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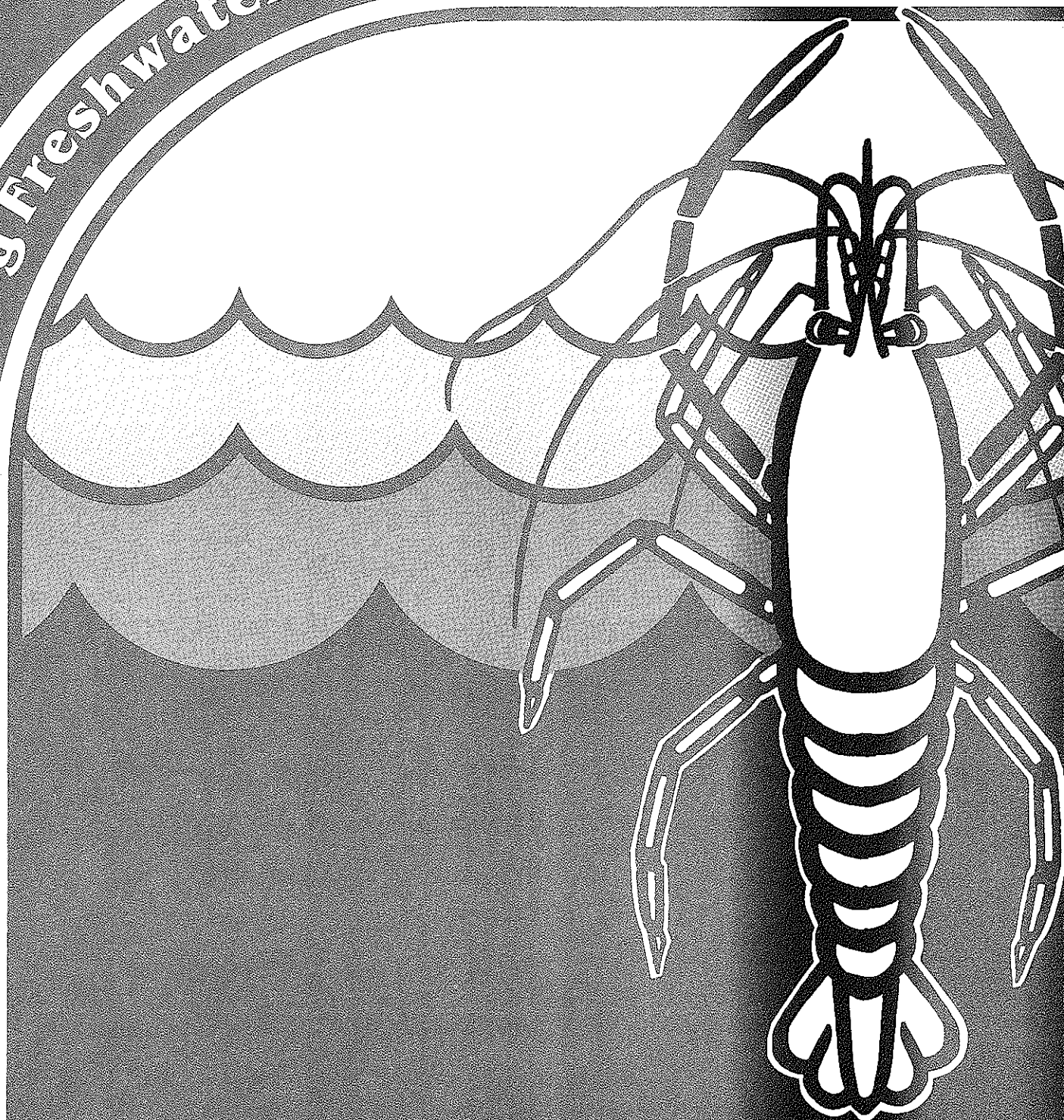
Costs of Processing & Hauling Freshwater Shrimp in Mississippi



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Costs of Processing and Hauling Freshwater Shrimp in Mississippi

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Table of Contents

List of Tables

List of Figures

List of Appendix Tables

Cost of Processing and Hauling Freshwater Shrimp in Mississippi

Introduction

The interest of researchers and farmers in Mississippi and throughout the Southern Region of the United States concerning the economic feasibility of producing and marketing freshwater shrimp continues to grow. From 1984 to 1985, landings of marine shrimp in the United States increased by 31.9 million pounds to a total of 333 million pounds [13]. It is believed that these landings may have reached a peak [10, 11], due in part to loss of vital estuaries and declining water quality.

The United States imports more than 50 percent of its marine shrimp supply [13]. With the consumption of shrimp growing in other developed nations in conjunction with a leveling off of world wide landings of marine shrimp, any increases in the supply of shrimp in the Unites States will come only through cultured species—either imported or produced domestically.

Recent experiments by Mississippi Agricultural and Forestry Experiment Station (MAFES) scientists concerning production of fresh-water shrimp (*Macrobrachium rosenbergii*) in small ponds have been encouraging. These experiments are being continued with the objective of developing techniques that will result in profitable production systems. However, regardless of production regime, adequately assessing the market potential for freshwater shrimp requires knowledge about the total cost for freshwater shrimp at the retail level. Since assembling and processing costs may comprise a significant portion of that total cost, a reliable estimate of assembly and processing costs must be obtained before the economic feasibility of producing and marketing freshwater shrimp can be assessed.

Objectives

The general objective of this study was to estimate costs for assembling and processing freshwater shrimp. More specific objectives were to:

1. Synthesize an efficient processing plant capable of assembling, processing, and storing an assumed quantity of freshwater shrimp;
2. Define plant processing procedure in terms of distinct phases of operation and identify all equipment and labor needs for each phase;
3. Estimate total investment, annual ownership, and annual operating costs for the synthesized plant under selected capacities; and
4. Identify feasible methods of transporting shrimp an assumed distance from farms to the processing plant, and estimate transport costs.

Methods and Procedures

Objective 1 was begun by assuming a quantity of shrimp to be processed by the plant. The assumed quantity was based on a daily processing capacity that is within the range of existing Gulf Coast plants. The synthesized plant would have a capability of processing in a 2-month period the quantity of freshwater shrimp that would be produced from 1,000 acres of ponds, assuming an average yield of 1,500 pounds (live weight) per acre.

The technology assumed is the most efficient technology currently available for processing shrimp into the green headless frozen form. Possible alternative technologies were not investigated. The synthesized plant was then divided into phases of operation.

In Objective 2, equipment requirements of each phase and equipment prices (with a few exceptions) were provided by appropriate suppliers. Other prices were obtained from published sources [4]. Building costs were obtained from personal interviews with building manufacturers and contractors. Land costs were obtained from a Mississippi Cooperative Extension Service specialist located on the Mississippi Gulf Coast. Labor requirements were obtained from interviews with processors, manufacturers' specifications, and some limited time-motion studies performed by MAFES researchers during the processing of the 1985 experimental crop.

Only one size of plant was synthesized; however, two levels of operating capacity were assumed. First, it was assumed that the plant would process marine shrimp for 7 months and freshwater shrimp for 2 months, resulting in a 9-month operation (Scenario I). Operating hours per month assumed for each of the 7 months of processing marine shrimp were based on

5-year average monthly landings of northern gulf marine shrimp (Appendix Table 1). Second, it was assumed that the plant would process only freshwater shrimp, and consequently, would operate only for 2 months of the year (Scenario II). The data obtained for satisfying Objectives 1 and 2 were also used to derive annual ownership and operating costs for both plant scenarios in Objective 3.

In Objective 4, costs for hauling shrimp from production ponds to the processing plant were estimated for two methods of hauling: iced in refrigerated trucks, and live-hauling. Costs of live-hauling shrimp were derived from an earlier study of live-hauling catfish [7]. Costs of hauling in refrigerated trucks were based on data obtained from shrimp processors, and on truck costs associated with live-hauling. The quantity of live shrimp per load in live-haul trucks was based on a preliminary density test conducted during the harvest of the 1985 MAFES crop.

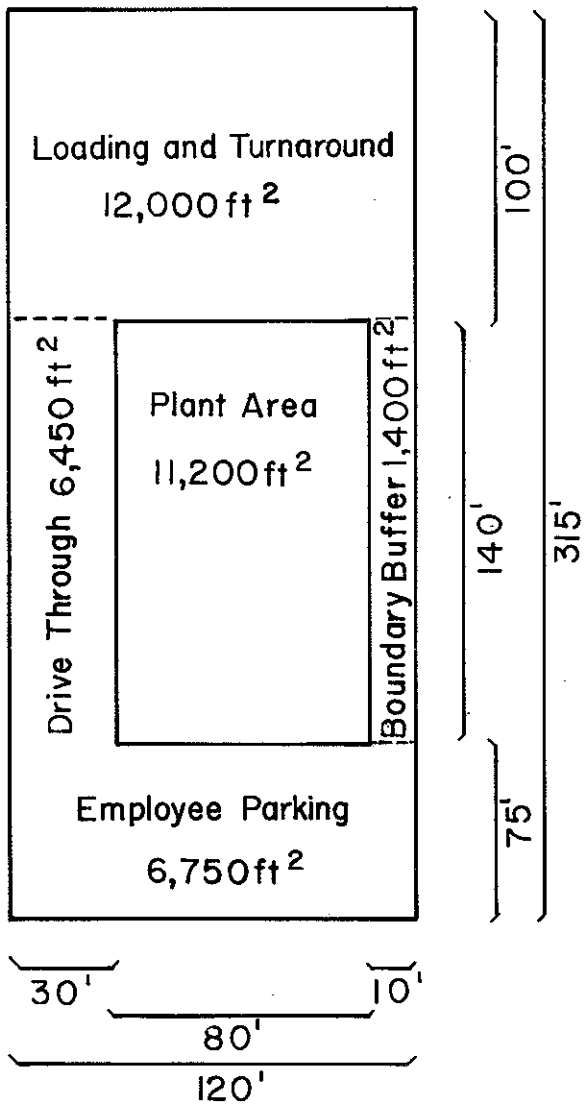

Figure 1. Schematic of real estate requirements for the model plants.

