914 | 146,842 |
| Return | -3,532 | 10,283 | 19,628 | 19,628 | 27,949 | 27,949 | 27,949 | 27,949 | 27,949 | -3,532 | -3,532 | -3,532 | — |
| Accumulated return | -3,532 | 6,751 | 26,379 | 46,007 | 73,956 | 101,905 | 129,854 | 157,803 | 185,752 | 182,220 | 178,688 | 175,156 | 175,158 |
| Option 4: | | | | | | | | | | | | | |
| Total costs | 8,991 | 11,322 | 12,725 | 12,725 | 15,152 | 15,152 | 15,152 | 15,152 | 15,152 | 8,991 | 8,991 | 8,991 | 148,498 |
| Return | -3,609 | 10,160 | 19,475 | 19,475 | 27,766 | 27,766 | 27,766 | 27,766 | 27,766 | -3,609 | -3,609 | -3,609 | — |
| Accumulated return | -3,609 | 6,551 | 26,026 | 45,501 | 73,267 | 101,033 | 128,799 | 156,565 | 184,331 | 180,722 | 177,113 | 173,504 | 173,502 |
| Option 5: | | | | | | | | | | | | | |
| Total costs | 9,098 | 12,603 | 14,896 | 14,896 | 18,210 | 18,210 | 18,210 | 18,210 | 18,210 | 9,098 | 9,098 | 9,098 | 169,842 |
| Return | -3,716 | 8,874 | 17,304 | 17,304 | 24,708 | 24,708 | 24,708 | 24,708 | 24,708 | -3,716 | -3,716 | -3,716 | — |
| Accumulated return | -3,716 | 5,158 | 22,462 | 39,766 | 64,474 | 89,182 | 113,890 | 138,598 | 163,306 | 159,590 | 155,874 | 152,158 | 152,159 |

NOTE: Sum of individual items may not be equal to the total because of rounding.

Table 20. Efficiency: Average Net Returns Per Dollar of Total Costs

| Type of building | Plant | Option 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| | | dollars | | | | |
| New | I | .27 | .26 | .24 | .22 | .16 |
| | II | .55 | .53 | .49 | .48 | .37 |
| | III | .79 | .77 | .72 | .70 | .54 |
| | IV | .92 | .90 | .84 | .83 | .64 |
| | V | 1.09 | 1.07 | 1.01 | .98 | .75 |
| Used | I | .38 | .37 | .34 | .33 | .25 |
| | II | .69 | .68 | .63 | .61 | .49 |
| | III | .96 | .94 | .88 | .86 | .67 |
| | IV | 1.10 | 1.08 | 1.01 | .99 | .77 |
| | V | 1.29 | 1.27 | 1.19 | 1.17 | .90 |

Table 21. Average Net Returns Per Case

| Type of building | Plant | Option 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| | | dollars | | | | |
| New | I | 4.92 | 4.80 | 4.40 | 4.21 | 3.09 |
| | II | 8.12 | 8.01 | 7.60 | 7.44 | 6.17 |
| | III | 10.13 | 10.03 | 9.64 | 9.50 | 8.11 |
| | IV | 10.99 | 10.91 | 10.53 | 10.40 | 8.93 |
| | V | 11.99 | 11.90 | 11.53 | 11.42 | 9.88 |
| Used | I | 6.39 | 6.27 | 5.87 | 5.68 | 4.56 |
| | II | 9.40 | 9.29 | 8.88 | 8.72 | 7.45 |
| | III | 11.26 | 11.16 | 10.77 | 10.63 | 9.24 |
| | IV | 12.03 | 11.95 | 11.57 | 11.44 | 9.97 |
| | V | 12.97 | 12.88 | 12.51 | 12.40 | 10.86 |

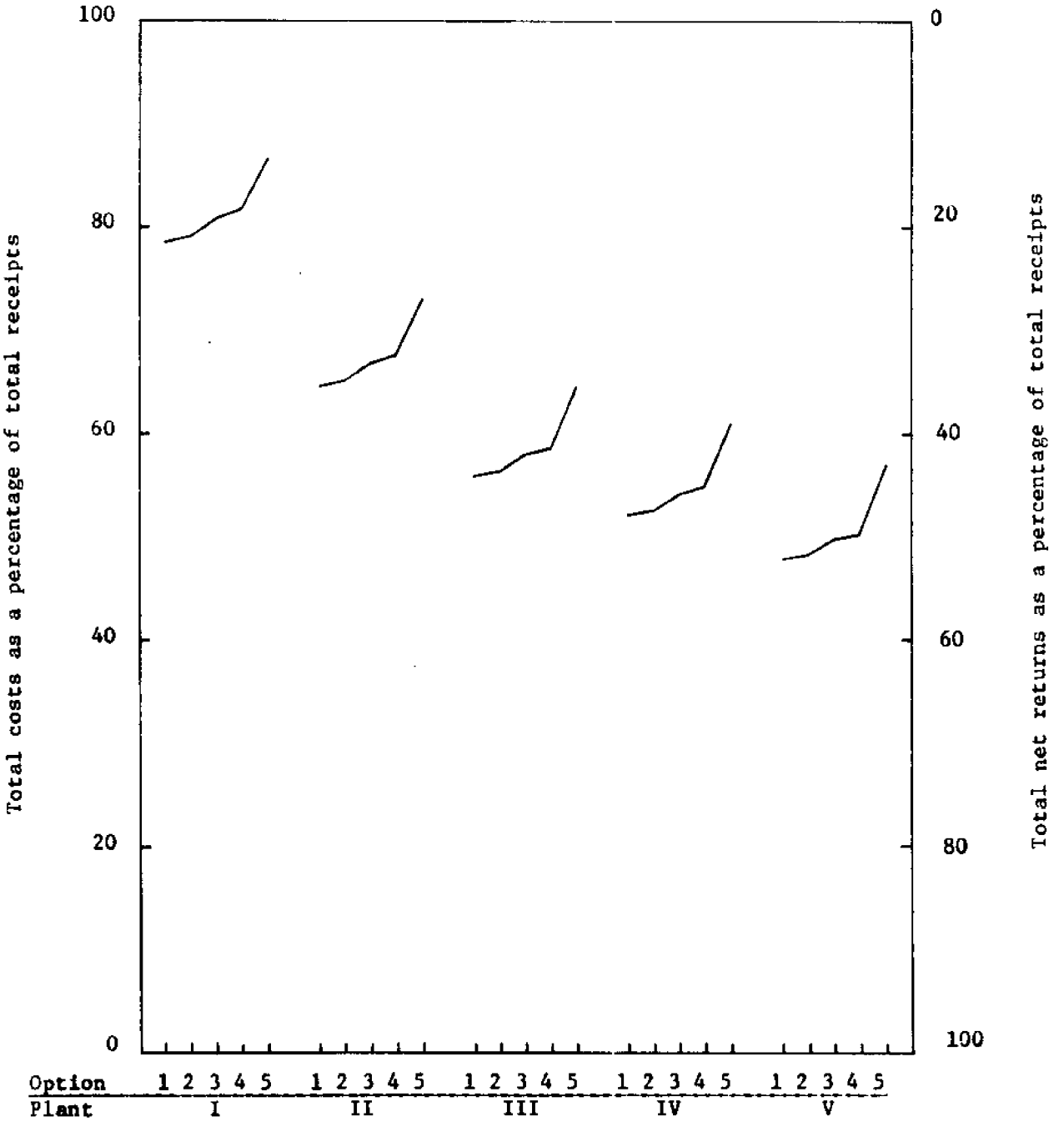



Figure 15. Proportion of total costs and total net returns to the total receipts associated with new building.

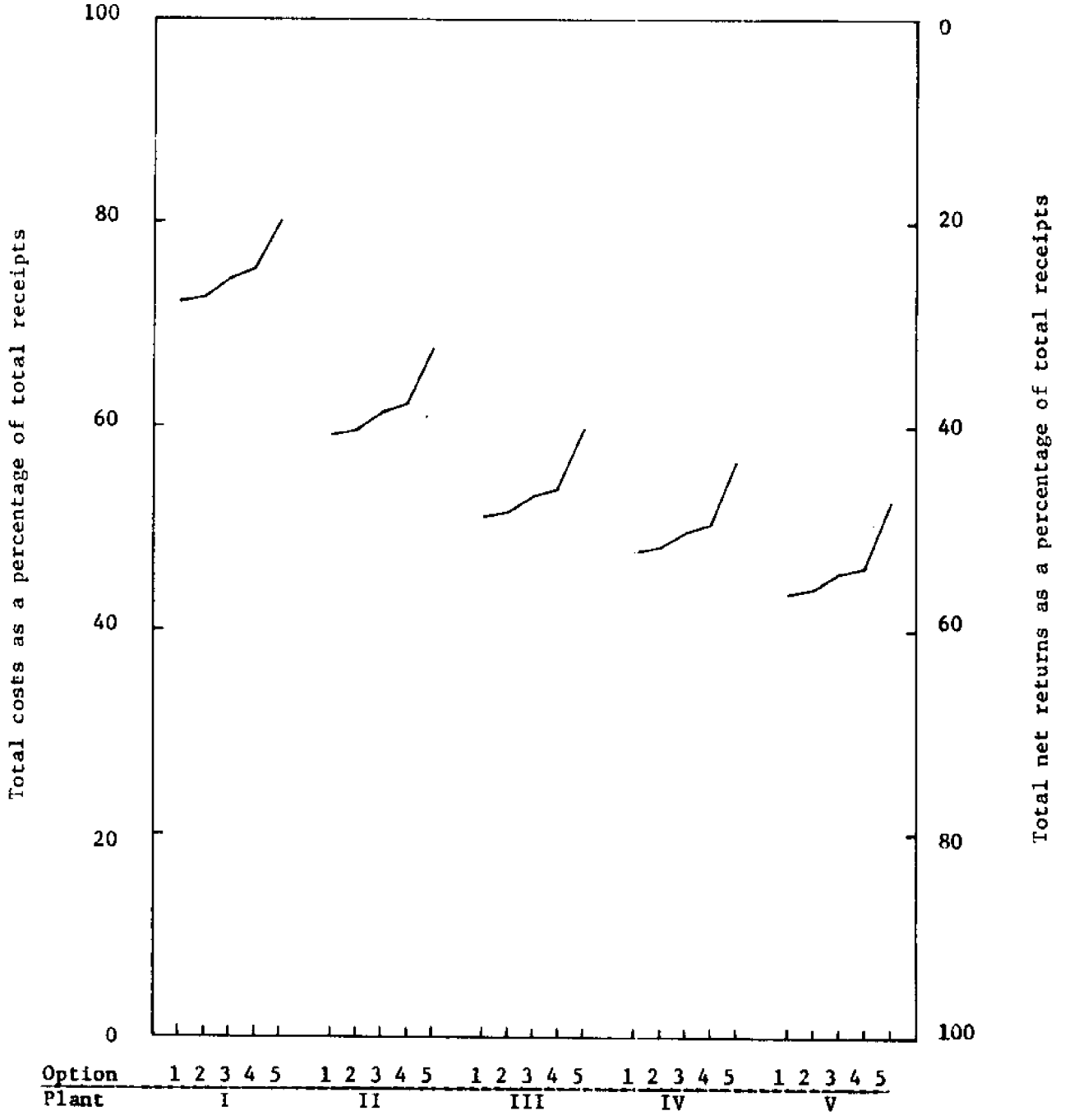



Figure 16. Proportion of total costs and total net returns to the total receipts associated with used building.

As stated earlier, Option 5 does not have a cultch preparation stage. Therefore, in Table 21 the figures between Options 1 through 4 and Option 5 are the indications of how much money can be saved in each option if cultch is prepared by plant facilities. More specifically, depending on options chosen, $1.12 to $1.83 and $1.54 to $2.11 per case are saved in Plant I and Plant V, respectively, if cultch is prepared by the plant. This result is dependent, of course, upon the assumed cost conditions for cultch preparation and the assumed price of $4.50 per case of pre-cleaned cultch.

Average costs per case associated with cultch preparation in different options and plants can be found in Table 21. Since a cost of $4.50 per case is assigned for cultch in Option 5, $4.50 minus the difference between average net returns per case for Options 1 through 4 and Option 5 are the average costs per case associated with cultch preparation for that particular option and plant. Table 22 shows the average costs per case associated with cultch preparation in different options and plants. There is no difference in costs of cultch preparation between a new building and a used building. The average cultch preparation costs per case for Plant I ranged from $2.67 to $3.38, and for Plant V from $2.39 to $2.96. These costs decrease as plant capacity increases, mainly because of sliding scale charges of city water and power. Table 23 demonstrates that costs of cultch preparation contribute a substantial percentage of total costs per case of oyster seed. For Option 5, purchased cultch accounts for about 23 to 37 percent of the total costs.

