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Content

Cost - size Relationships in the Processing of Farm-raised Catfish in the Delta of Mississippi

The increase in commercial pro-uction and processing of farm-aised catfish in recent years has een dramatic. Water acres have ıcreased by an average of 20% per ear over the last 10 years. More ıan 65,000 acres of water were sed in the production of farm-aised catfish in Mississippi in 1983 3].[1] About 140 million pounds of arm-raised catfish (live-weight) vere processed in 1983 [6], most of vhich was in the Delta area of Iississippi. The annual one-shift apacity of commercial processing lants in Mississippi increased from 8 million pounds in 1979 [5] to an stimated 200 million pounds in 983.

The catfish industry has grown onsiderably, but its current size nay be only a small proportion of ts potential. The per capita con-umption of fish and seafood in the Jnited States was about 12.3 pounds nnually in 1982 [7], with farm-raised catfish representing about 4% of total consumption. Small increases in per capita consumption likely will bring about large increases in production and processing in Mississippi. A one-pound increase in U.S. per capita catfish consumption would increase total quantity demanded by more than 400 million pounds (live-weight). Such increases will occur as catfish continue to capture a greater share of the market for fish.

Rapid growth in processing capacity generally has paralleled the growth in farm production. This expansion in processing capacity occurred with little published research information on the economics of catfish processing. Entrepreneurs have been handicapped by a lack of published information concerning cost-size relationships in catfish processing and costs associated with alternative processing technologies. Consequently, the annual one-shift capacity of commercial processing plants operating in 1983 varied from 7 to 48 million pounds live-weight and reflected a range in technology from highly labor intensive to almost fully automated. As the industry continues to grow and mature, it will become more critical that processing plants of the most efficient size be designed around the most efficient processing technologies available.

The market potential for farm-raised catfish cannot be assessed adequately without some understanding of the consumer demand for the product. In order to plan studies of consumer demand, it is important to know the total costs of placing the product in retail outlets, and it is evident that processing costs represent a significant portion of total costs.

Objectives

The overall objective of this study vas to discover cost of processing arm-raised catfish and to discover f economies of size exist in the atfish processing industry.

The specific objectives of the study vere to (1) identify alternative plant sizes and technologies that are believed to capture most size economies, (2) synthesize efficient catfish processing plants that correspond in size to the plants identified and to determine the costs of processing catfish by phases of the processing cycle for each plant size and (3) determine if economies of size exist by evaluating per-unit cost of processing for plants of different sizes.

[1]*Numbers in brackets refer to items cited by those numbers in References.*

Procedure

Objective 1 was achieved through the use of available information on the capacity of the processing plants in the Delta. From this information alternative plant sizes that generally encompass the plant sizes existing in the Delta were designated. Also, from available information as well as personal interviews with industry leaders, the percentages of various product forms and packaging procedures currently used, along with expectations for the future, were identified for the representative plants.

For objective 2, catfish processing plants similar in size to the representative plants identified in objective 1 were synthesized using the economic-engineering approach. Each phase (or stage) of the processing cycle was identified, and costs for each of the phases were determined. When alternative technology existed for performing functions at each stage, the most efficient was used. Appropriate equipment prices were obtained from processors and suppliers. Installation charges and building needs were estimated through contractors and industry personnel. Labor data were obtained from processors' input-output records, from engineering and/or time and motion studies and from manufacturers' specifications. After determining the least-cost method for accomplishing each phase, or each function within a phase, the phases were aggregated into an efficient overall processing plan.

To accomplish objective 3, annual ownership and operating costs for plants of each size were determined using data obtained in objective The total cost of processing w evaluated for each of the plant si to determine if economies of s exist in the catfish processi industry.

In order to discover if econom of size exist in the catfish processi industry, it is first necessary discover cost of processing catfi for alternative plant sizes or p cessing capacities. To determi this, the data obtained must consistent with maximum physic and economic efficiency in order estimate the least-cost combinatio for chosen plant sizes [2]. Therefo the economic-engineering approac supplemented with a survey of exi ing plants, was chosen to estima the cost components of processi catfish in plants of different size

The Economic - Engineering Approach

Alternative technologies exist for performing different phases of catfish processing, and evaluating the cost variation for each of these options is vital. In order to have overall efficiency in the operation, the least-cost method must be determined for each phase of processing. The determined input-output coefficients and cost estimates for each phase then can be aggregated into a minimum total cost function for the catfish processing facility [2].