Model Plant Facilities and Equipment

All land, building, and equipment requirements necessary for processing green headless shrimp are presented in this section, by phases of operation. The synthesized model plant has the capacity to process 2,505,600 pounds of headless shrimp in 9 months (Scenario I) or 691,200 pounds of headless shrimp in 2 months (Scenario II). During the peak of processing, plant capacity was based on 10 hours per day, 6 days per week. Scenario I assumes processing at capacity during June-October only. No processing would be done during January-March. For other months, processing at the following percentages of capacity is assumed: May and November, 75; December, 50; and April, 25. Under Scenario II it was assumed that the plant operates at capacity during the 2 months September and October, and would process no shrimp during the other 10 months.

Real Estate

The most important locational factors for a processing plant under Scenario I are proximity to the Gulf and accessibility by truck and shrimp boat. Therefore, waterfront property, on a bay or inlet with a pier, is required. The processing plant requires a waterfront of 120 feet, with total required space of 37,800 square feet, as illustrated in Figure 1. Land costs for this area with waterfront averaged $1,000 per front foot for lots of this general size [15].

A plant processing only freshwater shrimp (Scenario II) would not require waterfront property. Average cost of land in the same general area, but not waterfront property, was estimated to be $30,000 an acre [15].

Land requirements for both scenarios included space for the turn-around and unloading area, employee parking, drive-through, and 10-foot spacing between plant and property line. The plant site needs to be accessible by a public paved road and be served by electricity, water, and sewage. To meet the requirements for reduced insurance rates, the plant should be located within city limits, or in an area served by a fire department, and be accessed by a paved road.

Building Requirements

Several factors were important in determining the cost of a modern shrimp processing plant, with the type of building and topography of the land being

significant factors. The synthesized plant in this study was assumed to be constructed on level ground built up an additional 5 feet higher than its original base of 10 feet above sea level [15].

The construction of the building consisted of an inner masonry wall surrounding the processing floor with an exterior of metal siding reinforced by steel beams placed every 20 feet. The concrete slab floor required a depth of 6 inches due to the weight of equipment.

The plant's floor plan was based upon what was considered necessary to adequately house the required equipment as defined by equipment dimensions, space for working labor, and walkways. The "required equipment" was determined from the desired daily and annual processing capacity of the plant. Average construction costs for the building, including the slab, masonry, plumbing, electrical, etc., were estimated to be $28 per square foot [12]. A schematic showing the processing area layout of equipment and dimensions is presented in Figure 2.

Waste Treatment

The method of effluent disposal utilized was based upon the most common method employed by marine shrimp processors along the Mississippi Gulf Coast [15]. It was assumed that liquid or dissolved effluents that meet state requirements would be piped back into the bay.

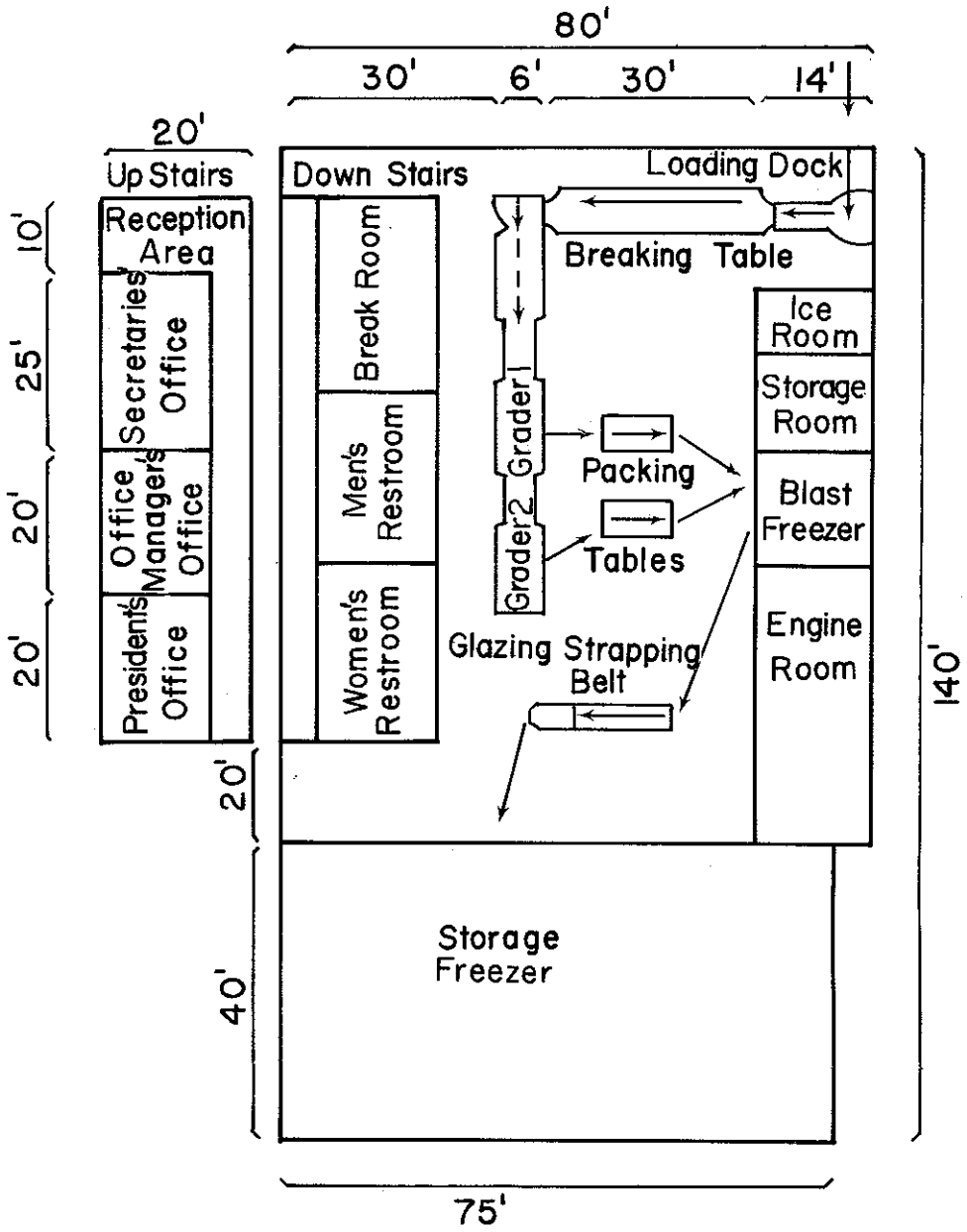

Figure 2. Schematic of the model plant with product flow.

Solid effluent wastes, consisting mostly of broken heads and discarded shells, would be collected in perforated baskets and screened drains. The collected solid effluent (approximately 16,000 pounds per day) would be placed in daily collectable dumpsters. The daily collection rate, at the time of this study, was $28 per loaded dumpster, while the rent for the dumpsters was $75 per month [3].

Parking and Loading

Requirements for parking and loading space were estimated to be .43 acre. This estimate was based on 270 square feet required parking space for every two employees and 12,000 square feet for the loading and unloading of trucks [4]. Space requirements for parking and loading are displayed in Table 1.

Processing Equipment

Equipment costs include all equipment necessary to process green headless shrimp. Each piece of equipment is categorized by phase in the processing cycle. The various phases of the cycle are: (1) receiving; (2) breaking; (3) grading; (4) packing; (5) blast freezing; (6) glazing; and (7) storage freezing. All equipment comprising the plant's processing technology is included in Appendix Table 2.

Receiving

There are few equipment requirements for the receiving phase. Since the shrimp are delivered to the plant in wooden crates aboard refrigerated trucks, a forklift is necessary for crate transfer from the trucks onto the loading dock. (The shrimping industry typically trades unprocessed shrimp by the "barrel," which contains 210 pounds of shrimp and 100 pounds of ice. The contents of two wooden crates make a "barrel" when each crate contains 105 pounds of shrimp and 50 pounds of ice.) The forklift, which is also used inside the plant, was assumed to be electric. After the crates are unloaded from the truck, the shrimp are removed by hand from the crates into an automated wash receiving/tank.

This particular receiving tank consists of an automatic float system, adjustable overhead freshwater spray system, ice baffle, volume control paddle, and a conveyor belted overflow drain for the regulated delivery of the product to the breaking table [8]. An illustration of the receiving tank is shown in Figure 3.

Table 1. Estimated land requirements for a synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Facility Area	Amount
	(sq. ft.)
Building	11,200
Turnaround and unloading[a]	12,000
Parking	6,750
30-foot drive-through	6,450
Miscellaneous[b]	1,400
Total land	37,800

[a] Includes parking for trucks.
[b] Consists of area around building for buffer.

Breaking

Breaking, or the removal of the shrimp heads, is performed by hand as "breakers" pick the shrimp off of an open stainless steel transporting belt and separate the head from the tail. The remaining tail portions of the shrimp are placed into a free-flowing flume trough. The flume, which is located on both sides of the transport belt, discharges the tails into another ice baffled receiving tank. The breakers, who are positioned on a platform on both sides of the flume breaking table, place the removed heads into stainless steel funnels. These discarded heads are removed, weighed, and discharged into dumpsters.