Monthly and cumulative seed production and total receipts and costs for Plant I appear in Figures 17 and 18. These figures reveal the distribution of total receipts, total costs, and total returns, which would be generated through the year for Plant I. The vertical distance between total receipts and total costs represents cumulative net returns. Cumulative total costs for Option 5 are the highest, and those of Option 1 are the lowest. Cumulative total costs of all other options (Options 2 through 4) fall within this range.

Cumulative total costs and total receipts associated with a new building and a used building, for Plants I and V, are compared in Figure 19.

Table 22. Average Costs Per Case Associated with Cultch Preparation

| Type of building | Plant | Option 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| | | dollars | | | | |
| Both new and used | I..... | 2.67 | 2.79 | 3.19 | 3.38 | 4.50 |
| | II..... | 2.55 | 2.66 | 3.07 | 3.23 | 4.50 |
| | III..... | 2.48 | 2.58 | 2.97 | 3.11 | 4.50 |
| | IV..... | 2.43 | 2.52 | 2.90 | 3.03 | 4.50 |
| | V..... | 2.39 | 2.48 | 2.85 | 2.96 | 4.50 |

Table 23. Costs of Cultch Preparation As a Percentage of Total Costs Per Case

| Type of building | Plant | Option 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| | | percent | | | | |
| New | I..... | 14.8 | 15.3 | 17.2 | 18.0 | 22.6 |
| | II..... | 17.1 | 17.7 | 19.9 | 20.8 | 26.7 |
| | III..... | 19.3 | 19.9 | 22.2 | 23.0 | 30.2 |
| | IV..... | 20.2 | 20.8 | 23.3 | 24.0 | 32.0 |
| | V..... | 21.7 | 22.3 | 24.8 | 25.6 | 34.3 |
| Used | I..... | 16.1 | 16.7 | 18.6 | 19.5 | 24.4 |
| | II..... | 18.7 | 19.4 | 21.7 | 22.6 | 28.9 |
| | III..... | 21.1 | 21.8 | 24.3 | 25.1 | 32.7 |
| | IV..... | 22.1 | 22.8 | 25.4 | 26.2 | 34.5 |
| | V..... | 23.8 | 24.5 | 27.2 | 27.9 | 37.1 |

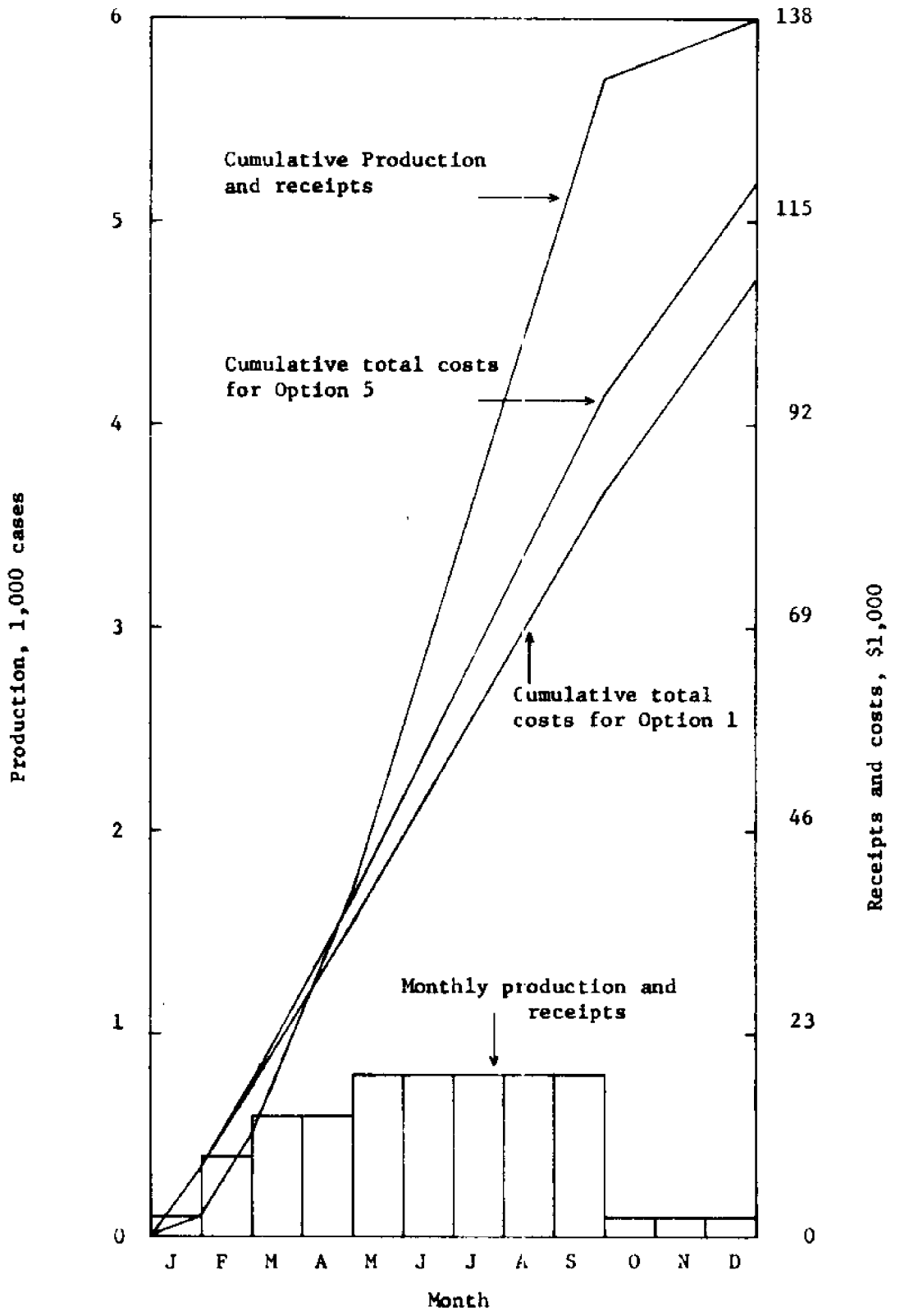



Figure 17. Monthly and cumulative oyster seed production, total receipts and costs associated with new building for Plant I, Options 1 and 5.

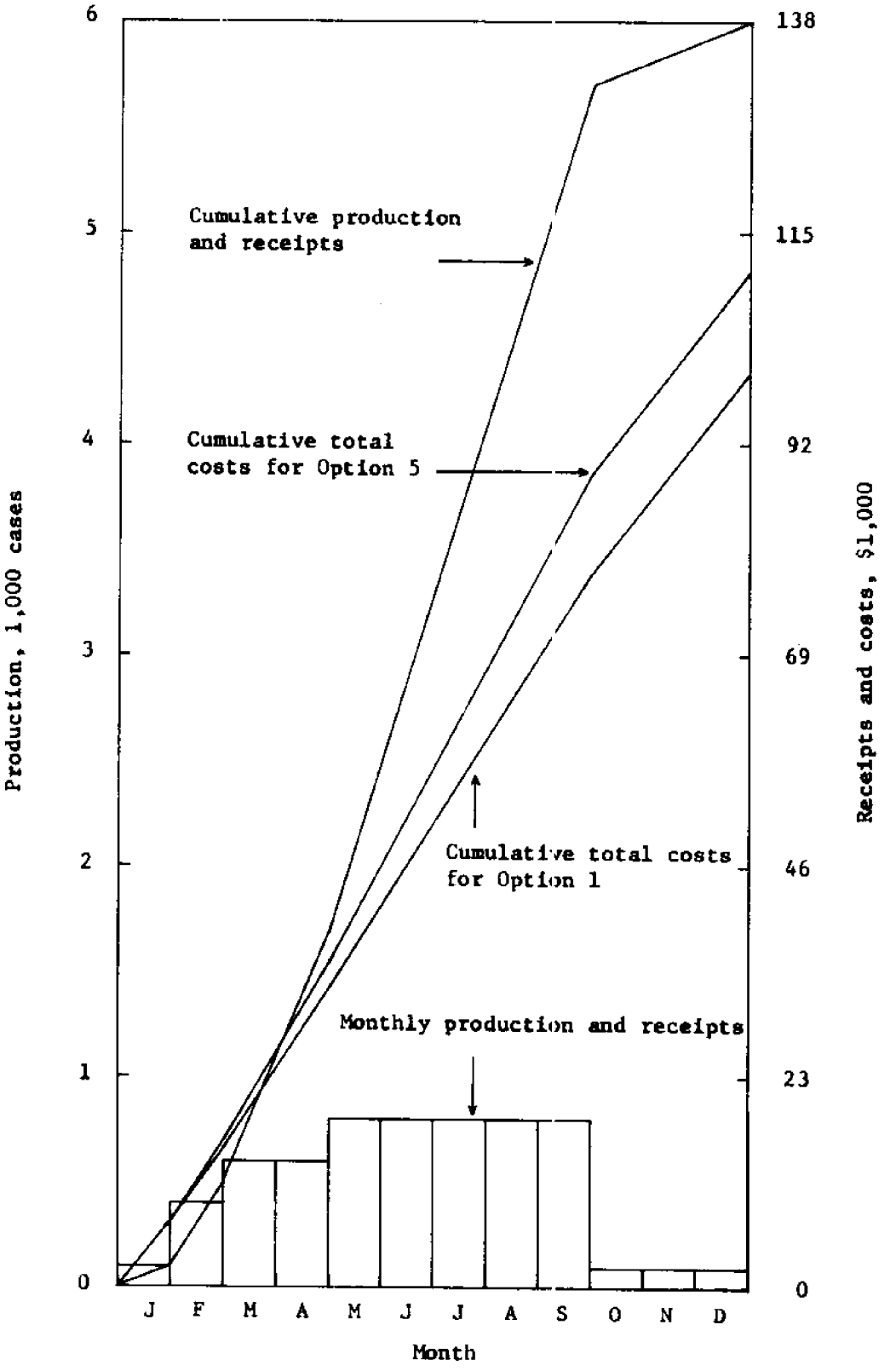



Figure 18. Monthly and cumulative oyster seed production, total receipts and costs associated with used building for Plant I, Options 1 and 5.