The economic-engineering approach is well suited for this type of analysis. It allows the production process to be divided into specific phases so that the most efficient technology can be selected for each phase. The most efficient techniques for each of the phases can then be merged into an efficient working firm. The economic-engineering approach is particularly relevant in analyzing industries that exhibit wide variations in firm size, technology utilization, level of management employed and degree of excess capacity. These characteristics generally identify an "infant" industry where the economic-engineering approach may be the only applicable methodology to measure efficiency [2,9].

There are two major advantages of this approach. First, the most efficient technology can be used for each phase of processing as opposed to adopted technology. This offers a more realistic approach to assessing what can actually be achieved. Second, because cost estimates are formulated through a "building block" approach, the effects of price changes for selected inputs can be examined easily [2].

Some criticism of the economic-engineering approach is aimed at the derivation of cost estimates. Some of the costs involved with a particular technique may be overlooked. Problems also may occur in keeping the technology within feasible bounds. For example, performance rates quoted by man facturers may be in excess of wh is actually attainable in t industry. Verification of these rat by processors is certainly mand tory in order to provide sound co estimates. This means that go judgment coupled with the "chec ing out" of cost and performan rates is necessary to provide val cost estimates. An additional cri cism is that of time. This involv how to deal with time in regard resource flows and rewards ov time with imperfect knowledg risk and uncertainty [2, 3].

These weaknesses exist in t economic-engineering approach, b it may be the only feasible way determine the costs for this n and unique industry. It is believ that this approach, coupled wi careful and rigorous scrutiny of elements of the processing facili provides sound estimates of cost

Model Plants and Product Mix

Four plant sizes (models) were selected for analysis. Daily one-shift capacities of the plants were ,000, 64,000, 96,000 and 160,000 pounds live-weight, for Models I, II, II and IV, respectively. Plant sizes were determined primarily on the basis of performance rates of the most efficient technology presently available for heading and eviscerating catfish. The most efficient technologies for other supporting phases of processing were based on capacities consistent with the heading and eviscerating equipment selected.

The particular product mix that a catfish processing plant produces is important in determining that plant's processing cost. For instance, a plant that processes a high percentage of fillets obviously has a higher processing cost per unit of output than does a plant that processes a high percentage of whole fish. This is true because the actual processing cost per pound live-weight is higher for fillets, and a lower yield of saleable product is obtained. The product mix chosen for this study was based on industry averages, adjusted to reflect trends.

The actual product mixes were obtained from personal interviews with management representatives of cooperating plants. Also, leaders in the processing industry expressed their opinions as to what product-mix changes seem to be forthcoming in the industry. Based on this information, a product mix believed to be representative of what the industry will be producing over the next few years was designated for this study. This mix (in terms of output) consisted of about 60% whole fish, 35% fillets and 5% steaks. To achieve this output mix, live fish entering the plant must be allocated to the three product forms approximately as follows: 50% to whole fish, 45% to fillets and 5% to steaks. It was further assumed that 50% of each category in the mix is processed for sale in the fresh market, and 50% is allocated to the frozen market. Of the 50% in fresh form, one half is processed as ice-packed fish, and one half is in tray pack (chilled) form. This product mix is illustrated in Figure 1.