It was assumed that 32 experienced head breakers together could break an average of 1,500 pounds of tails per hour. This assumption is based on interviews of plant managers and verified by time-motion studies conducted by MAFES scientists (see Appendix Table 10). All exposed metal portions of the flume system are of stainless steel. A diagram of the flume breaking system is provided in Figure 4.

Grading

The shrimp tails are placed into the flowing flume and deposited into another automated ice baffle, rinsed, and transported to the grading machine conveyor belts. These elevated conveyor belts carry the shrimp tails to the mechanical graders where they are dropped into the water-lubricated, fully adjustable grading rollers [8]. The graders sort shrimp according to a preset size category and deposit the shrimp tails down side shoots into perforated plastic baskets. Thus, each basket contains only shrimp tails within a narrowly defined size range. A diagram of one of the two graders required in the model plant's grading system is presented in Figure 5.

Packing

The packing phase of the synthesized processing plant is also accomplished by hand labor. The sized shrimp tails are carried in perforated baskets from the grader to one of three stainless steel packing tables. Each table is 4 feet by 8 feet in dimension with two electronic scales at one end. The shrimp are weighed according to size count, and placed 5 pounds per properly labeled box. These polyethylene

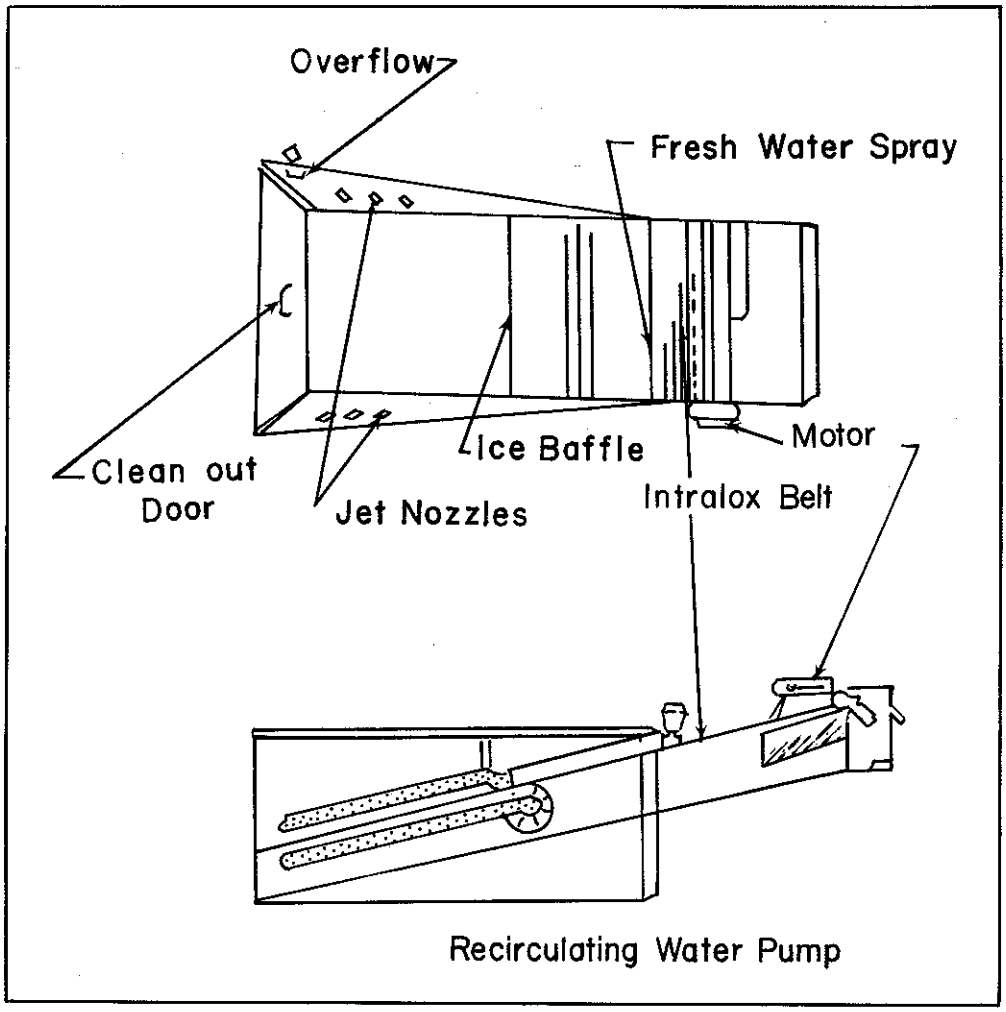

Figure 3. An illustration of the wash/receiving tank.

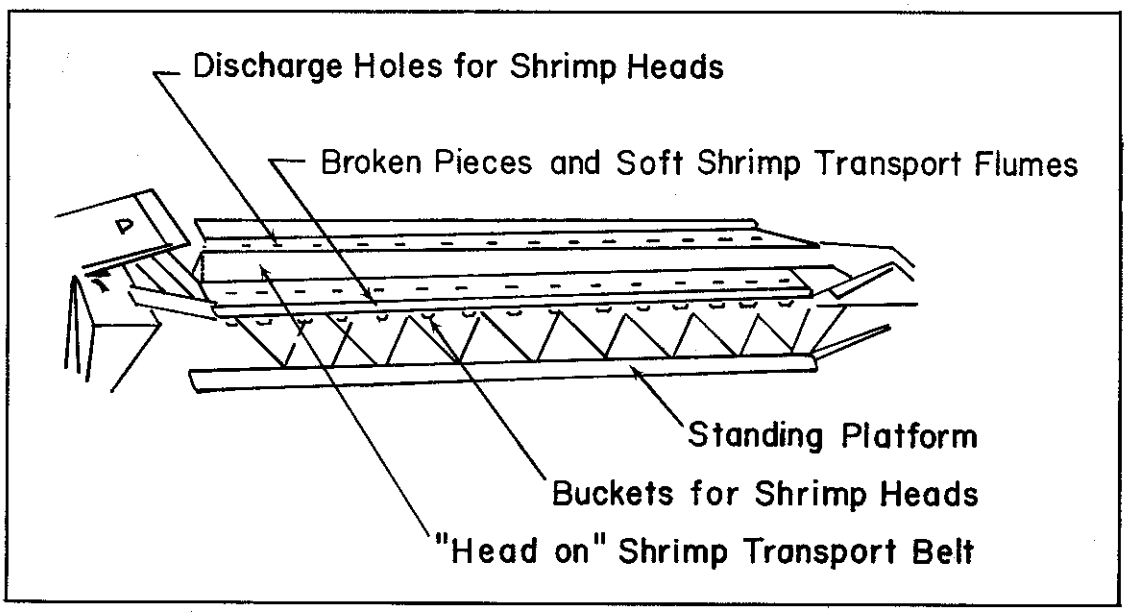

Figure 4. An illustration of the flume breaking table.

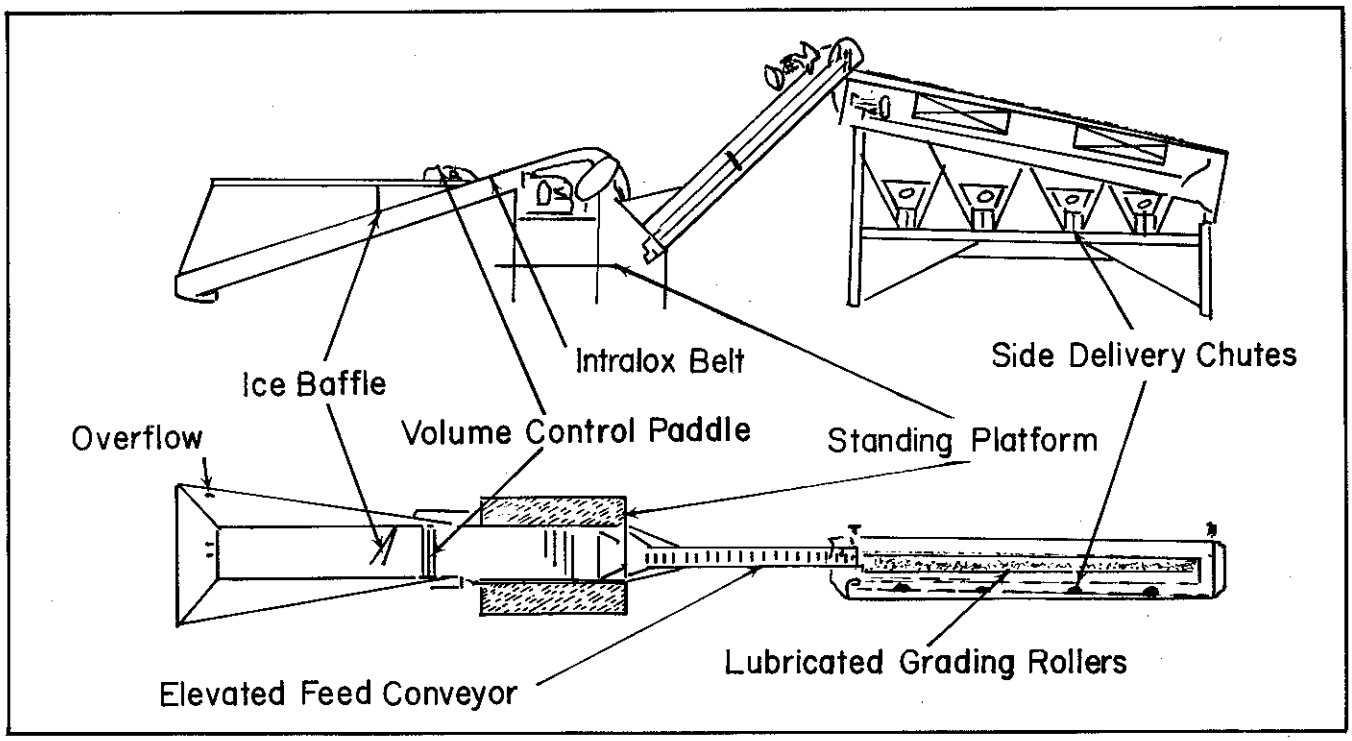

Figure 5. Schematic of one 1,000-pound-per-hour grader and receiving tank.

laminated cardboard boxes are placed 10 to a master carton. Each 13.25 by 11.75 by 16.375-inch corrugated carton is loaded on to a galvanized steel freezer cart that holds 22 cartons or 1,100 pounds of shrimp [3]. That portion of the plant floor where the weighing and packing occurs can be seen in Figure 2.