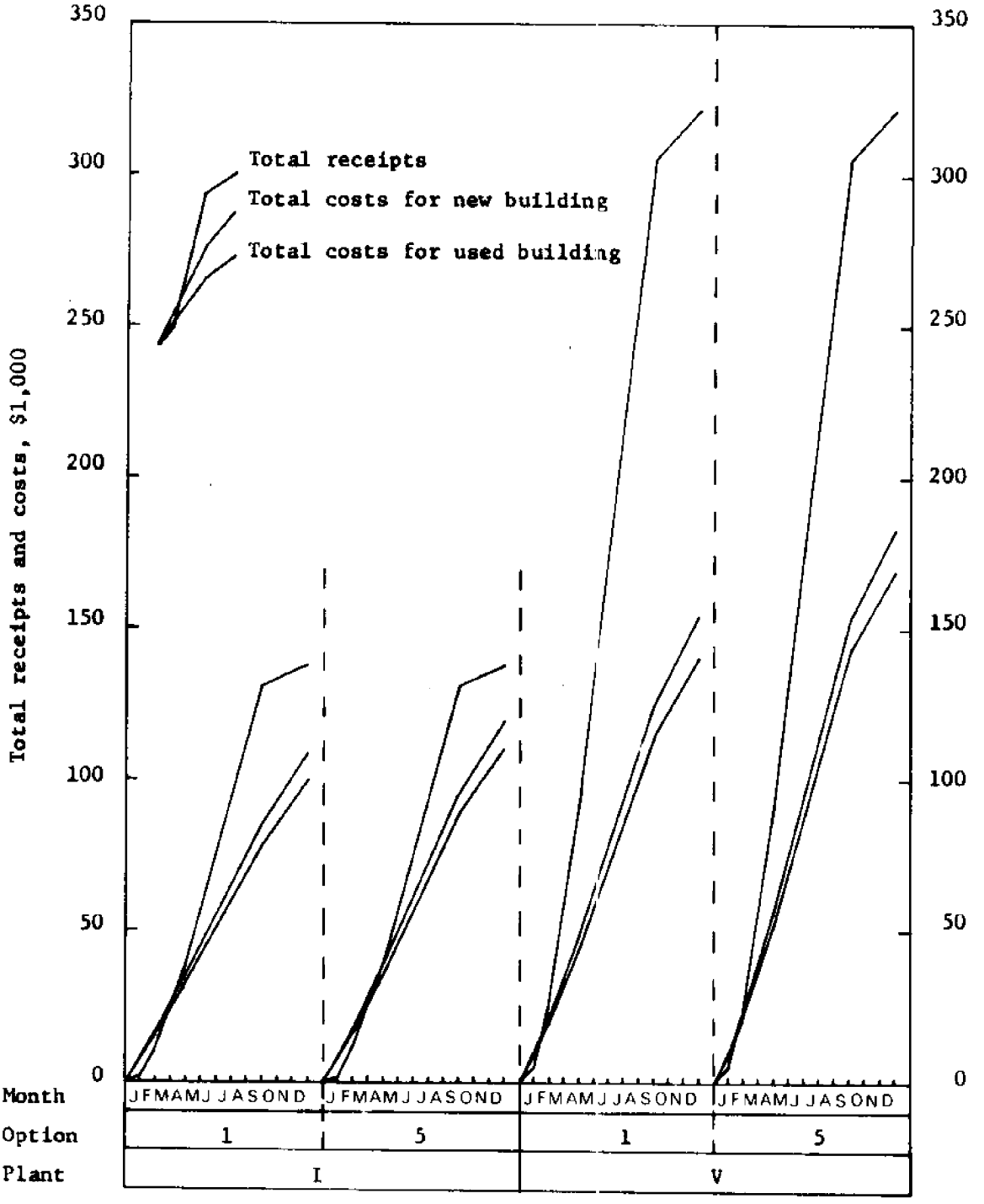



Figure 19. Cumulative total receipts and costs associated with new building and used building for Plants I and V.

## ECONOMIES OF SIZE

As the size of the plant and the scale of operation become larger, considering expansion from the smallest possible plant, certain economies of scale are usually realized. That is, after adjusting all inputs optimally, the unit cost of production can be reduced by increasing the size of the plant. Two broad forces - specialization of labor and technological factors - enable producers to reduce unit cost by expanding the scale of operation. These forces give rise to the negatively sloped portion of the long-run average cost curve [2], and are practically demonstrated in the next section.

Analysis of size economies is usually considered in terms of short- and long-run situations. According to Madden [7], short-run economies are viewed as resulting from fuller utilization of a fixed plant, and long-run economies as resulting from efficiencies obtained by changing plant size, presumably involving a longer time period. The treatment of any resources as "fixed" is usually based on the length of the planning horizon being examined, the longevity of the resources involved, and the costs of changing these resources. Which resources are treated as "fixed" in the short-run has no effect on the eventual shape of the long-run average cost curve. The long-run average cost curve assumes all resources are variable, including those designated as fixed in the short-run. A curve that is drawn tangent to the short-run curves approximates the long-run economies-of-size curve for that range of output represented by the short-run curves. This curve indicates the average total cost of production that would be experienced by firms of different sizes under assumed price relationships and technologies.

### Short-Run and Long-Run Cost Functions

This section will cover the cost of production for the designed 5 plants, both at full capacity and at two lesser capacities, and under the short- and long-run conditions. Long-run planning cost functions can be derived from Tables 24 and 25, using 5 observations. Two additional points were estimated for each option and plant by reducing output by 10 and 20 percent from the planned capacity, in order to get the short-run cost functions. Such a reduction of output does not affect the fixed costs. Variable costs, depending on the characteristics of the item, may or may not change. Variable costs associated with cultch preparation, and

Table 24. Cost Changes Within Plants, with Respect to Output Per Year, Associated with New Building

| Item | Plant I | II | III | IV | V |
|---|---|---|---|---|---|
| | cases | | | | |
| Planned capacity output per year..... | 6,000 | 8,000 | 10,000 | 12,000 | 14,000 |
| | dollars | | | | |
| Option 1: | | | | | |
| Total costs..... | 108,482.64 | 119,079.46 | 128,741.64 | 144,072.19 | 154,263.17 |
| Average costs..... | 18.08 | 14.88 | 12.87 | 12.01 | 11.01 |
| Option 2: | | | | | |
| Total costs..... | 109,233.14 | 119,945.16 | 129,722.96 | 145,168.38 | 155,475.48 |
| Average costs..... | 18.20 | 14.99 | 12.97 | 12.09 | 11.10 |
| Option 3: | | | | | |
| Total costs..... | 111,609.76 | 123,183.33 | 133,632.67 | 149,678.04 | 160,571.39 |
| Average costs..... | 18.60 | 15.40 | 13.36 | 12.47 | 11.47 |
| Option 4: | | | | | |
| Total costs..... | 112,748.11 | 124,451.22 | 135,030.04 | 151,203.42 | 162,227.20 |
| Average costs..... | 18.79 | 15.56 | 13.50 | 12.60 | 11.58 |
| Option 5: | | | | | |
| Total costs..... | 119,467.44 | 134,646.42 | 148,891.89 | 168,797.64 | 183,571.17 |
| Average costs..... | 19.91 | 16.83 | 14.89 | 14.07 | 13.12 |
| | cases | | | | |
| 90% capacity output per year..... | 5,400 | 7,200 | 9,000 | 10,800 | 12,600 |
| | dollars | | | | |
| Option 1: | | | | | |
| Total costs..... | 106,709.05 | 116,719.35 | 125,790.20 | 140,004.89 | 149,609.32 |
| Average costs..... | 19.76 | 16.21 | 13.98 | 12.96 | 11.87 |
| Option 2: | | | | | |
| Total costs..... | 107,424.84 | 117,539.24 | 126,713.82 | 141,031.44 | 150,740.77 |
| Average costs..... | 19.89 | 16.32 | 14.08 | 13.06 | 11.96 |
| Option 3: | | | | | |
| Total costs..... | 109,5[illegible].45 | 120,498.48 | 130,298.16 | 145,185.29 | 155,427.46 |
| Average costs..... | 20.28 | 16.74 | 14.48 | 13.44 | 12.34 |
| Option 4: | | | | | |
| Total costs..... | 110,603.78 | 121,714.76 | 131,630.94 | 146,633.20 | 156,992.24 |
| Average costs..... | 20.48 | 16.90 | 14.63 | 13.58 | 12.46 |
| Option 5: | | | | | |
| Total costs..... | 116,318.96 | 130,454.14 | 143,649.11 | 161,981.43 | 175,710.82 |
| Average costs..... | 21.54 | 18.12 | 15.96 | 15.00 | 13.95 |
| | cases | | | | |
| 80% capacity output per year..... | 4,800 | 6,400 | 8,000 | 9,600 | 11,200 |
| | dollars | | | | |
| Option 1: | | | | | |
| Total costs..... | 104,935.31 | 114,359.98 | 122,838.52 | 135,937.25 | 144,956.01 |
| Average costs..... | 21.86 | 17.87 | 15.35 | 14.16 | 12.94 |
| Option 2: | | | | | |
| Total costs..... | 105,616.33 | 115,133.35 | 123,704.57 | 136,894.39 | 146,006.18 |
| Average costs..... | 22.00 | 17.99 | 15.46 | 14.26 | 13.04 |
| Option 3: | | | | | |
| Total costs..... | 107,398.74 | 117,709.00 | 126,940.32 | 140,683.56 | 150,282.64 |
| Average costs..... | 22.37 | 18.39 | 15.87 | 14.65 | 13.42 |
| Option 4: | | | | | |
| Total costs..... | 108,459.08 | 118,873.27 | 128,208.56 | 142,054.01 | 151,757.06 |
| Average costs..... | 22.60 | 18.57 | 16.03 | 14.80 | 13.55 |
| Option 5: | | | | | |
| Total costs..... | 113,170.35 | 126,261.40 | 138,406.29 | 155,168.45 | 167,854.92 |
| Average costs..... | 23.58 | 19.73 | 17.30 | 16.16 | 14.99 |

Table 25. Cost Changes Within Plants, with Respect to Output Per Year, Associated with Used Building

| Item | Plant I | II | III | IV | V |
|---|---|---|---|---|---|
| | cases | | | | |
| Planned capacity output per year..... | 6,000 | 8,000 | 10,000 | 12,000 | 14,000 |
| | dollars | | | | |
| Option 1: | | | | | |
| Total costs..... | 99,634.64 | 108,855.46 | 117,430.64 | 131,579.19 | 140,533.17 |
| Average costs..... | 16.61 | 13.60 | 11.74 | 10.97 | 10.03 |
| Option 2: | | | | | |
| Total costs..... | 100,385.14 | 109,721.16 | 118,411.96 | 132,675.38 | 141,745.48 |
| Average costs..... | 16.73 | 13.71 | 11.84 | 11.05 | 10.12 |
| Option 3: | | | | | |
| Total costs..... | 102,762.76 | 112,960.33 | 122,322.67 | 137,185.04 | 146,842.39 |
| Average costs..... | 17.13 | 14.12 | 12.23 | 11.43 | 10.49 |
| Option 4: | | | | | |
| Total costs..... | 103,901.11 | 114,228.22 | 123,720.04 | 138,710.42 | 148,498.20 |
| Average costs..... | 17.32 | 14.28 | 12.37 | 11.56 | 10.60 |
| Option 5: | | | | | |
| Total costs..... | 110,620.44 | 124,423.42 | 137,581.89 | 156,304.64 | 169,842.17 |
| Average costs..... | 18.44 | 15.55 | 13.76 | 13.03 | 12.14 |
| | cases | | | | |
| 90% capacity output per year..... | 5,400 | 7,200 | 9,000 | 10,800 | 12,600 |
| | dollars | | | | |
| Option 1: | | | | | |
| Total costs..... | 97,861.05 | 106,495.35 | 114,479.20 | 127,511.89 | 135,879.32 |
| Average costs..... | 18.12 | 14.79 | 12.72 | 11.81 | 10.78 |
| Option 2: | | | | | |
| Total costs..... | 98,576.84 | 107,315.24 | 115,402.82 | 128,538.44 | 137,010.77 |
| Average costs..... | 18.25 | 14.90 | 12.82 | 11.90 | 10.87 |
| Option 3: | | | | | |
| Total costs..... | 100,657.45 | 110,275.48 | 118,988.16 | 132,692.29 | 141,698.46 |
| Average costs..... | 18.64 | 15.32 | 13.22 | 12.29 | 11.25 |
| Option 4: | | | | | |
| Total costs..... | 101,756.78 | 111,491.76 | 120,320.94 | 134,140.20 | 143,263.24 |
| Average costs..... | 18.84 | 15.48 | 13.37 | 12.42 | 11.37 |
| Option 5: | | | | | |
| Total costs..... | 107,471.96 | 120,231.14 | 132,339.11 | 149,488.43 | 161,981.82 |
| Average costs..... | 19.90 | 16.70 | 14.70 | 13.84 | 12.86 |
| | cases | | | | |
| 80% capacity output per year..... | 4,800 | 6,400 | 8,000 | 9,600 | 11,200 |
| | dollars | | | | |
| Option 1: | | | | | |
| Total costs..... | 96,087.31 | 104,135.98 | 111,527.52 | 123,444.25 | 131,226.09 |
| Average costs..... | 20.02 | 16.27 | 13.94 | 12.86 | 11.72 |
| Option 2: | | | | | |
| Total costs..... | 96,768.33 | 104,909.35 | 112,393.57 | 124,401.39 | 132,276.18 |
| Average costs..... | 20.16 | 16.39 | 14.05 | 12.96 | 11.81 |
| Option 3: | | | | | |
| Total costs..... | 98,551.74 | 107,486.00 | 115,630.32 | 128,190.56 | 136,553.64 |
| Average costs..... | 20.53 | 16.79 | 14.45 | 13.35 | 12.19 |
| Option 4: | | | | | |
| Total costs..... | 99,612.08 | 108,650.27 | 116,898.56 | 129,561.01 | 138,028.06 |
| Average costs..... | 20.75 | 16.98 | 14.61 | 13.50 | 12.32 |
| Option 5: | | | | | |
| Total costs..... | 104,323.35 | 116,038.40 | 127,096.29 | 142,675.45 | 154,125.92 |
| Average costs..... | 21.73 | 18.13 | 15.89 | 14.86 | 13.76 |

labor costs for summer helpers, would vary in direct proportion to the output reduction. Oil costs for the boiler, charges for electric demand, sewer, garbage, telephone, and costs for light and power other than cultch preparation would remain constant with output reductions of 10 and 20 percent.