Dressing percentage or yield obtained when processing live fish

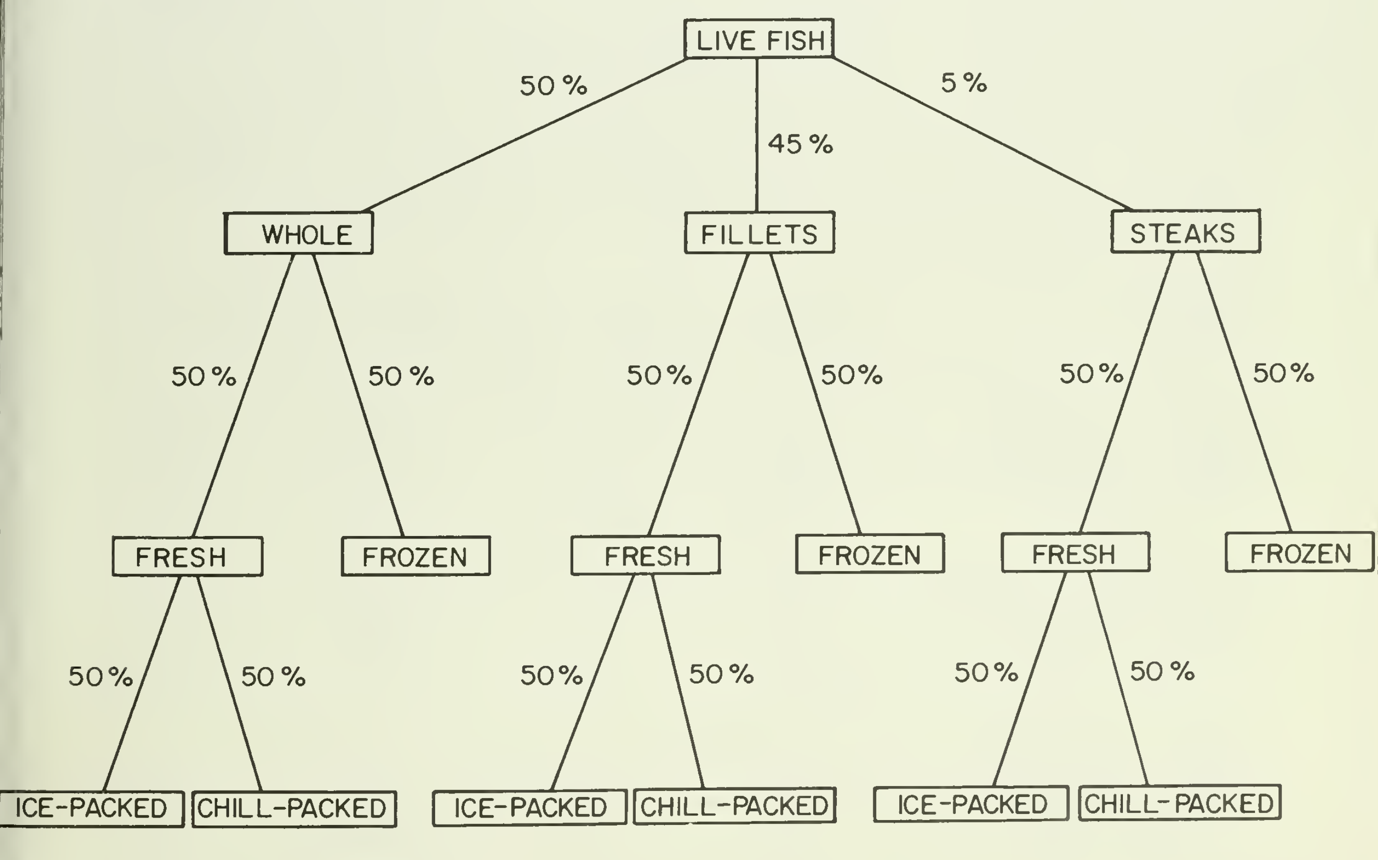

FIGURE I. ILLUSTRATED PRODUCT MIX FOR THE MODEL CATFISH PROCESSING PLANTS.

into various product forms varies among existing plants. For instance, the dressing percentage for whole fish has ranged from 59 to as high as 62. This range is largely explained by variations in size of fish processed and by whether the dorsal fin is removed. As the size of fish increases, dressing percentages increase. Also, some plants elect to remove the dorsal fin, and some do not.

The yield of whole fillets generally varies from 38 to 42% of live weight. Again, the size of fish plays a major role in this variation. Fillets are processed into two individual forms ---whole or shank. Shank fillets are whole fillets with belly flap ("nugget") removed. The yield of shank fillets ranges from 80 to 89% of the whole fillet, the remainder being nuggets. These variations arise from the method of filleting and/or the amount of nugget left on the shank fillet. In essence, some plants sell more of the fillet as a nugget than do others.

For the purposes of this stud was assumed that the average s of a catfish for processing was 1 pounds. Based on this assumpt the dressing percentages used the various product forms w whole fish 60%, whole fillets 4 and steaks 55%. The annual dres weight distributions for the f model plants, based on the giv product mix and the assumed dre ing percentages, are presented Table 1.