Blast Freezing

Once the shrimp tails are boxed, cartoned, and loaded onto the freezer carts, each cart is pushed into a small 15 by 15-foot galvanized steel-sided blast freezer. The daily processed shrimp are typically kept overnight in the freon-activated blast freezer, where as many as 22,000 pounds of tails can be exposed to surface temperatures as low as -40°F [1]. The freezer, however, has the capacity to freeze a maximum of 14,400 pounds of tails to internal temperatures of -10° to 0°F in a 12-hour period. After verification of the blast freezer's room temperature, the shrimp are removed three carts at a time.

Glazing

The cartons of frozen shrimp removed from the blast freezer are opened. At this point, each cart is led to a conveyor-belted glazing system where open shrimp boxes are placed on the 14-foot conveyor belt. The belt carries each box under a four-nozzle, preset, regulated spray that coats the frozen shrimp with a thin layer of water, which is immediately turned into a moisture sealing glaze [3]. After passing boxed shrimp under the spray, the belt deposits each box at a small collecting table. Here the boxes are closed, turned over, recartoned, and double strapped with special plastic bands. The strapped cartons are then stacked on wooden pallets.

This whole conveyor belt, nozzle, and strapping system can be purchased through a custom manufacturer, or as usually the case, be built by a local machinist at lower cost. This study assumed use of the higher-cost custom manufactured system because the availability of a local machinist and needed equipment is not assured. Location of the glazing belt in the model plant is shown in Figure 2.

Storage Freezing

Storage freezing of the shrimp tails is the last phase in the processing of green headless shrimp. An electric forklift is used to place 1,750-pound loaded pallets into a large storage freezer for temporary or long term storage.

The storage freezer is a galvanized-steel-walled, double-insulated, and freon-activated system [1] capable of maintaining 690,000 pounds of processed tails at approximately 0°F surface temperature. Dimensions of the freezer are 70 feet long by 36 feet wide, with a 25-foot ceiling. The storage freezer's volume of space to volume of boxed shrimp tails is a three to one ratio [3]. Holding capacity for the storage freezer was based upon the ability to store 8 weeks processing at maximum output. The storage freezer's location within the plant is shown in Figure 2.

Estimated Investment Requirements and Annual Costs for Two Scenarios of a Model Plant

Investment Requirements

Initial investment requirements consisted of equipment and facility needs discussed previously and listed in Appendix Table 2. Investment estimates do not include harvesting equipment, because it was assumed that processing does not include harvesting. Initial investment estimates for the given plant are presented in Table 2.

Land and building costs for Scenarios I and II comprise 47.7 percent and 45.7 percent, respectively, of total investment. The blast and storage freezing equipment was the same for both scenarios, accounting for 23.4 percent and 28 percent, respectively, of total investment. All other required investment items accounted for 28.9 and 26.3 percent of total investment for Scenarios I and II, respectively, with no item accounting for more than 7.0 percent for Scenario I or 8.5 percent for Scenario II.

Annual Ownership Costs

Ownership costs consist of depreciation, interest, taxes, and insurance. These costs occur whether the asset is used or not, and are fixed in the short run. Annual ownership costs are obtained by "annualizing" total ownership costs.

Depreciation

Depreciation of an item is the non-cash expense used to reflect the loss in value of an asset from age, wear, tear, and obsolescence. Depreciation of an asset can be calculated by several methods. The straight-line method was deemed most appropriate for this study. That method involves subtracting the salvage value from the item's initial cost, then dividing the resulting amount by the useful life of the item. In this study, all durable items were assumed to have zero salvage value.

In determining the depreciation cost of the building, a useful life of 30 years was assumed. Considering that the building consists of a thick slab floor, rustproof metal siding, and steel beams every 20 feet, along with the level of maintenance that is generally provided to existing shrimp plants, a 30-year estimate was not considered excessive. Depreciation cost for each piece of equipment was estimated, based on useful life data obtained from manufacturers and supported by interviews with an existing processor (Appendix Table 2). Detailed depreciation costs are

Table 2. Estimated investment requirements and percentage of initial cost, by specific item, for a synthesized shrimp processing plant, two operating scenarios, Mississippi Gulf Coast, 1986.

Item	Scenario I		Scenario II	
	($)	(%)	($)	(%)
Land[a]	120,000	13.3	35,000	4.6
Building	310,000	34.4	310,000	41.1
Breaking equipment[b]	57,164	6.3	57,164	7.6
Grading equipment[c]	63,236	7.0	63,236	8.4
Weighing & packing equipment[d]	7,500	.8	7,500	1.0
Blast freezing equipment[e]	98,612	10.9	98,612	13.1
Glazing & strapping equipment[f]	18,000	2.0	18,000	2.4
Icemaking equipment[g]	18,750	2.1	18,750	2.5
Forklift	28,000	3.1	28,000	3.7
Storage freezer	112,847	12.5	112,847	15.0
Office equipment	11,325	1.2	11,325	1.5
Miscellaneous[h]	12,000	1.3	12,000	1.6
Total	857,434	100.0	772,434	100.0

[a] Includes $8,967 for a waste water line connecting the Scenario II plant to the bay.
[b] Consists of two ice baffles and one flume system.
[c] Consists of two graders.
[d] Consists of three packing tables and six scales.
[e] Consists of blast freezer and 26 freezer carts.
[f] Consists of strapping machine and glazing belt.
[g] Thirty percent of initial investment for icemaking equipment consisting of ice maker and ice conveyor, goes into the processing of shrimp, the other 70 percent is allocated to hauling cost.
[h] Includes minor items of equipment, licenses, permits, and hookup for utilities.

Table 3. Estimated annual ownership costs, two operating scenarios, synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Item	Scenario I	Scenario II
	($)	
Building depreciation	10,333	10,333
Equipment depreciation[a]	35,303	35,303
Waste water line depreciation		448
Insurance	10,220	10,220
Interest on investment	58,646	48,984
County taxes	30,363	21,155
Municipal taxes	9,632	8,777
Total annual ownership costs	154,497	135,220

[a] Seventy percent of depreciation and interest on icemaking equipment shown in Appendix Table 3 was charged to hauling costs.

included in Appendix Table 3. A summary of depreciation costs is presented in Table 3.

Insurance

Insurance coverage for the equipment and building consisted of fire, vandalism, and extended coverage. In Mississippi, actual rates for each type of coverage were set by the state rating bureau. The rates used to determine total insurance costs added to $2.67 per $100 on 80 percent of initial cost of buildings and equipment. Annual insurance costs for the building and all equipment are included in Table 3.

Interest

Interest was charged at a rate of 12 percent on one-half the initial investment in depreciable items such as buildings and equipment. Interest of 12 percent was also charged on the full value of land. Interest costs for both processing plant scenarios are included in Table 3.

Taxes

Both municipal and county taxes for the model plant were based on rates applicable to the coastal region. Millage rates used for county and city taxes were 73.83 and 67.12 mills, respectively. Millage rates were applied to 15 percent of initial value of land and one-half initial value of buildings and equipment. Inventory tax was based on 6 weeks production at capacity for Scenario I and 4 weeks maximum production for Scenario II. Estimated municipal and county property taxes for both processing plant scenarios are included in Table 3.

Annual Operating Costs for Scenario I

Annual operating costs arise from the actual operation of a given enterprise. Operating costs for this model plant included labor, utilities, repairs and maintenance, supplies, and interest on operating capital.

Labor Costs

Estimates of labor requirements were based upon the output level of the model plant and the equipment necessary to provide that output level. The estimated number of employees needed to operate the model plant at capacity were based on manufacturers' recommendations, and interviews with management of existing shrimp processing plants. Data obtained from interviews were consistent with results of time-motion studies presented in Appendix Table 10. Employee requirements, with corresponding hourly wage, are presented by job classification in Appendix Table 5. Labor cost, except for the president (plant manager) and head breakers, are presented on an hourly wage basis. Head breakers are typically paid on a "piece" basis. Hourly performance and wage rates were based upon interviews and supported by time-motion studies. The president's salary was based upon the minimum income necessary to retain his employment. It was assumed that the plant owner functions as president, comptroller, marketing director, and plant manager.

Total annual salary costs associated with each job classification are presented in Appendix Table 6. Fringe benefits for all labor operating on the processing floor was assumed to be 15 percent, while fringe benefits for management and non-floor operators was assumed at 20 percent. Total labor costs for the processing plant are summarized in Table 4.

Utilities

Electricity Costs. Electricity costs for the model plant were based upon the electrical requirement of each piece of processing equipment's electric motor, and the electricity required for plant lighting.