The following long-run average production cost functions have been made with the simple linear regression method, using 5 observations based on Tables 24 and 25. These functions show the expected average costs per case for options and plants of full output capacity with a given condition and technology.

Functions associated with new building:

(1) $$APCN_1 = \frac{\$72,651}{V} + \$5.8277$$

(2) $$APCN_2 = \frac{\$73,055}{V} + \$5.8854$$

(3) $$APCN_3 = \frac{\$73,526}{V} + \$6.2209$$

(4) $$APCN_4 = \frac{\$74,277}{V} + \$6.2855$$

(5) $$APCN_5 = \frac{\$69,896}{V} + \$8.1179$$

Functions associated with used building:

(6) $$APCU_1 = \frac{\$67,346}{V} + \$5.2260$$

(7) $$APCU_2 = \frac{\$67,750}{V} + \$5.2837$$

(8) $$APCU_3 = \frac{\$68,223}{V} + \$5.6192$$

(9) $$APCU_4 = \frac{\$68,973}{V} + \$5.6838$$

(10) $$APCU_5 = \frac{\$64,592}{V} + \$7.5162$$

where:

$APCN_1$ ••• $APCN_5$ = average production costs per case, associated with new building, for Options 1-5.

$APCU_1 \cdots APCU_5$ = average production costs per case, associated with used building, for Options 1-5.

V = output of oyster seed, by cases, per year.

The long-run average production cost curve, or function, is a relationship between costs and output, which shows the minimum average production costs for any level of output when all inputs are variable. Figures 20 through 23 show the relationship of short-run to long-run average production costs. There are "fixed" factors associated with each of these figures, however. In Figures 20 and 21, the cultch preparation method of Option 1 is applied to all of the curves, while in Figures 22 and 23 Option 5 is used. The solid lines are the long-run average cost curves or the long-run planning cost curves, and the dotted lines are the short-run average cost curves for the fixed plants, Plants I through V.

These figures show that the long-run average cost curves are downward sloping, and mean that as the size of plant increases, the average costs per case decrease when plants are operating at near capacity. These downward-sloping parts are associated with economies of size. As shown in these figures, the short-run average cost curves (all the dotted lines) are moving toward the long-run planning costs until they coincide, when the rate of output nears capacity. The production at which the short-run average cost is the lowest is the most efficient rate of output. For any plant, operating at below capacity increases average costs significantly. For example, in Option 1, operating at 80 percent of capacity increases average costs by $3.78 and $1.93 per case for Plants I and V, respectively, associated with a new building, and by $3.41 and $1.69 per case for those plants associated with a used building, respectively. No attempt was made to estimate costs for those operations in excess of the full capacity.

There are definite economies of size with increasing plant capacity. As the plant capacity increases from 6,000 to 14,000 cases per year, average costs per case decrease between 35 and 40 percent for all options. Figures 20 through 23 indicate that further economies of size might exist for even larger plants. The slopes of the long-run average production cost curves are negative and, within the output range examined, do not become parallel to the horizontal axis, because

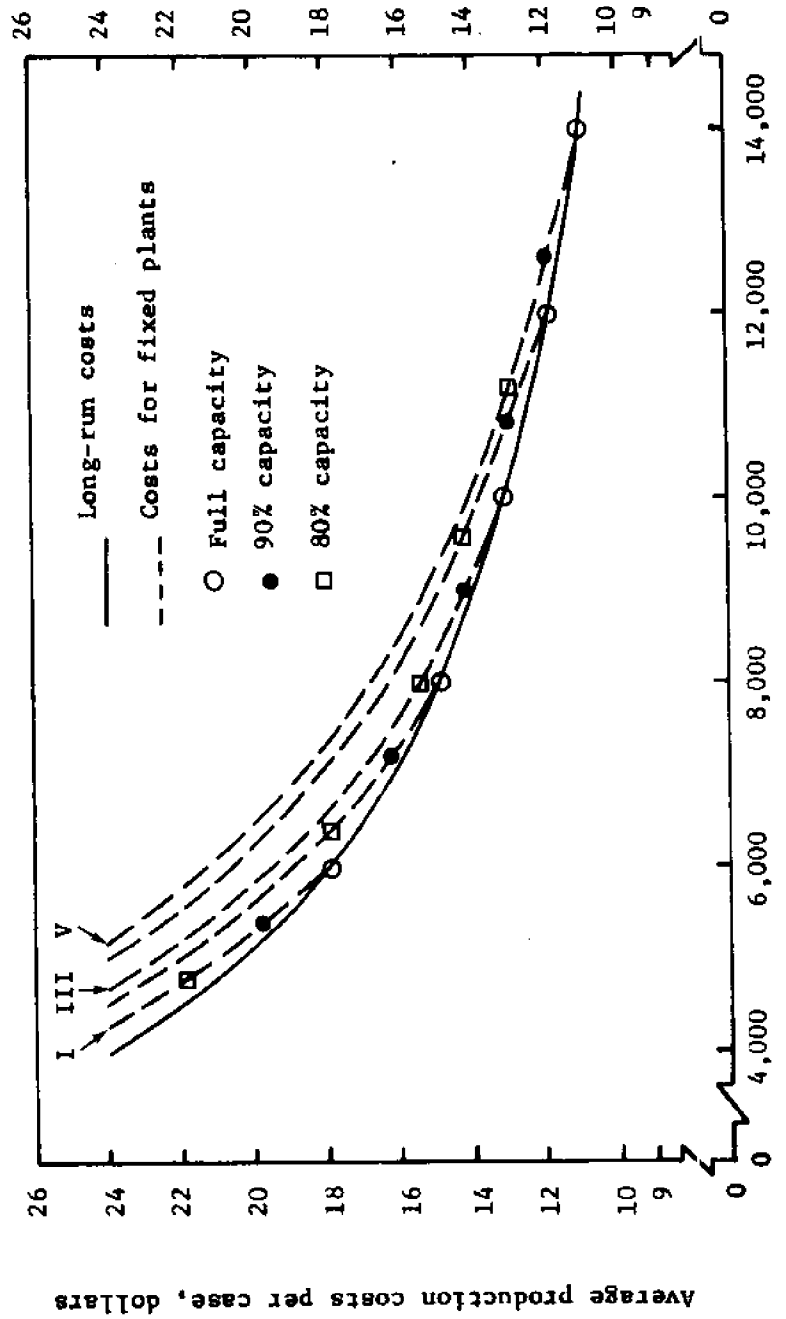



Figure 20. Relation of short-run to long-run average production costs associated with new building in Option 1 for Plants I to V.

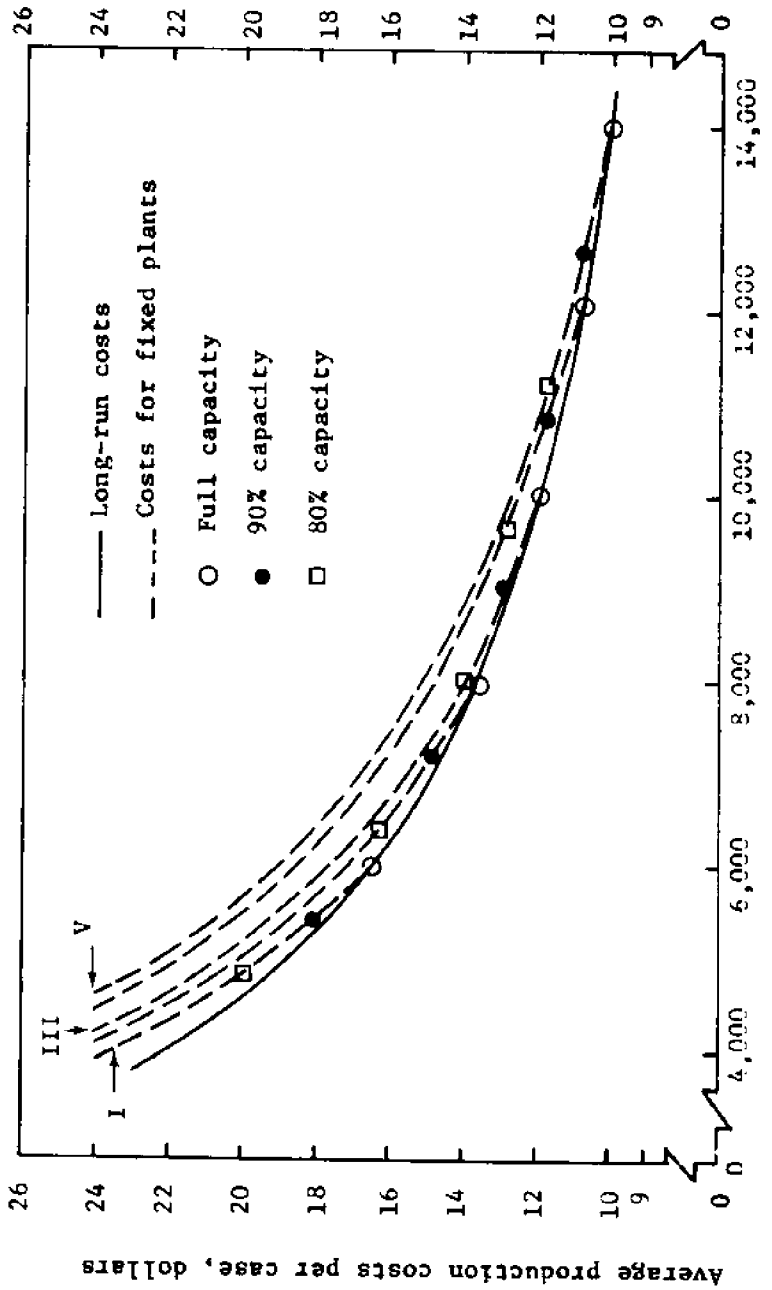



Figure 21. Relation of short-run to long-run average production costs associated with used building in Option 1 for Plants I to V.

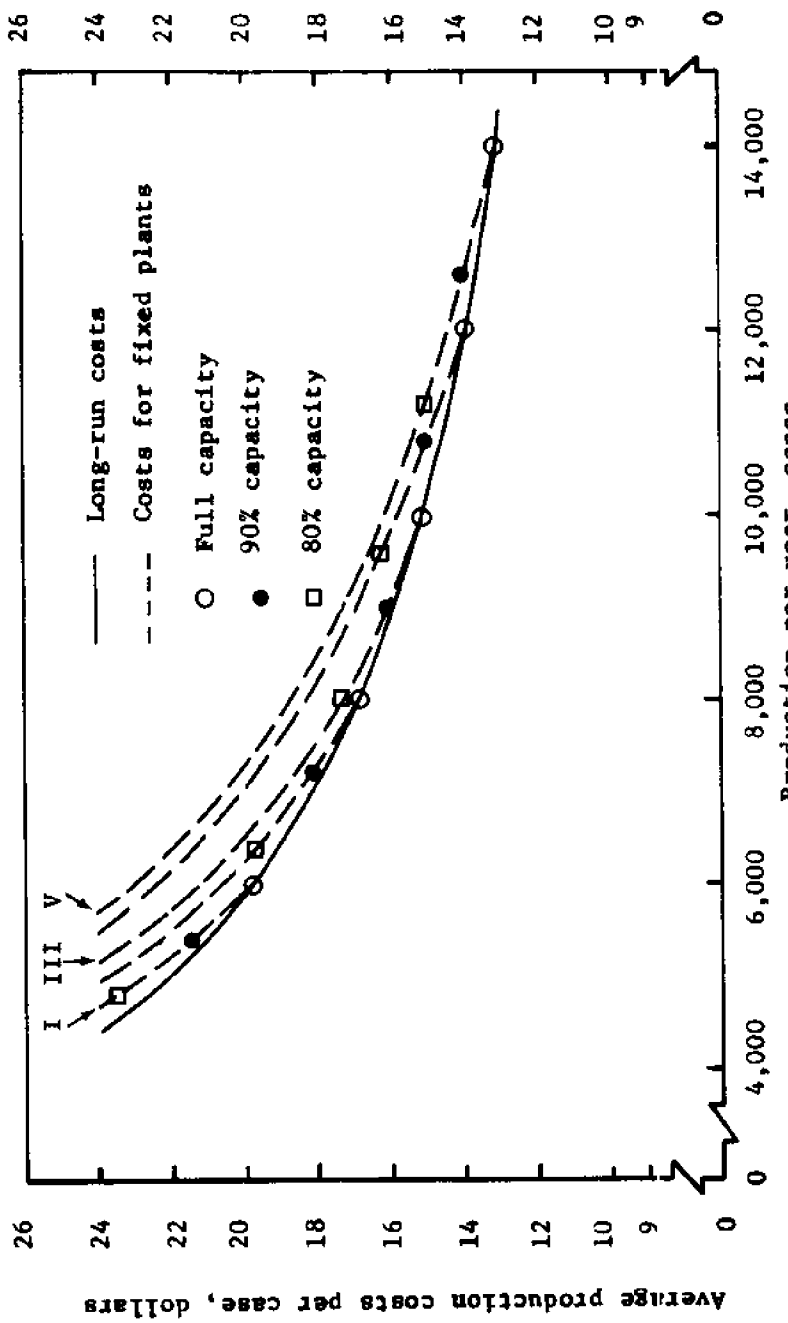



Figure 22. Relation of short-run to long-run average production costs associated with new building in Option 5 for Plants I to V.