Plant Facilities

Real Estate

Selection ot a plant site is critical, and making this decision requires careful consideration. The foremost consideration should be proximity to the cafish farms. Other factors include (1) site accessibility, including convenient connections with highway systems and railroad lines; (2) size, shape and cost of the site, including preparation and development; (3) availability and cost of utilities at the site; (4) industrial zoning status of the site, existing easements and other legal considerations; (5) availability of suitable labor; (6) availability of fire protection and police security and (7) annual taxes and insurance rates for the site.

All model plants were assumed to be in the Delta of Mississippi. Plants were assumed to be located on a paved road where three-phase el tricity and a water system capal of supplying 500 gallons per min were available. Availability of municipal sewage system was n assumed; thus, cost of a was treatment system adequate for tre ment and discharge of plant efflue was included in the study. La meeting these requirements has estimated average value of $2,0

Table 1. Annual dressed weight distribution of product mix for four model catfish processing plants, Delta area of Mississippi, 1983

Product Form	Plant Size Model I	Model II	Model III	Model IV
	------------	thousands	of pounds	------------
Whole (ice pack)	576.0	1,152.0	1,728.0	2,880.0
Whole (tray pack)	576.0	1,152.0	1,728.0	2,880.0
Whole (frozen)	1,152.0	2,304.0	3,456.0	5,760.0
Total whole	2,304.0	4,608.0	6,912.0	11,520.0
Fillets (ice pack)	345.6	691.2	1,036.8	1,728.0
Fillets (tray pack)	345.6	691.2	1,036.8	1,728.0
fillets (frozen)	691.2	1,382.4	2,073.6	3,456.0
Total fillets	1,382.4	2,764.8	4,147.2	6,912.0
Steaks (ice pack)				
Steaks (tray pack)	52.8	105.6	158.4	264.0
Steaks (frozen)	52.8	105.6	158.4	264.0
Total steaks	105.6	211.2	316.8	528.0
Total	3,897.6	7,795.2	11,692.8	19,488.0

r acre. Land requirements and sts are presented in Table 2.

Land requirements were based ı requirements for buildings, a ceiving and holding area for live tfish, parking, loading and area r the waste-water treatment faci- ty. Additional area also was allow- l for each plant around the waste- ater lagoon to satisfy state law quirement of a 300 foot buffer one on all sides of the waste-treat- ıent facility.

Waste - Treatment Facility

The method of effluent disposal used by a catfish processing plant depends largely upon the facility location and the accessibility of a municipal sewage system. Alternatives include (1) use of an existing system capable of handling the needs of the plant and pretreating effluent before discharge; (2) locating this facility in the country, with treatment and discharge into an existing drainageway and (3) locating the facility in the country and treating and storing the effluent for irrigation purposes. Methods (2) and (3) necessitate primary and secondary treatment of effluent before discharge or use for irrigation.

For the purposes of this study, the second method was chosen because (1) there are apparent

Table 2. Estimated land requirements and costs for four model catfish processing plants, Delta area of Mississippi, 1983

Facility Area	Unit	Plant Size			
		Model I	Model II	Model III	Model IV
Receiving[a]	sq. ft.	3,680	4,960	6,240	8,800
Building[b]	sq. ft.	15,004	22,212	28,850	42,005
Waste treatment[c]	sq. ft.	558,000	729,189	818,389	981,504
Parking and loading[d]	sq. ft.	20,250	32,940	45,630	65,070
Miscellaneous[e]	sq. ft.	42,445	55,353	62,240	74,450
Total land	sq. ft.	639,376	844,654	961,349	1,171,829
	(Acres)	(14.68)	(19.39)	(22.07)	(26.90)
Total cost	dollars	29,356	38,781	44,139	53,803

a/ Includes holding vats and live haul area.

b/ Includes eviscerating and processing rooms, refrigeration, offices, break room, and storage.

c/ Includes area for buffer zone.

d/ Based on two employees per parking space.

e/ Includes area between plant and waste treatment facility as well as an area for landscaping.

advantages to locating outside municipalities and (2) the economic feasibility of using the effluent for irrigation in the Delta has not been investigated.