Electricity costs for each piece of processing equipment were calculated based upon its motor's horsepower. Once the horsepower ratings for all equipment involved were obtained from the manufacturer, each rating was placed into the following equa-

Table 4. Estimated total labor costs, two operating scenarios, synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Operation	Scenario I	Scenario II
	($)	
Receiving and breaking	598,688	192,685
Grading and packing	90,160	25,760
Blast freezing and glazing	33,810	9,660
Packing and storage	45,080	12,880
Salaried and office personnel	173,796	114,528
Total	941,574	355,513

tion to determine the electricity costs for that particular motor [6]:

$$E = .746 \times HP \times C \times N \times 100/Eff.$$

where

E = electrical cost of motor
HP = horsepower of motor
C = electricity rate in dollars per kwh
N = number of operating hours
Eff. = normal full-load efficiency (%) of original motor

To derive annual electricity costs for each motor, total operating hours per year were used for number of operating hours (N). The efficiency percentage, which varied for each horsepower rating, was obtained from Graingers net price motorbook catalog [6]. The electricity rate used for this study was 7.5 cents per kwh, the average monthly rate charged by Mississippi Power Company to its business customers in the Biloxi, MS, area. Data used for estimating electrical costs of motors are presented in Appendix Table 7. Estimated annual electricity costs for freezers are included in Appendix Table 8.

Estimates of annual lighting costs were based upon the average electrical requirements for a comparable plant size. These electrical requirements for plant lighting amounted to 40 watts per square foot of floor space per month. Total annual electricity costs for the model plant are included in Table 5.

Water Costs. Processing green headless shrimp requires large quantities of water. The greatest portion of water required by the model plant was for rinsing and moving shrimp through the flume trough and baffle tanks. The graders also used a significant amount of water for their overhead spray component. The estimated daily requirements of water per piece of equipment are presented in Appendix Table 9.

Total annual costs of water used by the model processing plant also included water for cleanup. The estimate for water cost was based upon rates charged by Biloxi City Water Association. The rates for commercial water use in Biloxi were $1.00 per 1,000 gallons drinking water and $1.50 per 1,000 gallons sewage. Total annual water costs for this plant are included in Table 5.

Telephone Costs. Telephone costs were based on a two-line, five-phone, intercom system, with an outgoing WATS line and an incoming 800-number covering Mississippi, Florida, Alabama, Georgia, and parts of Texas. Telephone rates used were based on service provided by South Central Bell and AT&T. The South Central Bell rate was $157.94 per month. Total costs of assumed AT&T service consisted of $42.80 per month for WATS service, and long-distance service charge at the rates of 28¢ per minute for the first 15 hours and 25¢ per minute for the next 25 hours. Under assumed long-distance usage, total telephone costs were estimated to be $600 per month when the plant was operating at capacity. During months when the plant operated at less than capacity, the portion of telephone cost associated with actual usage was adjusted proportionately. Total annual telephone cost is included in Table 5.

Table 5. Estimated annual operating costs, two operating scenarios, synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Item	Scenarios I	Scenarios II
	($)	
Labor	941,574	355,513
Utilities		
Electricity[a]	40,765	27,650
Water	1,363	361
Telephone	6,315	5,513
Repairs and maintenance	17,638	5,324
Supplies and services		
Packaging	36,382	10,036
Transporting	51,746	14,471
Washdown	42	21
Miscellaneous	10,000	4,687
Waste disposal	3,336	1,572
Subtotal	1,109,163	425,148
Interest on operating capital	162,094	178,955
Total annual operating cost	1,271,257	604,103

[a] Seventy percent of costs associated with icemaking were charged to hauling costs.

Repairs and Maintenance Costs

Annual repairs and maintenance costs for all equipment and the building were obtained from interviews with equipment dealers, interviews with existing plant managers, and related publications concerning seafood processing [4]. Repairs and maintenance costs were converted to a percentage of the purchase price of the asset (Appendix Table 2).

The estimates of repairs and maintenance costs for this study, presented in Appendix Table 3, may seem unrealistically low for some equipment items. However, all labor costs involved in repair and maintenance were included in the plant repairman's salary costs. Maintenance costs for the building itself were estimated to be only one percent of purchase price. Total repairs and maintenance costs for the model processing plant are included in Table 5.

Supplies and Services

Additional necessary items required in the processing of green headless shrimp consist of packaging and transporting supplies, washdown equipment, and miscellaneous supplies and services.

Packaging supplies consist of the boxes, cartons,

and straps necessary to prepare and contain the processed shrimp in frozen storage.

Transport supplies, those items used to contain the shrimp for movement within the processing plant, include wooden pallets for loading and storing, and the large perforated collecting baskets used in grading.

Washdown supply costs consist of two replacement water hoses with nozzles.

Miscellaneous supplies include brooms, shovels, hand brushes, cleanser, chlorine, paper towels, rakes, and general overhead such as postage. Estimated costs of supplies and services are included in Table 5.

Waste Disposal Costs

The annual costs associated with waste disposal were the charges for hauling away solid wastes collected daily in dumpsters, and the monthly rent on dumpsters. The per-load hauling charge was $28 and rent on the dumpster amounted to $75 per month. Waste disposal costs, which are included in Table 5, were based on the use of one dumpster, which would be hauled away every other day.

Interest on Operating Capital

Interest on annual operating capital was charged at a rate of 12 percent on one-ninth of the plant's total operating cost, plus the average value of frozen inventory. Average inventory for the model plant was estimated to be 40 percent of freezer storage capacity. Average value of inventory was obtained by multiplying the average inventory by the 5-year average wholesale price for 30-35 count marine shrimp tails ($4.44 per pound) [14]. Interest costs are shown in Table 5.

Annual Operating Costs for Scenario II

Since most of the operating costs were calculated in the same manner for both scenarios, this portion of the study primarily explains the differences in costs for the two operating scenarios.

Labor Costs

Labor costs for Scenario II are not proportionately less than for Scenario I, because some labor is required year-round. In addition to the work of the president (who also acts as plant manager and salesman), some maintenance, loading out frozen shrimp, and secretarial duties are required year round. It was assumed that these additional duties would be performed by the plant maintenance man, who operated the forklift, and a single secretary assisting in the office. Maintaining freezer equipment and loading of shrimp required 40 hours per week from the maintenance man while the secretary worked part-time 20 hours per week at the normal hourly rates as presented in Appendix Table 5.

Utilities

Electricity costs for each piece of equipment under Scenario II, excluding storage freezer, were calculated using the same formula as used for Scenario I. The only difference in the result was in the number of operating hours (N), which were proportionately less than in Scenario I for every piece of equipment except the storage freezer. The storage freezer was operated year round in order to make available a constant supply of processed shrimp to regular customers throughout the year. Electricity costs per item are included in Appendix Table 8.

Water costs for Scenario II were proportionately lower than water costs for Scenario I. Less water was required because virtually all water use occurred during the operation of processing equipment and cleanup. Thus, water use and cost for Scenario II were 27 percent of those of Scenario I.

Telephone costs for Scenario II were only slightly less than those for Scenario I. For the plant to continue marketing its stored product for a full year, local service and WATS service were maintained year

Table 6. Estimated annual costs, two operating scenarios, synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Item	Scenario I	Scenario II
	($)	
ANNUAL OWNERSHIP COSTS		
Depreciation	45,636	46,084
Insurance	10,220	10,220
Interest	58,646	48,984
Taxes	39,995	29,932
Subtotal	154,497	135,220
ANNUAL OPERATING COSTS		
Labor	941,574	355,513
Utilities		
Electricity	40,765	27,650
Water	1,363	361
Telephone	6,315	5,513
Repairs and maintenance	17,638	5,324
Supplies and services		
Packaging	36,382	10,036
Transporting	51,747	14,471
Washdown	42	21
Miscellaneous	10,000	4,687
Waste disposal	3,336	1,572
Subtotal	1,109,162	425,148
Interest on operating capital	162,094	178,955
Total annual operating costs	1,271,256	604,103
Total costs	1,425,753	739,323
Total pounds processed	2,505,600	691,200
Cost per pound	.57	1.07

round. The portion of long distance costs required for marketing the product were the same for both scenarios.

Repair and Maintenance Costs

Since no information was available concerning annual repair and maintenance estimates for equipment used only 2 months of the year, a percentage of the repair cost for Scenario I was estimated for Scenario II. Some amount of deterioration occurs to equipment and buildings whether they are used or not. In this case, it was assumed that repair and maintenance costs for Scenario II amounted to 30 percent of the repair costs for Scenario I.

Supplies and Services Costs

Supplies and services costs for Scenario II were based upon the proportionate 27 percent of costs of supplies for Scenario I. This proportionate percentage was used to estimate costs of all supplies and services excluding packaging costs. Packaging supply costs were based on packaging supplies necessary for packing the estimated output for Scenario II. Thus, annual supplies and service costs for Scenario II were approximately 27 percent of the costs for Scenario I.

Interest on Operating Capital

Annual interest on operating capital was charged at a rate of 12 percent on one-half of total annual operating cost. Interest was also charged on average inventory, which was assumed to be one-half of the maximum storage capacity for a period of 10 months.

Annual Cost Analysis

Total annual costs of processing freshwater shrimp under Scenarios I and II were $1,425,753 and $739,323, respectively (Table 6). Given the processing volumes of Scenarios I and II of 2,505,600 and 691,200 pounds, respectively, costs per pound of processing green headless shrimp for Scenarios I and II were $.57 and $1.07, respectively. Per-pound cost of processing shrimp only 2 months of the year (Scenario II) is almost twice as much as for the plant operating 9 months of the year (Scenario I). The major components of the cost are shown in cents per pound in Table 7.

Ownership costs for Scenario I made up only 10.82 percent of the total annual cost, whereas ownership costs under Scenario II represented 18.29 percent of total cost (Table 8). The reason for this is that owner-

Table 7. Estimated annual cost components expressed in cents per pound for a synthesized shrimp processing plant, two operating scenarios, Mississippi Gulf Coast, 1986.