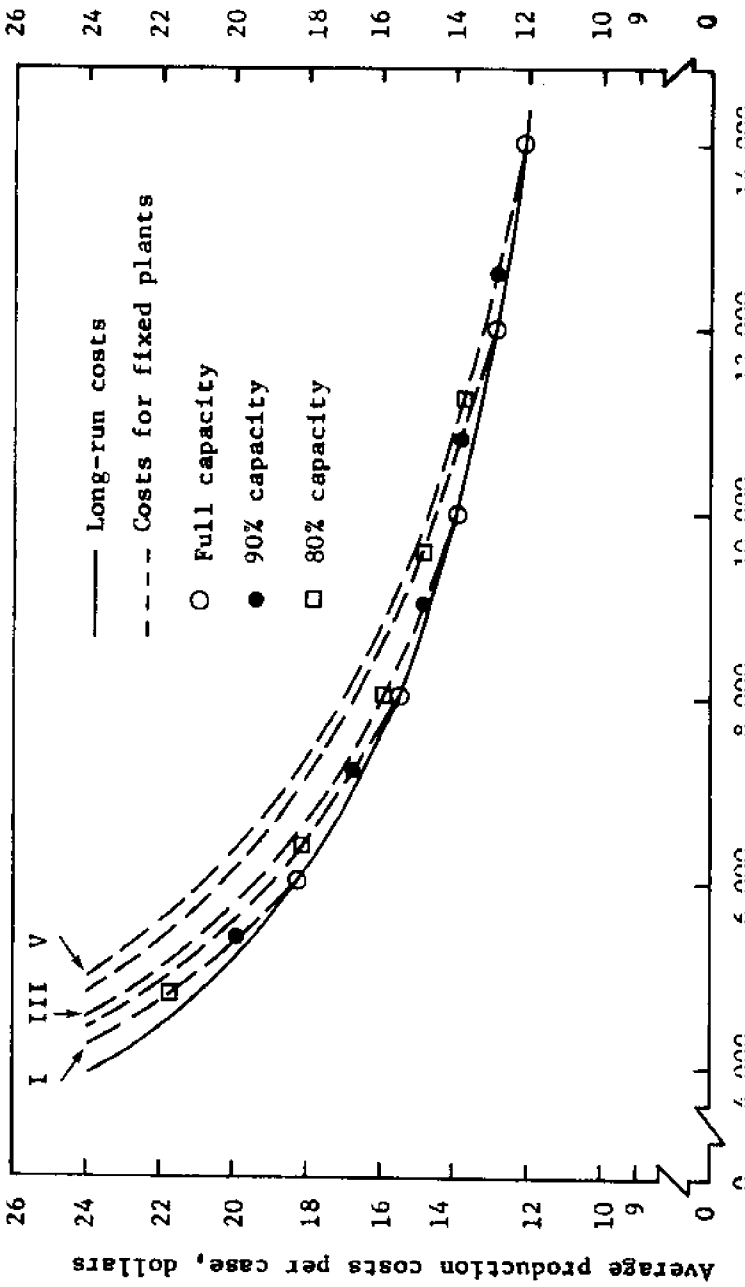



Figure 23. Relation of short-run to long-run average production costs associated with used building in Option 5 for Plants I to V.

each successive plant has a lower average cost per case when it operates at its planned capacity.

Figures 24 and 25 show the long-run average production cost curves under different options. Option 1 has the lowest average costs, and Option 2 has the second lowest, compared with other options, and Option 5 has the highest average costs.

## SUMMARY AND CONCLUSIONS

This study analyzes the economic feasibility of producing Pacific oyster seed in the Pacific Northwest. Economic feasibility exists when there are positive total receipts after deducting all costs incurred in the production of oyster seed. Plant models with 5 different capacities (Plants I through V) were designed and analyzed. Two different building cost estimations were made for each plant, based on an estimate of $25 per square foot for a new building and $10 equivalent per square foot for a used building. Each plant capacity has 10 different cost figures, 5 for a new building and 5 for a used building, based on options for cultch preparation. Total costs, average costs, total receipts, net returns, and accumulated net returns for each option and plant were analyzed, both month by month and on an annual basis. This was done to indicate how much gain or loss occurs in each month, and the anticipated annual average costs and benefits. Variable factors affecting the cost of production were analyzed. Long-run average cost functions and the relationships between production costs and plant sizes were also analyzed.

Space requirements for Plant I to produce 6,000 cases of oyster seed per year were 5,770 square feet, while for Plant V, with a 14,000 case annual capacity, they were 8,955 square feet. Thus, a 133 percent increase in output capacity required only about a 55 percent increase in space. The main increase in space requirements was for larval rearing and algal food production.

Total initial investment costs for building and equipment were highest in Option 2 and lowest in Option 5, among all options for each plant. Total initial investment costs for each plant associated with a new building were almost double those associated with a used building, but the difference of average costs among these two types of building was about $1 to $1.50 per case. Of the total initial investment costs, about 51 to 78 percent was for buildings and 22 to 49 percent for equipment.

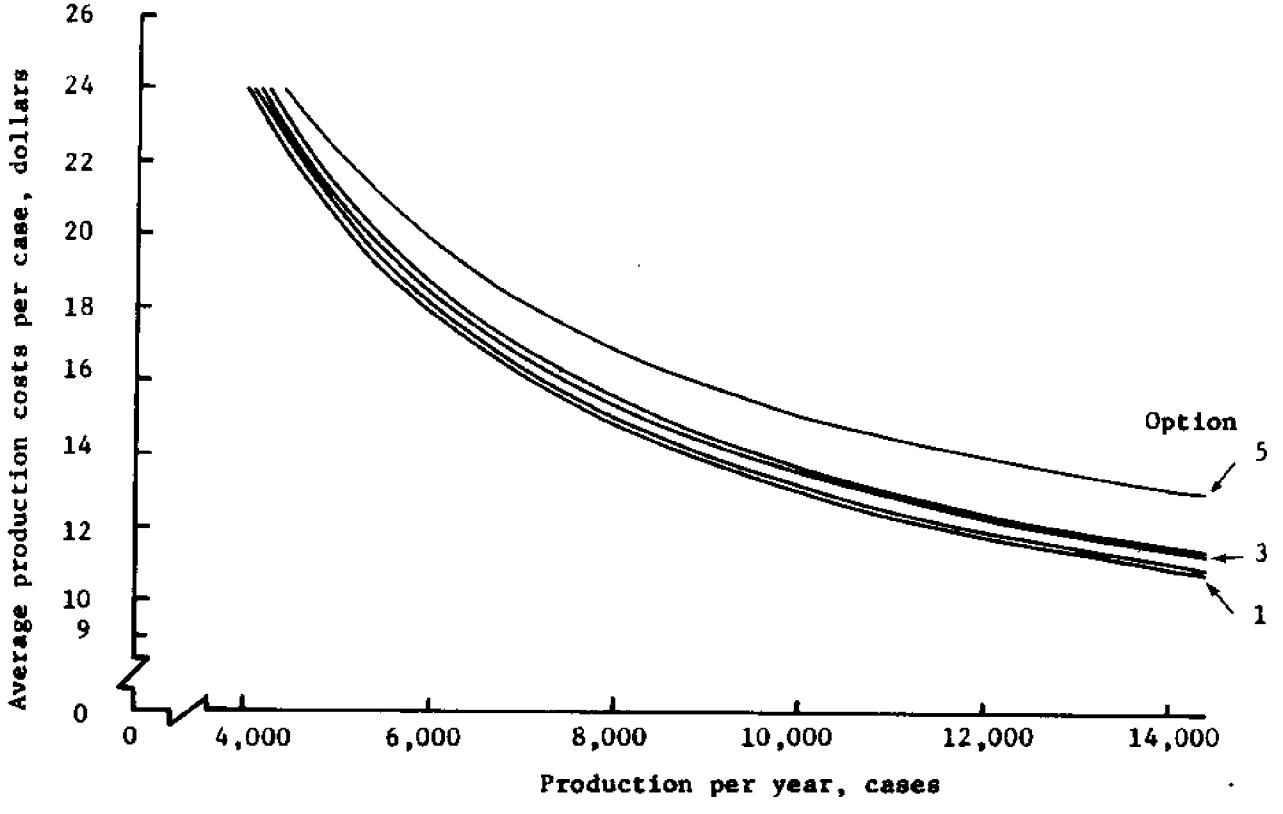



Figure 24. Long-run average production cost curves associated with new building under different options for Plants I to V.

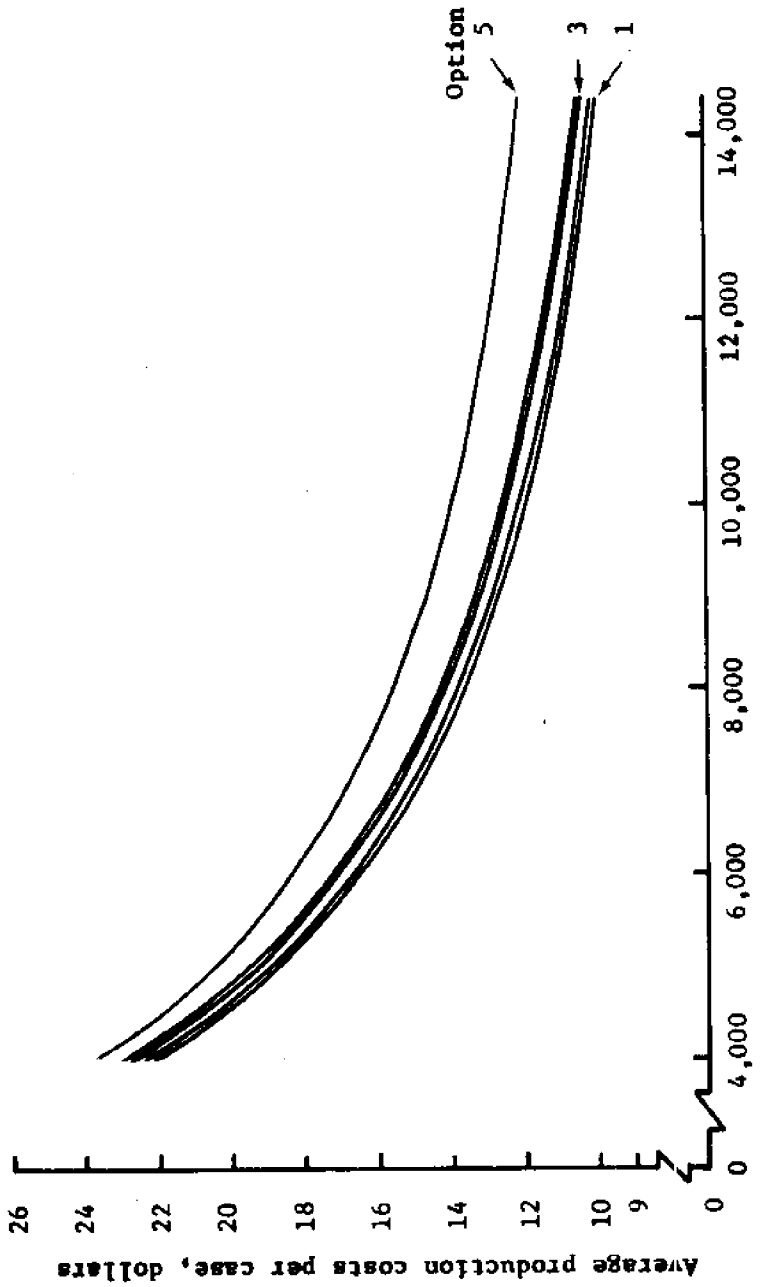



Figure 25. Long-run average production cost curves associated with used building under different options for Plants I to V.

The proportion of fixed costs to the total for Options 1 through 4 for the 5 plant capacities fell between 60 and 76 percent in case of a new building, and 57 to 73 percent for a used building. But, in Option 5, the proportion fell to the range of 52 to 67 percent for a new building, and 48 to 64 percent for a used building.

Labor costs, including supervision, administration, full-time and part-time labor were the major components affecting the cost of production among all plants, ranging from 39 to 50 percent of the total for Options 1 through 4 for a new building, and 43 to 55 percent for a used building. But, in Option 5, these proportions varied from 30 to 43 percent and 33 to 46 percent for those plants associated with a new building and a used building, respectively.

Utilities, materials, and supplies were the next major components affecting the cost of production, ranging from 19 to 29 percent of the total costs in Options 1 through 4 for a new building and all plant sizes, and 21 to 32 percent for a used building. But, in Option 5, these proportions varied from 31 to 43 percent and 33 to 46 percent for a new building and a used building, respectively.

Average costs varied with options, sizes of plant, and also with months of the year. During the winter months, average costs per case for Plant I were about $80 and $72 for each option associated with a new building and a used building, respectively. During the summer months, these costs for Plant I, for both new and used buildings, varied between $11 and $14, depending on options. These variations of average costs between summer and winter months narrowed with increased output capacities.

Annual average costs per case for Plant I, associated with a new building and a used building, ranged from $18.08 to $19.91 and $16.61 to $18.44, respectively, and those costs for Plant V ranged from $11.01 to $13.12 and from $10.03 to $12.14, respectively.

There is no difference in costs of cultch preparation between a new building and a used building. Average cultch preparation costs per case, for Plant I. ranged from $2.67 to $3.38, and for Plant V from $2.39 to $2.96, in Options 1 through 4. These costs decreased with increasing plant size, mainly because of

sliding scale charges of city water and power. Cultch preparation is an important item in terms of average costs per case. The proportion of total cost allocated to cultch preparation ranged from 15 to 18 percent for Plant I and 22 to 26 percent for Plant V for Options 1 through 4 within a new building. But, in Option 5 for these plants, the proportions were about 23 and 34 percent, respectively. These proportions associated with a used building were about 2 percent higher than those of a new building in each option and plant.

There were definite economies of size with successive increased plant capacity. As the plant capacity increased from 6,000 to 14,000 cases per year, average costs per case decreased from 35 to 40 percent for all options. In other words, the size of the plant has a significant effect on the cost of production. This study also indicated that further economies of size might exist for even larger plants.

Throughout this study the Option 1 method of cultch preparation is the most favorable in terms of cost saving, compared with other options, and Option 2 is the second most favorable; Option 5 is the least favorable.

Because the initial investment costs for a new building were rather high, this study suggests considering buying or operating an existing building, if possible; thereby the owner can make about $1 to $1.50 more net returns per case than if he invested in a new building.

Finally, this study concluded that producing Pacific oyster seed in the Pacific Northwest, within the limits addressed in this study, is economically feasible.

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## GLOSSARY OF TERMS AS USED IN OYSTER CULTURE

Algae (sing. alga): Single-celled microscopic marine plants that are planktonic and reproduce primarily by dividing.

Batch: The quantity produced at one cycle (from adult oyster to seed).

Bushel: 8 dry U.S. gallons or 1.245 cubic feet.

$CoCl_2 \cdot 6H_2O$: Cobaltous chloride, hexahydrate.

Conditioning: Process whereby glycogen in adult oyster is converted to gamete.

Cultch: Material used to collect oyster spat, usually oyster shell.

$Cu\ SO_4 \cdot 5H_2O$: Cupric sulfate, pentahydrate.

$FeCl_3 \cdot 6H_2O$: Ferric chloride, hexahydrate.

FeEDDHA: Sodium ferric ethylenediamine di-[o-hydroxyphenyl-acetate].

FeEDTA: Sodium ferric ethylenediamine terraacetate.

Fertilization: The union of the egg and sperm.

g: Gram; 1 g = 1,000 mg = .032 ounces.

$H_3BO_3$: Boric acid.

ℓ: Liter; 1 ℓ = 1,000 mℓ = 2.113 pints.

Larvae (sing. larva): Immature free-swimming stage of oyster development following fertilization of egg, but prior to metamorphosis to adult body form.

$MnCl_2 \cdot 4H_2O$: Manganese chloride, quadrahydrate.

$MnSO_4 \cdot H_2O$: Manganous sulfate, monohydrate.

Mollusk: One of a group of soft, unsegmented animals (clam, snail, octopus).

$Na_2EDTA$: Disodium ethylenediamine tetraacetate.

$Na_2GLY \cdot 6H_2O - \beta$: Glycerophosphoric acid, disodium salt.

$NaHCO_3$: Sodium bicarbonate.

$NaH_2PO_4 \cdot H_2O$: Sodium phosphate, monobasic.

$NaNO_3$: Sodium nitrate.

$NaMoO_4 \cdot 2H_2O$: Sodium molybdate, bihydrate.

PVC: Polyvinyl chloride.

Rearing: Maintenance of the free-swimming stage of the oyster.

Seed: A young oyster.

Setting: Process of the oyster larvae attaching to a substrata (cultch).

Spat: A newly settled or attached young oyster; a postlarval oyster.

Spawning: Eliciting sex products from adult oyster.

Sulmet: Sulfamethazine, antibiotic.

Tris: Amino [hydroxymethyl] propandiol.

μ: Micron; 1 μ = .001 millimeter.

Veliger: A larval mollusk in the stage when it has developed the velum.

Velum: The ciliated locomotor organ of the molluscan larvae.

$Zn\ SO_4 \cdot 7H_2O$: Zinc sulfate, heptahydrate.

# APPENDIX

Appendix Table I - 1. Monthly and Annual Total Costs and Costs Per Case for Plant 1

| Cultch preparation method | Option 1 | | | | | Option 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used..... | 100 | 400 | 600 | 800 | 6,000 | 100 | 400 | 600 | 800 | 6,000 |
| | dollars | | | | | dollars | | | | |
| Variable costs, new and used: | | | | | | | | | | |
| Part-time labor..... | 58 | 233 | 349 | 466 | 3,494 | 58 | 233 | 349 | 466 | 3,494 |
| Utilities, materials, & supplies..... | 1,001 | 1,573 | 1,927 | 2,260 | 20,729 | 972 | 1,558 | 1,922 | 2,265 | 20,613 |
| Variable repairs..... | 70 | 78 | 77 | 75 | 885 | 70 | 81 | 81 | 80 | 927 |
| Others..... | 56 | 94 | 118 | 140 | 1,256 | 55 | 94 | 118 | 141 | 1,252 |
| Total..... | 1,185 | 1,978 | 2,471 | 2,941 | 26,364 | 1,155 | 1,966 | 2,470 | 2,952 | 26,286 |
| Total fixed & variable, new..... | 8,028 | 8,821 | 9,314 | 9,784 | 138,483 | 8,067 | 8,878 | 9,383 | 9,864 | 109,233 |
| Total fixed & variable, used..... | 7,291 | 8,084 | 8,577 | 9,047 | 99,635 | 7,330 | 8,141 | 8,645 | 9,127 | 100,385 |
| Costs per case: | | | | | | | | | | |
| Fixed costs, new..... | 68.43 | 17.11 | 11.41 | 8.55 | 13.69 | 69.12 | 17.28 | 11.52 | 8.64 | 13.82 |
| Fixed costs, used..... | 61.06 | 15.26 | 10.17 | 7.63 | 12.22 | 61.75 | 15.44 | 10.29 | 7.72 | 12.35 |
| Variable costs, new & used..... | 11.85 | 4.95 | 4.12 | 3.68 | 4.39 | 11.55 | 4.91 | 4.12 | 3.69 | 4.38 |
| Total costs/case, new..... | 80.28 | 22.06 | 15.53 | 12.23 | 18.09 | 80.67 | 22.19 | 15.64 | 12.33 | 18.20 |
| Total costs/case, used..... | 72.91 | 20.21 | 14.29 | 11.31 | 16.61 | 73.30 | 20.35 | 14.41 | 11.41 | 16.73 |

| Cultch preparation method | Option 3 | | | | | Option 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used..... | 100 | 400 | 600 | 800 | 6,000 | 100 | 400 | 600 | 800 | 6,000 |
| | dollars | | | | | dollars | | | | |
| Variable costs, new and used: | | | | | | | | | | |
| Part-time labor..... | 58 | 233 | 349 | 466 | 3,494 | 58 | 233 | 349 | 466 | 3,494 |
| Utilities, materials, & supplies..... | 1,055 | 1,796 | 2,254 | 2,691 | 23,978 | 1,054 | 1,812 | 2,280 | 2,729 | 24,221 |
| Variable repairs..... | 69 | 77 | 76 | 73 | 871 | 70 | 80 | 80 | 78 | 913 |
| Others..... | 59 | 106 | 134 | 162 | 1,417 | 59 | 106 | 136 | 164 | 1,432 |
| Total..... | 1,241 | 2,212 | 2,813 | 3,392 | 29,760 | 1,241 | 2,231 | 2,845 | 3,437 | 30,070 |
| Total fixed & variable, new..... | 8,062 | 9,033 | 9,634 | 10,213 | 111,610 | 8,131 | 9,121 | 9,735 | 10,327 | 112,742 |
| Total fixed & variable, used..... | 7,325 | 8,295 | 8,897 | 9,475 | 102,763 | 7,394 | 8,384 | 8,998 | 9,590 | 103,901 |
| Costs per case: | | | | | | | | | | |
| Fixed costs, new..... | 68.21 | 17.05 | 11.37 | 8.53 | 13.64 | 68.90 | 17.22 | 11.48 | 8.61 | 13.78 |
| Fixed costs, used..... | 60.84 | 15.21 | 10.14 | 7.60 | 12.17 | 61.53 | 15.38 | 10.25 | 7.69 | 12.31 |
| Variable costs, new & used..... | 12.41 | 5.53 | 4.69 | 4.24 | 4.96 | 12.41 | 5.58 | 4.74 | 4.30 | 5.01 |
| Total costs/case, new..... | 80.62 | 22.58 | 16.06 | 12.77 | 18.60 | 81.31 | 22.80 | 16.22 | 12.91 | 18.79 |
| Total costs/case, used..... | 73.25 | 20.74 | 14.83 | 11.84 | 17.13 | 73.94 | 20.96 | 14.99 | 11.99 | 17.32 |

| Cultch preparation method | Option 5 | | | | |
|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used..... | 100 | 400 | 600 | 800 | 6,000 |
| | dollars | | | | |
| Variable costs, new and used: | | | | | |
| Part-time labor..... | — | — | — | — | — |
| Utilities, materials, & supplies..... | 1,244 | 2,650 | 3,559 | 4,449 | 36,990 |
| Variable repairs..... | 68 | 73 | 70 | 64 | 807 |
| Others..... | 66 | 136 | 181 | 226 | 1,890 |
| Total..... | 1,378 | 2,859 | 3,810 | 4,739 | 39,687 |
| Total fixed & variable, new..... | 8,026 | 9,509 | 10,459 | 11,387 | 119,467 |
| Total fixed & variable, used..... | 7,289 | 8,770 | 9,721 | 10,650 | 110,620 |
| Costs per case: | | | | | |
| Fixed costs, new..... | 66.48 | 16.62 | 11.08 | 8.31 | 13.30 |
| Fixed costs, used..... | 59.11 | 14.78 | 9.85 | 7.39 | 11.83 |
| Variable costs, new & used..... | 13.78 | 7.15 | 6.35 | 5.92 | 6.61 |
| Total costs/case, new..... | 80.26 | 21.77 | 17.43 | 14.23 | 19.91 |
| Total costs/case, used..... | 72.89 | 21.93 | 16.20 | 13.31 | 18.44 |

NOTE: "New" and "used" refer to the costs associated with a new building at $25 per square foot, and a used building at $10 equivalent per square foot, respectively.