Item	Scenario I	Scenario II
	(¢/lb)	
ANNUAL OWNERSHIP COSTS		
Depreciation	1.82	6.66
Insurance	.41	1.48
Interest	2.34	7.00
Taxes	1.60	4.30
Subtotal	6.17	19.44
ANNUAL OPERATING COSTS		
Labor	37.58	51.40
Utilities		
Electricity	1.63	4.00
Water	.05	.05
Telephone	.25	.80
Repairs and maintenance	.70	.77
Supplies and services		
Packaging	1.45	1.45
Transporting	2.10	2.09
Washdown	0.00	0.00
Miscellaneous	.40	.68
Fuel costs		
Waste disposal	.13	.13
Subtotal	44.30	61 .40
Interest on operating capital	6.47	25.90
Total annual operating costs	50.77	87.30
Total cost per pound	57.00	107.00

Table 8. Estimated annual cost components expressed as a percentage of total costs for a synthesized shrimp processing plant, two operating scenarios, Mississippi Gulf Coast, 1986.

Item	Scenario I	Scenario II
	(%)	
ANNUAL OWNERSHIP COSTS		
Depreciation	3.20	6.23
Insurance	.72	1.38
Interest	4.10	6.62
Taxes	2.80	4.05
Subtotal	10.82	18.29
ANNUAL OPERATING COSTS		
Labor	66.00	48.10
Utilities		
Electricity	2.86	3.74
Water	.10	.05
Telephone	.44	.75
Repairs and maintenance	1.24	.72
Supplies and services		
Packaging	2.55	1.36
Transporting	3.63	1.96
Washdown	0.00	0.00
Miscellaneous	.70	.63
Waste disposal	.23	.21
Subtotal	77.75	57.57
Interest on operating capital	11.36	24.24
Total annual operating costs	89.11	81.76
Total	100.00	100.00

ship costs are fixed and diminish as a proportion of total costs as plant production increases. Depreciation and interest on investment, combined, made up the major portion of ownership costs for both scenarios, comprising 7.3 percent of total annual costs for Scenario I and 12.85 percent of total annual costs for Scenario II.

Labor cost represented the single greatest component of operating cost for both scenarios, as seen in Table 6. Labor costs for Scenarios I and II amounted to $941,574 and $355,513, respectively. This translates into a labor cost of 37.58 cents per pound for Scenario I and 51.40 cents per pound for Scenario II (Table 7).

Hauling Costs

Two methods for hauling freshwater shrimp from farms to the processing plant were considered: (1) hauling ice-packed shrimp on refrigerated trucks (similar to the method commonly used for hauling marine shrimp); and (2) live-hauling in aerated freshwater tanks (similar to the method used for hauling catfish). While some data used in deriving ice-packed hauling costs were obtained from marine shrimp processors, methods used in estimating trucking costs of both hauling techniques were based upon data obtained from a previous study on the costs of live-hauling catfish [7]. Precautions and management practices necessary to deliver live-hauled fish in good health were assumed to be appropriate for live-hauling shrimp [9].

The method of harvesting freshwater shrimp was described in a previous MAFES report [2]. Basically, the freshwater shrimp ponds are drained and the shrimp collected in half-inch mesh cages placed under the drain pipe in a harvest basin. For this study, it was assumed that the hauling trucks would be at the harvest site when harvesting begins, so that stress to the shrimp would be minimized. In the case of live-hauling, each cage load of shrimp would be removed from the basin, weighed, and placed directly into the aerated tanks of the live-haul trucks. In the case of ice-packed hauling, each cage load of shrimp would be placed into an ice bath tank in which the shrimp are chill-killed. Minutes later the chill-killed shrimp would be removed, weighed, and packed in wooden boxes, each containing 105 pounds of shrimp and 50 pounds of ice. The boxes would then be stacked on wooden pallets in the truck to accommodate unloading at the processing plant.

Important factors in determining the total costs for both methods of hauling were trucking and labor costs. Trucking costs depended primarily upon type and size of truck. It was assumed that the size and type of trucks used to haul live catfish in the Delta could be used for both methods of shrimp hauling, but equipped differently; that is, straight flatbed trucks with 270-horsepower engines equipped with five- to seven-speed transmissions and twin rear axles. For live-hauling, it was assumed that each truck would carry four separately designed aerated tanks. It was assumed that the truck used to haul ice-packed shrimp would be equipped with a single refrigerated, insulated box. Initial costs for each type of truck are presented in Table 9.

In order to determine total annual and per-pound costs for each method of hauling, the number of trucks required, the number of miles hauled, and the number of loads hauled for each method must be known. The number of trucks used for each method could be derived if the amount of shrimp carried per load and the load time were known. The carrying capacity for refrigerated trucks, 15,700 pounds live weight, was supplied by marine shrimp processors. Under the assumptions that each truck would average only 40 miles per hour on a paved road and would travel an average one-way distance of 50 miles, time required per load was such that only two trips per day could be made.

Data on carrying capacity for live-haul trucks were based on shrimp-to-water density tests conducted at Mississippi State University. (The unpublished preliminary tests were not replicated, thus were not

Table 9. Estimated initial investment per truck for live-hauling and ice-packed hauling of freshwater shrimp, 1986.

Item	Live-haul Truck	Refrigerated Truck
	($)	
Truck[a]	62,500	62,500
20 ft. bed and MD-150 refrigerator[b]		17,700
Aerator motor[c]	1,500	
Aerator blower	1,500	
Four (4x5x8) tanks	8,500	
Total	74,000	80,200

[a] Truck cost obtained from local dealers.
[b] Insulated bed and refrigeration requirements and prices obtained from Gulf City Body Inc., Mobile AL.
[c] Aerator and livehaul equipment requirements and prices supplied by Delta Pride Catfish Processors, Indianola, MS.

conclusive.) The results of these tests suggest that it was reasonable to haul 4,000 pounds of live shrimp per load up to 100 miles one way. However, as in the previous case, the average trip was assumed to be 50 miles one way. Time per load for live-hauling shrimp (7.08 hours per load) was derived by substituting appropriate data into a formula used in a previous catfish live-haul study [7]. Based upon this time per load, along with the above stated capacity of each load, and daily processing capacity (32,000 pounds live weight), the number of trucks needed for the ice-packed and live-haul methods were three and four trucks, respectively. The three refrigerated trucks (one truck would be required for hauling ice) were able to handle daily processing capacity with one trip per day each. Daily processing capacity required four live-haul trucks, each making two trips per day.

From the above information, number of trips per day for each method of hauling was totaled so as to provide the total number of trips annually for each method. Since each trip was assumed to be an average of 50 miles one way (average distance from shrimp ponds to the processing plant), total number of trips traveled by each method of hauling was derived.

Annual Ownership Costs

Annual ownership costs for both methods of hauling freshwater shrimp consisted of depreciation, interest on investment, insurance, and taxes on all investment items. Depreciable items for the live-haul method of shrimp transport consisted solely of trucks and associated equipment. In the case of hauling shrimp packed in ice on refrigerated trucks, a portion of the cost of the icemaking system in the processing plant was allocated to hauling. Based on ice requirements for hauling and processing, it was assumed that 70 percent of total annual costs of the icemaking system (icemaker and conveying system) was allocated to hauling costs. Initial investment costs for a 10-ton icemaker and conveying system are presented in Appendix Table 2. Annual ownership costs for ice-packed hauling were the same for both processing plant scenarios. Hauling costs are summarized in Table 10.

Depreciation and Interest

Depreciation costs were derived by the straight-line method. Salvage value of trucks for both methods of hauling was assumed to be 10 percent of initial cost with an 8-year useful life. Salvage value for the icemaking equipment for the ice-packed method of hauling was assumed to be zero with a useful life of 10 years. Interest on average investment for both methods of hauling shrimp was based on a rate of 12 percent for all investment items.

Insurance

Insurance costs of trucks for both hauling methods were derived by adjusting for inflation the insurance

Table 10. Estimated total annual costs and costs per pound of two methods of hauling freshwater shrimp 50 miles one-way from farms to two synthesized processing plants, 1986.

Item	Refrigerated Trucks		Live-haul Trucks[a]
	Scenario I	Scenario II	
	($)		
OWNERSHIP COSTS			
Depreciation	31,375	31,375	33,300
Interest on investment	18,504	18,504	19,536
Insurance	2,053	2,053	1,785
Taxes	2,325	2,325	1,621
Subtotal	54,257	54,257	56,242
OPERATING COSTS			
Labor	49,392	14,112	18,816
Electricity	2,571	709	0
Water	304	84	230
Repairs	6,709	1,880	3,264
Fuel	11,733	3,168	8,448
Supplies	40,061	11,261	0
Subtotal	110,770	31,215	30,758
Interest on operating capital	1,477	1,873	1,845
Total annual cost	166,504	87,345	88,845
Total quantity hauled (lb)	5,568,000	1,536,000	1,536,000
Cost per pound ($)	.0299	.0568	.0578

[a] Cost of live-hauling freshwater shrimp is the same for both scenarios.

costs reported in a 1984 study of costs of live-hauling catfish [7]. Seventy percent of the insurance cost of ice-making equipment in the processing plant was included in ice-packed hauling cost. Total annual insurance costs for both hauling methods are included in Table 10.

Taxes

Taxes on trucks for both methods of hauling were based on rates representative of the study area. Taxes on icemaking equipment for the ice-packed hauling method were 70 percent of the municipal and county taxes previously derived for icemaking equipment.

Annual Operating Costs

The costs arising from the actual operation of hauling equipment included labor, electricity, water, repairs, fuel, and supplies, with electricity and supply costs arising only with the ice-packed method of hauling. Unlike ownership costs, operating costs varied with output, resulting in different operating costs for the ice-packed method of hauling for the two plant scenarios. A summary of operating costs is included in Table 10.

Labor Costs

Labor costs for both methods of hauling consisted solely of driver labor, which was based on a rate of $7.00 per hour with time and a half for overtime, plus 20 percent for fringe benefits. It was assumed that drivers worked 10 hours per day during the months when the plant was operating at capacity. It was also assumed that any assistance needed by the harvesting crew in icing shrimp for the ice-packed hauling method was performed by the truck drivers.

Electricity Costs

Electricity costs for the ice-packed hauling method were based upon the electrical requirements of the processing plants' icemaking equipment. The electricity cost for the icemaking equipment was based upon its motor's electrical requirements. It was assumed that 70 percent of these costs were used in the production of ice for shrimp hauling, as presented in Table 10. No electricity costs were assumed for the live-hauling method, since no ice was required.

Water Costs

Water costs for the ice-packed method of shrimp hauling were derived from the water used in the plant's icemaker for making the ice required for icing shrimp in refrigerated trucks. Annual water costs for live-hauling consisted of the water required for filling aerated tanks. All water costs were based upon a rate of $1.00 per 1,000 gallons—the rate charged by Biloxi City Water Association.

Repairs and Maintenance Costs

Repairs and maintenance costs for trucks used in both hauling methods amounted to 8.5¢ per mile. Estimates of repair and maintenance costs of icemaking equipment, which were obtained from a major supplier, amounted to 50 percent of its initial cost spread over a useful life of 10 years. Seventy percent of these costs were allocated to hauling costs.

Fuel Costs

Diesel fuel costs for both methods of hauling were based on a highway fuel consumption rate of 5 miles per gallon, plus 2 gallons per trip for loading and unloading. Price of diesel fuel was assumed to be $1.00 per gallon.

Supplies

The only additional items required in the hauling of freshwater shrimp were the wooden boxes used for packing and loading iced shrimp in refrigerated trucks and wooden pallets used to load and unload packed boxes of iced shrimp. Total annual costs for wooden boxes were based on $2.25 per box, each having an average life of three trips. The cost for pallets was based on a price of $7.25 per pallet. It was estimated that 40 pallets were required annually.

Interest on Operating Capital

For both scenarios interest on operating capital was charged at an annual rate of 12 percent. Interest was charged on one-ninth of the total operating cost for Scenario I, and on one-half the total operating cost for Scenario II.

Hauling Cost Analysis

Under Scenario I, it was assumed that the synthesized plant would process marine shrimp 7 months and freshwater shrimp for 2 months, and that all shrimp were hauled in refrigerated trucks. Total annual hauling cost for Scenario I amounted to $166,504, or approximately 3¢ per pound (Table 10).

Under Scenario II, the synthesized plant operated for only 2 months, processing only freshwater shrimp. The freshwater shrimp could be hauled in either refrigerated trucks or in live-haul trucks. Total annual hauling costs amounted to $87,345 if refrigerated trucks were used and $88,845 if live-haul trucks were used. Thus, cost per pound for hauling under Scenario II was 5.7¢ for hauling ice-packed shrimp in refrigerated trucks, and 5.8¢ for live-hauling shrimp (Table 10).

Summary, Conclusions, and Limitations

The continued decline in domestic landings of marine shrimp and the increase in consumption have resulted in large quantities of imported shrimp by the United States. The increasing consumption and declining domestic landings suggest that a potential market may exist for farm-raised freshwater shrimp (*Macrobrachium rosenbergii*). Presently, farmers in Mississippi and throughout the United States are interested in the economic feasibility of producing and marketing such a product.

Recent experiments in production, processing, and storage of freshwater shrimp have been encouraging, as have preliminary tests of consumer acceptance. But no assessment of assembly or processing costs has been published. If the economic feasibility of freshwater shrimp production in Mississippi is to be adequately assessed, an estimate of processing costs is required.

The synthetic firm approach was used in this study to estimate costs of assembling and processing freshwater shrimp in the Gulf Coast area of Mississippi. Data for the study were obtained from personal interviews with processors and extension personnel, manufacturers' specifications, appropriate dealer estimates, and limited time-motion studies.

A plant and operation capable of assembling and processing 14,400 pounds per day of green headless shrimp were synthesized. Space requirements of equipment and personnel necessary to efficiently process those shrimp were based upon currently used technology. A plant capable of this daily capacity was formulated based on the necessity to process and store 691,200 pounds of shrimp tails within the 2-month harvest period for freshwater shrimp. Processing costs were estimated for the synthesized plant operating under two scenarios: 9 months of operation (Scenario I) and 2 months of operation (Scenario II).

Except for land cost, the estimated initial investments for both scenarios of the model plant were the same. Equipment costs represented the largest percentage of total investment, with 52 percent for Scenario I and 54 percent for Scenario II. Freezer equipment alone comprised 23 and 28 percent of total investment for Scenarios I and II, respectively. The remaining major items, building and land combined, comprised 48 and 46 percent of total investment for Scenarios I and II, respectively.

Annual ownership costs for the 9- and 2-month scenarios were $154,497 and $135,220, respectively. Annual operating costs amounted to $1,271,257 for Scenario I and $604,103 for Scenario II. Total annual costs for Scenarios I and II were $1,425,753 and $739,323, respectively. Costs per pound of processing shrimp were $.57 for Scenario I and $1.07 for Scenario II.

The economic engineering approach was also used in estimating the costs for hauling freshwater shrimp. Data and methodology used in developing these cost estimates were partly obtained from a previous study concerned with live-hauling catfish [7] and from interviews with equipment suppliers and commercial shrimp processors.

Costs were estimated for two methods of hauling shrimp: hauling in refrigerated trucks, and live-hauling. Estimated costs for hauling shrimp in refrigerated trucks were 3¢ and 5.7¢ per pound, respectively, for Scenarios I and II. Cost of hauling in live-haul trucks for Scenario II was 5.8¢ per pound.

Conclusions

Based on the results of this study, costs of processing freshwater shrimp in a plant that also processes marine shrimp (Scenario I) were much lower than for the plant built solely for processing freshwater shrimp (Scenario II). Costs of hauling freshwater shrimp were also much lower for Scenario I because the refrigerated trucks were used over a longer period of time. Costs of hauling freshwater shrimp to a plant operating for 2 months (Scenario II) were essentially the same for both hauling methods studied.

Limitations

Only one product form was studied—frozen, green headless shrimp. Cost estimates were limited to assembly and processing costs. No harvesting, distribution, or marketing charges (except for manager's salary and telephone charges) were included in the costs for processing shrimp. Thus, some additional marketing research is needed before the economic feasibility of freshwater shrimp production can be adequately assessed.

Costs were formulated utilizing the industry's accepted processing methods and technologies, which provide an initial estimate of the cost to process green headless shrimp. While there may be lower cost alternatives, none were discovered in this research. Also, this analysis contains a shortcoming inherent in any synthesis of an operation where processing volume is specified at the outset: such analysis precludes a look at economies of scale.

Quantity of shrimp hauled per load is critical in determining cost of live-hauling. The hauling density used in estimating costs was based on unreplicated tests. Further tests are needed to evaluate possible densities for live-hauling over various distances.

List of References

[1] Brilley, Tom, and Brian Burridge. 1986. Personal correspondence and telephone conversations, Master-Bilt Products, New Albany, MS.

[2] Clardy, Glynda N., Marty J.Fuller, and John E. Waldrop. 1985. "Preliminary Economic Evaluation of Freshwater Shrimp Production in Mississippi," Dept. of Agric. Econ. Res. Rpt. No. 159, Mississippi Agricultural and Forestry Experiment Station, Mississippi State Univ.

[3] Delcambre, Paul J., Sr. 1986. Personal interviews and telephone conversations, President, Del's Seaway Shrimp and Oyster Co. Inc., Biloxi, MS.

[4] Fuller, Marty J. 1984. "Cost-Size Relationships in the Processing of Farm-Raised Catfish in the Delta Area of Mississippi. Unpub. Ph.D. dissertation, Mississippi State University.

[5] Godwin, Harold L., and Joe A. Hanson. 1977. "The Status of Prawn Processing". *In* Shrimp and Prawn Farming in the Western Hemisphere. (p. 292-297).

[6] Grainger, W. W. 1982. Graingers Wholesale Net Price Motorbook Catalog, No. 361. W. W. Grainger Inc.

[7] Keenum, Mark E., and James G. Dillard. 1984. "Operational Characteristics and Costs of Custom Harvesting and Hauling Farm-Raised Catfish." Dept. of Agric. Econ. Res. Rpt. No. 153, Mississippi Agricultural and Forestry Experiment Station, Mississippi State Univ.

[8] Metzger, Shirley. 1986. Correspondence and telephone conversations, President, Sort-Rite International Inc., Harlingen, TX.

[9] Mississippi Cooperative Extension Service. 1982 "For Fish Farmers," Monthly Newsletter, Oct. 25, Ref. 82-5. Mississippi Cooperative Extension Service, Mississippi State Univ.

[10] Sandifer, Paul A., and T. I. J. Smith. 1978. Aquaculture of Malaysian Prawns in Controlled Environments. J. of Food Tech.

[11] Sandifer, Paul A. 1979. The Necessity for Aquaculture Development. J. of Marine Tech. Soc. 13(3):35-39.

[12] Thomas, Terry. 1986. Personal interviews, President, Thomas Engineering Co., Starkville, MS.