Appendix Table 1 - 2. Monthly and Annual Total Costs and Costs Per Case for Plant II

| Cultch preparation method | Option 1 | | | | | Option 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used..... | 134 | 534 | 800 | 1,066 | 8,000 | 134 | 534 | 800 | 1,066 | 8,000 |
| | dollars | | | | | dollars | | | | |
| Variable costs, new and used: | | | | | | | | | | |
| Part-time labor..... | 78 | 311 | 466 | 621 | 4,659 | 78 | 311 | 466 | 621 | 4,659 |
| Utilities, materials, & supplies..... | 1,123 | 1,900 | 2,389 | 2,858 | 25,464 | 1,096 | 1,892 | 2,394 | 2,876 | 25,444 |
| Variable repairs..... | 70 | 81 | 81 | 80 | 926 | 71 | 84 | 87 | 88 | 962 |
| Others..... | 64 | 115 | 147 | 178 | 1,552 | 63 | 115 | 147 | 179 | 1,554 |
| Total..... | 1,335 | 2,407 | 3,083 | 3,737 | 32,601 | 1,308 | 2,402 | 3,094 | 3,764 | 32,639 |
| Total fixed & variable, new..... | 8,542 | 9,613 | 10,290 | 10,944 | 119,079 | 8,583 | 9,677 | 10,370 | 11,039 | 119,945 |
| Total fixed & variable, used..... | 7,690 | 8,761 | 9,438 | 10,092 | 108,855 | 7,731 | 8,825 | 9,518 | 10,187 | 109,721 |
| Costs per case: | | | | | | | | | | |
| Fixed costs, new..... | 53.78 | 13.50 | 9.01 | 6.76 | 10.81 | 54.29 | 13.62 | 9.09 | 6.83 | 10.91 |
| Fixed costs, used..... | 47.42 | 11.90 | 7.94 | 5.96 | 9.53 | 47.94 | 12.03 | 8.03 | 6.03 | 9.63 |
| Variable costs, new & used..... | 9.96 | 4.51 | 3.85 | 3.51 | 4.07 | 9.76 | 4.50 | 3.87 | 3.53 | 4.08 |
| Total costs/case, new..... | 63.74 | 18.01 | 12.86 | 10.27 | 14.88 | 64.05 | 18.12 | 12.96 | 10.36 | 14.99 |
| Total costs/case, used..... | 57.38 | 16.41 | 11.79 | 9.47 | 13.60 | 57.70 | 16.53 | 11.90 | 9.56 | 13.71 |

| Cultch preparation method | Option 3 | | | | | Option 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used..... | 134 | 534 | 800 | 1,066 | 8,000 | 134 | 534 | 800 | 1,066 | 8,000 |
| | dollars | | | | | dollars | | | | |
| Variable costs, new and used: | | | | | | | | | | |
| Part-time labor..... | 78 | 311 | 466 | 621 | 4,659 | 78 | 311 | 466 | 621 | 4,659 |
| Utilities, materials, & supplies..... | 1,200 | 2,193 | 2,820 | 3,402 | 29,646 | 1,202 | 2,216 | 2,858 | 3,454 | 30,009 |
| Variable repairs..... | 70 | 80 | 80 | 78 | 908 | 71 | 83 | 85 | 86 | 964 |
| Others..... | 68 | 129 | 168 | 205 | 1,761 | 67 | 131 | 170 | 208 | 1,782 |
| Total..... | 1,416 | 2,713 | 3,534 | 4,306 | 36,974 | 1,418 | 2,741 | 3,579 | 4,369 | 37,414 |
| Total fixed & variable, new..... | 8,600 | 9,897 | 10,718 | 11,490 | 123,183 | 8,671 | 9,994 | 10,832 | 11,622 | 124,451 |
| Total fixed & variable, used..... | 7,748 | 9,045 | 9,866 | 10,638 | 112,960 | 7,819 | 9,142 | 9,980 | 10,770 | 114,228 |
| Costs per case: | | | | | | | | | | |
| Fixed costs, new..... | 53.61 | 13.45 | 8.98 | 6.74 | 10.78 | 54.13 | 13.58 | 9.07 | 6.80 | 10.88 |
| Fixed costs, used..... | 47.25 | 11.86 | 7.91 | 5.94 | 9.50 | 47.77 | 11.99 | 8.00 | 6.00 | 9.60 |
| Variable costs, new & used..... | 10.57 | 5.08 | 4.42 | 4.04 | 4.62 | 10.58 | 5.13 | 4.47 | 4.10 | 4.68 |
| Total costs/case, new..... | 64.18 | 18.53 | 13.40 | 10.78 | 15.40 | 64.71 | 18.71 | 13.54 | 10.90 | 15.56 |
| Total costs/case, used..... | 57.82 | 16.94 | 12.33 | 9.98 | 14.12 | 58.35 | 17.12 | 12.47 | 10.10 | 14.28 |

| Cultch preparation method | Option 5 | | | | |
|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used..... | 134 | 534 | 800 | 1,066 | 8,000 |
| | dollars | | | | |
| Variable costs, new and used: | | | | | |
| Part-time labor..... | — | — | — | — | — |
| Utilities, materials, & supplies..... | 1,462 | 3,350 | 4,578 | 5,785 | 47,280 |
| Variable repairs..... | 68 | 74 | 71 | 87 | 822 |
| Others..... | 77 | 171 | 232 | 293 | 2,405 |
| Total..... | 1,607 | 3,595 | 4,881 | 6,145 | 50,507 |
| Total fixed & variable, new..... | 8,618 | 10,607 | 11,893 | 13,156 | 134,646 |
| Total fixed & variable, used..... | 7,767 | 9,755 | 11,041 | 12,304 | 124,423 |
| Costs per case: | | | | | |
| Fixed costs, new..... | 52.33 | 13.13 | 8.76 | 6.58 | 10.52 |
| Fixed costs, used..... | 45.97 | 11.53 | 7.70 | 5.78 | 9.24 |
| Variable costs, new & used..... | 11.99 | 6.73 | 6.10 | 5.76 | 6.31 |
| Total costs/case, new..... | 64.32 | 19.86 | 14.86 | 12.34 | 16.83 |
| Total costs/case, used..... | 57.96 | 18.26 | 13.80 | 11.54 | 15.55 |

NOTE: "New" and "used" refer to the costs associated with a new building at $25 per square foot, and a used building at $10 equivalent per square foot, respectively.

Appendix Table I - 1. Monthly and Annual Total Costs and Costs Per Case for Plant III

| Cultch preparation method | Option 1 | | | | | Option 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used | 166 | 666 | 1,000 | 1,334 | 10,000 | 166 | 666 | 1,000 | 1,334 | 10,000 |
| | dollars | | | | | dollars | | | | |
| Variable costs, new and used: | | | | | | | | | | |
| Part-time labor | 97 | 388 | 582 | 777 | 5,824 | 97 | 388 | 582 | 777 | 5,826 |
| Utilities, materials, & supplies | 1,243 | 2,224 | 2,852 | 3,460 | 30,203 | 1,217 | 2,223 | 2,867 | 3,491 | 30,279 |
| Variable repairs | 71 | 84 | 86 | 86 | 969 | 72 | 88 | 93 | 95 | 1,038 |
| Others | 70 | 135 | 176 | 216 | 1,850 | 69 | 135 | 177 | 218 | 1,857 |
| Total | 1,481 | 2,831 | 3,696 | 4,539 | 38,845 | 1,455 | 2,834 | 3,719 | 4,581 | 38,998 |
| Total fixed & variable, new | 8,972 | 10,322 | 11,188 | 12,031 | 128,742 | 9,016 | 10,394 | 11,279 | 12,141 | 129,723 |
| Total fixed & variable, used | 8,030 | 9,360 | 10,245 | 11,088 | 117,431 | 8,073 | 9,452 | 10,337 | 11,199 | 118,412 |
| Costs per case: | | | | | | | | | | |
| Fixed costs, new | 45.13 | 11.25 | 7.49 | 5.62 | 8.99 | 45.54 | 11.35 | 7.56 | 5.67 | 9.07 |
| Fixed costs, used | 39.45 | 9.83 | 6.55 | 4.91 | 7.86 | 39.87 | 9.94 | 6.62 | 4.96 | 7.94 |
| Variable costs, new & used | 8.92 | 4.25 | 3.70 | 3.40 | 3.88 | 8.77 | 4.26 | 3.72 | 3.43 | 3.90 |
| Total costs/case, new | 54.05 | 15.50 | 11.19 | 9.02 | 12.87 | 54.31 | 15.61 | 11.28 | 9.10 | 12.97 |
| Total costs/case, used | 48.37 | 14.08 | 10.25 | 8.31 | 11.74 | 48.64 | 14.20 | 10.34 | 8.39 | 11.84 |

| Cultch preparation method | Option 3 | | | | | Option 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used | 166 | 666 | 1,000 | 1,334 | 10,000 | 166 | 666 | 1,000 | 1,334 | 10,000 |
| | dollars | | | | | dollars | | | | |
| Variable costs, new and used: | | | | | | | | | | |
| Part-time labor | 97 | 388 | 582 | 777 | 5,824 | 97 | 388 | 582 | 777 | 5,824 |
| Utilities, materials, & supplies | 1,342 | 2,586 | 3,376 | 4,087 | 35,140 | 1,344 | 2,616 | 3,425 | 4,154 | 35,612 |
| Variable repairs | 70 | 82 | 84 | 83 | 945 | 72 | 87 | 90 | 92 | 1,014 |
| Others | 75 | 153 | 202 | 247 | 2,096 | 76 | 154 | 205 | 251 | 2,133 |
| Total | 1,584 | 3,209 | 4,244 | 5,194 | 44,005 | 1,589 | 3,245 | 4,302 | 5,274 | 44,583 |
| Total fixed & variable, new | 9,053 | 10,678 | 11,713 | 12,663 | 133,633 | 9,127 | 10,783 | 11,840 | 12,812 | 135,210 |
| Total fixed & variable, used | 8,111 | 9,735 | 10,771 | 11,721 | 122,323 | 8,184 | 9,841 | 10,898 | 11,870 | 123,720 |
| Costs per case: | | | | | | | | | | |
| Fixed costs, new | 44.99 | 11.21 | 7.47 | 5.60 | 8.96 | 45.41 | 11.32 | 7.54 | 5.65 | 9.04 |
| Fixed costs, used | 39.32 | 9.80 | 6.53 | 4.89 | 7.83 | 39.73 | 9.90 | 6.60 | 4.94 | 7.91 |
| Variable costs, new & used | 9.54 | 4.82 | 4.24 | 3.89 | 4.40 | 9.57 | 4.87 | 4.30 | 3.95 | 4.46 |
| Total costs/case, new | 54.53 | 16.03 | 11.71 | 9.49 | 13.36 | 54.98 | 16.19 | 11.84 | 9.60 | 13.50 |
| Total costs/case, used | 48.86 | 14.62 | 10.77 | 8.78 | 12.23 | 49.30 | 14.77 | 10.90 | 8.89 | 12.37 |

| Cultch preparation method | Option 5 | | | | |
|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used | 166 | 666 | 1,000 | 1,334 | 10,000 |
| | dollars | | | | |
| Variable costs, new and used: | | | | | |
| Part-time labor | — | — | — | — | — |
| Utilities, materials, & supplies | 1,670 | 4,041 | 5,596 | 7,132 | 57,574 |
| Variable repairs | 69 | 75 | 73 | 69 | 839 |
| Others | 87 | 206 | 283 | 360 | 2,921 |
| Total | 1,826 | 4,322 | 5,952 | 7,561 | 61,334 |
| Total fixed & variable, new | 9,123 | 11,618 | 13,249 | 14,857 | 143,892 |
| Total fixed & variable, used | 8,180 | 10,675 | 12,306 | 13,915 | 137,582 |
| Costs per case: | | | | | |
| Fixed costs, new | 43.95 | 10.96 | 7.30 | 5.42 | 8.76 |
| Fixed costs, used | 38.28 | 9.54 | 6.35 | 4.76 | 7.63 |
| Variable costs, new & used | 11.00 | 6.49 | 5.95 | 5.67 | 6.13 |
| Total costs/case, new | 54.95 | 17.45 | 13.25 | 11.14 | 14.89 |
| Total costs/case, used | 49.28 | 16.03 | 12.30 | 10.43 | 13.76 |

NOTE: "New" and "used" refer to the costs associated with a new building at $25 per square foot, and a used building at $10 equivalent per square foot, respectively.