[13] U.S. Department of Commerce. 1986. Fisheries of the United States, 1985. Current Fishery Statistics No. 8380. NOAA, NMFS. Washington, D.C.

[14] U.S. Department of Commerce, Shrimp Statistics. 1985. NOAA, NMFS, Southeast Fisheries Center, Miami, FL.

[15] Veal, David C. 1986. Personal interviews and telephone conversations, Program Leader, Sea Grant Advisory Service, MCES, Biloxi, MS.

Appendix

Appendix Table 1. Monthly landings of gulf marine shrimp, annual and 5-year averages, Northern Gulf region, 1981-1985.

Month	Year					5-Year	
	1981	1982	1983	1984	1985	Avg.	Monthly Pct.
	(1,000 lb)						
January	3,686	4,282	4,356	3,587	7,909	4,764	3
February	1,694	3,242	2,755	2,610	3,847	2,830	2
March	3,594	2,766	2,616	2,687	3,812	3,095	2
April	4,679	2,848	3,417	3,409	4,442	3,759	3
May	20,202	16,781	10,920	16,827	21,475	17,241	12
June	27,504	23,019	22,466	28,772	27,008	25,772	17
July	24,026	17,305	17,253	22,534	20,256	20,274	14
August	23,897	13,739	14,500	18,556	17,854	17,709	12
September	17,087	12,365	12,064	13,620	14,166	13,860	9
October	18,943	16,228	15,386	18,860	17,816	17,403	12
November	16,331	12,548	12,568	12,527	14,837	13,762	9
December	9,748	7,374	8,116	11,173	–	9,103	6[a]
Total						149,572	101[b]

[a] Based upon 4-year average.
[b] Does not add to 100 percent because of rounding.
Source: USDC, NOAA, NMFS.

Appendix Table 2. Data used for estimating annual ownership cost for processing and hauling freshwater shrimp, Mississippi Gulf Coast, 1986.

Item	Number	Estimated Cost New	Annual Repairs	Estimated Life
		($/item)	(% of new cost)	(yr)
Ice baffle	2	14,852	1.3	20
Flume system	1	27,460	2.4	20
Grader A	1	28,420	1.2	20
Grader AA	1	34,816	1.2	20
Glazing belt	1	6,000	5.0	20
Packing tables	3	500		15
Freezer carts	26	850		15
Scales	6	1,000	5.0	5
Forklift	1	28,000	5.0	15
Ice conveyor	1	17,500	5.0	10
Icemaker	1	45,000	5.0	10
Blast freezer	1	76,512	5.0	10
Storage freezer	1	112,847	5.0	10
Strapping machine	1	12,000	2.5	10
Office equipment	*	11,325		10
Truck	2	80,200	3.6	8
Miscellaneous equipment		12,000		10
Building	1	310,000	1.0	30
Land[a]		120,000		
Land[b]		35,000[c]		

* Assorted.
[a] Land cost for Scenario I.
[b] Land cost for Scenario II. Land cost includes $8,967 for a waste water line from the plant to the bay.
[c] Scenario II land price includes installation of liquid effluent release piping.

Appendix Table 3. Estimated annual depreciation, interest on average investment and repair and maintenance costs for all durable assets, synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Item	Depreciation	Interest	Repairs & Maintenance
	($)		
Ice baffle tank	1,485	1,782	393
Flume breaking system	1,373	1,648	654
Grading system equipment	3,162	3,794	787
Glazing system equipment	300	360	300
Packing tables	100	90	
Freezer carts	1,473	1,326	
Electronic scales	1,200	360	300
Electric forklift	1,867	1,680	1,400
Ice conveyor equipment[a]	1,750	1,050	875
10-ton icemaker	4,500	2,700	2,250
Blast freezer equipment	7,651	4,591	3,826
Storage freezer equipment	11,285	6,771	5,642
Strapper equipment	1,200	720	300
Office supplies	1,132	680	
Trucks (diesel)[b]	27,000	15,840	2,958
Miscellaneous equipment	1,200	720	
Building	10,333	18,600	3,100[c]
Land[d]	–	14,400	–
Land[e]	–	3,124	–
Waste water line	448	538	–

[a] Seventy percent of all ice making costs was allocated to hauling costs.
[b] All truck expenses were included in hauling costs.
[c] Repair cost for building was assumed to be only 1 percent annually due to the use of plant labor in making repairs.
[d] Scenario I.
[e] Scenario II.

Appendix Table 4. Estimated number of pieces and cost of office equipment, synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Equipment	Quantity Required	Cost of Item
	(No.)	($)
Executive desk	1	500
Executive chair	1	400
Office manager desk	1	525
Office manager chair	1	400
Secretaries desk	2	525
Secretaries chair	2	250
File cabinet	6	250
Book case	5	150
Guest chair	14	175
Supply cabinet	3	75
Table	5	85
Desk accessory	4	200
Typewriter & stand	3	600
Total		11,325

Appendix Table 5. Estimated number of employees by wage and salary scale, by job classification, synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Job Classification[a]	Wage and Salary Scales					
	Piece Rate	Dollars/Hour				
	17¢/lb.	5.00	6.00	7.00	8.00	10.00
	(no. of employees)					
Supervisor				2		
Office manager					1	
Grader		2				
Weigher & packer		6				
Blast freezer operator		2				
Glazer & strapper		2				
Storage freezer operator		2				
Forklift operator		1				
Repairman						1
Secretary			2			
Head breaker	32					

[a] Duties of more than one classification can be performed by an employee. One example, packers may be required to accompany drivers for loading shrimp on trucks.

Appendix Table 6. Estimated salary and fringe benefit costs, by job classification, two scenarios, synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Job Classification	Scenario					
	I			II		
	Salary[a]	Fringe Benefit[b]	Total	Salary[a]	Fringe Benefit	Total
	($)					
President	50,000	10,000	60,000	50,000	10,000	60,000
Floor supervisor	13,720	2,744	16,464	3,920	784	4,704
Office manager	18,560	3,692	22,252	4,480	896	5,376
Grader operator	9,800	1,470	11,270	2,800	420	3,220
Weighing & packing labor	9,800	1,470	11,270	2,800	420	3,220
Blast freezer loader	9,800	1,470	11,270	2,800	420	3,220
Storage freezer loader	9,800	1,470	11,270	2,800	420	3,220
Forklift operator	9,800	1,470	11,270	2,800	420	3,220
Repairman	23,200	4,640	27,840	21,600	4,320	25,920
Secretary full time	13,920	2,784	16,704	8,160	1,632	9,792
Secretary part time	11,760	2,352	14,112	3,360	672	4,032
Head breaker	16,209	2,440	18,709	5,236	785	6,021

[a] Salaries for all employees except president are based upon hourly wage, hours worked, and time-and-a-half overtime. Monthly salaries are higher for most classes of workers under Scenario II because of more overtime.

[b] Fringe benefits refer to social security, unemployment, workmens compensation, hospitalization, and seasonal bonuses.

Appendix Table 7. Estimated number of motors and horsepower, efficiency, and number of operating hours per motor, by item of equipment, two operating scenarios, synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Item	Number of Motors	H.P. of Motor	Efficiency of Motor	Number of Operating Hours Scenario	
				I	II
			(%)		
Ice baffle 1	1	.75	75.3	1,740	480
Ice baffle 2	1	.75	75.3	1,740	480
Grader AA	1	.75	75.3	1,740	480
Grader AA	1	1.00	77.0	1,740	480
Grader A	2	.75	75.3	1,740	480
Breaking flume	1	.75	75.3	1,740	480
Breaking flume	1	.50	75.9	1,740	480
Ice conveyor	2	3.00	85.5	174	48
Ice conveyor	2	1.50	82.0	174	48
Icemaker	1	33.00	90.0	1,740	480
Storage freezer	2	20.00	86.5	8,760	8,760
Blast freezer	3	20.00	86.5	4,176	1,152

Appendix Table 8. Estimated annual electricity costs, by equipment item, two operating scenarios, synthesized shrimp processing plant, Mississippi Gulf Coast, 1986.

Item	Scenario			
	I		II	
	($)	(% of total)	($)	(% of total)
Baffle system	193	.47	54	.20
Grader AA	223	.55	62	.22
Grader A	193	.47	54	.20
Breaking flume	161	.40	28	.10
Ice conveyor	31	.08	9	.10
Icemaker	1,053	2.60	285	1.00
Storage freezer	22,665	55.60	22,665	81.20
Blast freezer	16,207	40.00	4,471	16.20
Flourescent light	40	.10	25	.09
Total[1]				

[1]Totals do not add to 100 because of rounding.

Appendix Table 9. Manufacturer suggested daily water requirements for a synthesized shrimp processing plant operating at capacity, by item, Mississippi Gulf Coast, 1986.

Equipment Item	Daily Water Requirement
	(gallons)
Ice baffle receiving tank	1,500
AA-C5 shrimp grader	100
A-C5 shrimp grader	100
Ice baffle receiving tank	2,000
Deheading flume system with receiving tank	2,000
Icemaker	750
Total	6,450

Appendix Table 10. Results of time-motion studies concerning hand processing of freshwater shrimp, recorded in pounds per minute, and performed by a seven-man crew, Mississippi State University, 1986.

Item	Number Processed	Time Taken to Process	Weight of Processed Shrimp	Shrimp Processed/ Minute
	(no.)	(min)	(lb)	(lb/min)
Jumbo shrimp	26	2.33	3.9	1.6
Large shrimp	468	4.50	55.0	12.0
Medium shrimp	500	5.80	28.3	4.88
Small shrimp	350	5.54	7.5	1.35
Average, all sizes	336	4.54	23.7	5.22

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