Appendix Table 1 - 4. Monthly and Annual Total Costs and Costs Per Case for Plant IV

| Cultch preparation method | Option 1 | | | | | Option 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used | 200 | 800 | 1,200 | 1,600 | 12,000 | 200 | 800 | 1,200 | 1,600 | 12,000 |
| | dollars | | | | | dollars | | | | |
| Variable costs, new and used: | | | | | | | | | | |
| Part-time labor | 117 | 466 | 699 | 1,930 | 11,981 | 117 | 466 | 699 | 1,930 | 11,981 |
| Utilities, materials, & supplies | 1,388 | 2,573 | 3,328 | 4,062 | 35,091 | 1,363 | 2,578 | 3,351 | 4,106 | 35,262 |
| Variable repairs | 78 | 93 | 93 | 92 | 1,051 | 80 | 99 | 102 | 103 | 1,135 |
| Others | 79 | 157 | 206 | 304 | 2,406 | 78 | 157 | 208 | 307 | 2,419 |
| Total | 1,662 | 3,289 | 4,326 | 6,388 | 50,529 | 1,638 | 3,300 | 4,360 | 6,446 | 50,797 |
| Total fixed & variable, new | 9,457 | 11,084 | 12,121 | 14,184 | 144,072 | 9,502 | 11,164 | 12,224 | 14,310 | 145,168 |
| Total fixed & variable, used | 8,416 | 10,043 | 11,080 | 13,143 | 131,579 | 8,461 | 10,123 | 11,183 | 13,269 | 132,675 |
| Costs per case: | | | | | | | | | | |
| Fixed costs, new | 38.93 | 9.74 | 6.50 | 4.87 | 7.80 | 39.32 | 9.83 | 6.55 | 4.92 | 7.86 |
| Fixed costs, used | 33.77 | 8.44 | 5.63 | 4.22 | 6.76 | 34.12 | 8.53 | 5.69 | 4.26 | 6.82 |
| Variable costs, new & used | 8.31 | 4.11 | 3.60 | 3.99 | 4.21 | 8.19 | 4.13 | 3.63 | 4.03 | 4.23 |
| Total costs/case, new | 47.29 | 13.85 | 10.10 | 8.86 | 12.01 | 47.51 | 13.96 | 10.18 | 8.95 | 12.09 |
| Total costs/case, used | 42.08 | 12.55 | 9.23 | 8.21 | 10.97 | 42.31 | 12.66 | 9.32 | 8.29 | 11.05 |

| Cultch preparation method | Option 3 | | | | | Option 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used | 200 | 800 | 1,200 | 1,600 | 12,000 | 200 | 800 | 1,200 | 1,600 | 12,000 |
| | dollars | | | | | dollars | | | | |
| Variable costs, new and used: | | | | | | | | | | |
| Part-time labor | 117 | 466 | 699 | 1,930 | 11,981 | 117 | 466 | 699 | 1,930 | 11,981 |
| Utilities, materials, & supplies | 1,507 | 3,004 | 3,913 | 4,771 | 40,714 | 1,512 | 3,042 | 3,972 | 4,852 | 41,295 |
| Variable repairs | 78 | 92 | 90 | 88 | 1,024 | 79 | 97 | 99 | 99 | 1,107 |
| Others | 85 | 178 | 235 | 340 | 2,686 | 85 | 180 | 239 | 344 | 2,719 |
| Total | 1,787 | 3,740 | 4,937 | 7,129 | 56,405 | 1,793 | 3,785 | 5,009 | 7,225 | 57,102 |
| Total fixed & variable, new | 9,559 | 11,513 | 12,710 | 14,902 | 149,678 | 9,635 | 11,627 | 12,850 | 15,067 | 151,203 |
| Total fixed & variable, used | 8,518 | 10,472 | 11,669 | 13,861 | 137,185 | 8,594 | 10,586 | 11,809 | 14,026 | 138,710 |
| Costs per case: | | | | | | | | | | |
| Fixed costs, new | 38.86 | 9.72 | 6.48 | 4.86 | 7.77 | 39.21 | 9.80 | 6.53 | 4.90 | 7.84 |
| Fixed costs, used | 33.66 | 8.41 | 5.61 | 4.21 | 6.73 | 34.00 | 8.50 | 5.67 | 4.25 | 6.80 |
| Variable costs, new & used | 8.93 | 4.67 | 4.11 | 4.46 | 4.70 | 8.96 | 4.73 | 4.17 | 4.52 | 4.76 |
| Total costs/case, new | 47.79 | 14.39 | 10.59 | 9.32 | 12.47 | 48.17 | 14.53 | 10.70 | 9.42 | 12.60 |
| Total costs/case, used | 42.59 | 13.08 | 9.72 | 8.67 | 11.43 | 42.96 | 13.23 | 9.84 | 8.77 | 11.56 |

| Cultch preparation method | Option 5 | | | | |
|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used | 200 | 800 | 1,200 | 1,600 | 12,000 |
| | dollars | | | | |
| Variable costs, new and used: | | | | | |
| Part-time labor | — | — | — | 998 | 4,992 |
| Utilities, materials, & supplies | 1,909 | 4,762 | 6,627 | 8,472 | 68,012 |
| Variable repairs | 76 | 83 | 78 | 71 | 896 |
| Others | 99 | 242 | 335 | 477 | 3,695 |
| Total | 2,084 | 5,087 | 7,040 | 10,018 | 77,595 |
| Total fixed & variable, new | 9,684 | 12,687 | 14,640 | 17,618 | 168,798 |
| Total fixed & variable, used | 8,643 | 11,646 | 13,599 | 16,577 | 156,305 |
| Costs per case: | | | | | |
| Fixed costs, new | 38.00 | 9.50 | 6.33 | 4.75 | 7.60 |
| Fixed costs, used | 32.80 | 8.20 | 5.47 | 4.10 | 6.56 |
| Variable costs, new & used | 10.42 | 6.36 | 5.87 | 6.26 | 6.47 |
| Total costs/case, new | 48.42 | 15.86 | 12.20 | 11.01 | 14.07 |
| Total costs/case, used | 43.22 | 14.56 | 11.34 | 10.36 | 13.03 |

NOTE: "New" and "used" refer to the costs associated with a new building at $25 per square foot, and a used building at $10 equivalent per square foot, respectively.

Appendix Table 1 - 5. Monthly and Annual Total Costs and Costs Per Case for Plant V

| Cultch preparation method | Option 1 | | | | | Option 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used | 234 | 934 | 1,400 | 1,866 | 14,000 | 234 | 934 | 1,400 | 1,866 | 14,000 |
| | dollars | | | | | dollars | | | | |
| Variable costs, new and used: | | | | | | | | | | |
| Part-time labor | 136 | 544 | 815 | 2,085 | 13,146 | 136 | 544 | 815 | 2,085 | 13,146 |
| Utilities, materials, & supplies | 1,511 | 2,991 | 3,790 | 4,661 | 39,826 | 1,488 | 2,912 | 3,824 | 4,717 | 40,094 |
| Variable repairs | 79 | 96 | 98 | 97 | 1,093 | 81 | 102 | 107 | 110 | 1,194 |
| Others | 86 | 177 | 235 | 342 | 2,703 | 85 | 178 | 237 | 346 | 2,722 |
| Total | 1,812 | 3,718 | 4,938 | 7,185 | 56,768 | 1,790 | 3,736 | 4,983 | 7,258 | 57,153 |
| Total fixed & variable, new | 9,936 | 11,842 | 13,063 | 15,310 | 154,263 | 9,984 | 11,930 | 13,177 | 15,451 | 155,676 |
| Total fixed & variable, used | 8,792 | 10,698 | 11,919 | 14,166 | 140,533 | 8,840 | 10,786 | 12,033 | 14,307 | 141,746 |
| Costs per case: | | | | | | | | | | |
| Fixed costs, new | 34.72 | 8.70 | 5.80 | 4.35 | 6.96 | 35.02 | 8.77 | 5.85 | 4.39 | 7.07 |
| Fixed costs, used | 29.83 | 7.47 | 4.99 | 3.74 | 5.98 | 30.13 | 7.55 | 5.04 | 3.78 | 6.04 |
| Variable costs, new & used | 7.74 | 3.98 | 3.53 | 3.85 | 4.05 | 7.65 | 4.00 | 3.56 | 3.89 | 4.08 |
| Total costs/case, new | 42.46 | 12.68 | 9.33 | 8.20 | 11.01 | 42.67 | 12.77 | 9.41 | 8.28 | 11.10 |
| Total costs/case, used | 37.57 | 11.45 | 8.52 | 7.59 | 10.03 | 37.78 | 11.55 | 8.60 | 7.67 | 10.12 |

| Cultch preparation method | Option 3 | | | | | Option 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used | 234 | 934 | 1,400 | 1,866 | 14,000 | 234 | 934 | 1,400 | 1,866 | 14,000 |
| | dollars | | | | | dollars | | | | |
| Variable costs, new and used: | | | | | | | | | | |
| Part-time labor | 136 | 544 | 815 | 2,085 | 13,146 | 136 | 544 | 815 | 2,085 | 13,146 |
| Utilities, materials, & supplies | 1,648 | 3,401 | 4,438 | 5,451 | 46,122 | 1,654 | 3,446 | 4,508 | 5,547 | 46,813 |
| Variable repairs | 79 | 94 | 94 | 93 | 1,061 | 80 | 100 | 104 | 106 | 1,159 |
| Others | 93 | 202 | 267 | 382 | 3,016 | 94 | 205 | 271 | 387 | 3,055 |
| Total | 1,956 | 4,241 | 5,614 | 8,011 | 63,345 | 1,964 | 4,295 | 5,698 | 8,125 | 64,173 |
| Total fixed & variable, new | 10,058 | 12,343 | 13,716 | 16,113 | 160,571 | 10,135 | 12,466 | 13,870 | 16,296 | 167,227 |
| Total fixed & variable, used | 8,914 | 11,199 | 12,572 | 14,969 | 146,842 | 8,991 | 11,322 | 12,725 | 15,152 | 148,708 |
| Costs per case: | | | | | | | | | | |
| Fixed costs, new | 34.62 | 8.67 | 5.79 | 4.34 | 6.94 | 34.92 | 8.75 | 5.84 | 4.38 | 7.00 |
| Fixed costs, used | 29.74 | 7.45 | 4.97 | 3.73 | 5.96 | 30.03 | 7.52 | 5.02 | 3.77 | 6.02 |
| Variable costs, new & used | 8.36 | 4.54 | 4.01 | 4.29 | 4.53 | 8.39 | 4.60 | 4.07 | 4.35 | 4.58 |
| Total costs/case, new | 42.98 | 13.21 | 9.80 | 8.63 | 11.47 | 43.31 | 13.35 | 9.91 | 8.73 | 11.58 |
| Total costs/case, used | 38.10 | 11.99 | 8.98 | 8.02 | 10.49 | 38.42 | 12.12 | 9.09 | 8.12 | 10.60 |

| Cultch preparation method | Option 5 | | | | |
|---|---|---|---|---|---|
| Cost of each month by season | Winter (Oct-Jan) | Late winter (Feb) | Spring (Mar-Apr) | Summer (May-Sept) | Annual total |
| Production (cases), new and used | 234 | 934 | 1,400 | 1,866 | 14,000 |
| | dollars | | | | |
| Variable costs, new and used: | | | | | |
| Part-time labor | — | — | — | 998 | 4,992 |
| Utilities, materials, & supplies | 2,127 | 5,461 | 7,645 | 9,809 | 78,301 |
| Variable repairs | 76 | 84 | 79 | 73 | 912 |
| Others | 110 | 277 | 386 | 544 | 4,210 |
| Total | 2,313 | 5,822 | 8,110 | 11,424 | 88,415 |
| Total fixed & variable, new | 10,242 | 13,752 | 16,040 | 19,354 | 183,571 |
| Total fixed & variable, used | 9,098 | 12,608 | 14,896 | 18,210 | 169,842 |
| Costs per case: | | | | | |
| Fixed costs, new | 33.89 | 8.49 | 5.66 | 4.25 | 6.80 |
| Fixed costs, used | 29.00 | 7.26 | 4.85 | 3.64 | 5.82 |
| Variable costs, new & used | 9.88 | 6.23 | 5.79 | 6.12 | 6.32 |
| Total costs/case, new | 43.77 | 14.72 | 11.45 | 10.37 | 13.12 |
| Total costs/case, used | 38.88 | 13.49 | 10.64 | 9.76 | 12.14 |

NOTE: "New" and "used" refer to the costs associated with a new building at $25 per square foot, and a used building at $10 equivalent per square foot, respectively.