The level of effluent treatment necessary to meet federal regulations is dependent upon the flow of the drainageway into which the effluent is discharged. The greater and more consistent the flow of water in the drainageway, the less stringent are the regulations regarding the levels of effluents. For this study, it was assumed that there was year-round flow and that plants would be located on drainageways where flows are adequate.

Size of waste-treatment facilities needed varies according to the daily processing capacities of the plants. Costs of the waste-treatment facilities necessary for the four model plants are presented in Appendix Tables 1-4. Costs include construction, a pump station, engineering fees and permits required for construction, but do not include cost of land.

Building Requirements

Capital outlays necessary for modern catfish processing plants are mainly for buildings, processing equipment and trucks. Building costs are dependent upon several factors, such as the topography of the land and the type of building constructed.

For this analysis, it was assumed that the plants would be constructed on relatively level land. The general construction of the building w[illegible] assumed to be of metal wi[illegible] masonry interior walls. Cost es[illegible]mates reflect varying concrete sl[illegible] depths as necessary depending up[illegible] the freezer-cooler space in a par[illegible]cular plant.

Building layouts, in general, we[illegible] synthesized on the basis of th[illegible] equipment requirements for pr[illegible]cessing the given product mix. Floo[illegible] space requirements were based o[illegible] the square footage needed for th[illegible] specified equipment, as well as wall[illegible]ways and workspace requirement[illegible] in each general area of the pro[illegible]cessing facility. Average construc[illegible]tion costs of $45 per square foo[illegible] were used for all the model plants[illegible] Space requirements for specifi[illegible] plant area and construction cost[illegible] are presented in Table 3.

Table 3. Estimated building requirements and costs for four model catfish processing plants, Delta area of Mississippi, 1983

Facility Area	Unit	Plant Size Model I	Model II	Model III	Model IV
Receiving	sq. ft.	3,680	4,960	6,240	8,800
Eviscerating room	sq. ft.	2,025	2,925	3,825	5,700
Processing room	sq. ft.	4,050	5,850	7,650	11,400
Office	sq. ft.	5,306	6,557	7,330	8,409
Refrigeration	sq. ft.	1,880	3,762	5,642	9,406
Offal and equipment	sq. ft.	743	1,073	1,403	2,090
Miscellaneous	sq. ft.	1,000	2,000	3,000	5,000
Total	sq. ft.	18,684	27,172	35,090	50,805
Unit cost	$/sq. ft.[a]	45	45	45	45
Total cost	dollars	840,780	1,222,740	1,579,050	2,286,225

[a] Includes costs for building, mechanical, electrical, boilers, driveways and parking lot. Does not include any costs for refrigeration or processing equipment.

[2] *This rate was provided by a major building-construction firm that has been involved in constructing catfish processing plants in the area.*

Receiving

The receiving area is for unload-ng catfish from live-haul trucks nto holding vats, where the fish re kept alive until processed. Hold-ng vats were assumed to be 45 feet ong by 4 feet wide, sloping from 3 eet deep at one end to 4 feet deep at he other. This allows ease of exit rom the holding vat as fish are ssentially water flumed into a wait-ng receiving basket. Each vat can old about 4000 pounds of live cat-ish.

It was assumed that each plant has a catfish holding capacity equal to one-half of its daily processing capacity. This ensures a processing supply when delays are incurred in procuring fish. The receiving-area space requirements for each plant are presented in Table 3.

Parking and Loading

Space requirements for parking, loading-out processed fish and drive-ways were estimated on the basis of the number of employees and the size of the plant. Parking space was calculated on the basis of a require-ment of 270 square feet per car. It was assumed that employees travel to work in groups of two, on the average. Space requirements for driveways and loading areas were based on the number of trucks at the dock, turnaround and parking requirements and the drive area. This area was about the same as employee parking in each instance. Space requirements for the parking and loading areas for each model plant are presented in Table 2.

Equipment Requirements

All equipment needed to process e given product mix adequately as considered for each model plant. he equipment needs of the respec-ve plants were grouped into eneral categories, or phases, in e order that they occur in the rocessing cycle. These include (1) ceiving, (2) heading and eviscerat-g, (3) skinning, (4) chilling, (5) rting, (6) filleting, (7) ice packing,) tray packing, (9) steaking, (10) dividual quick freezing, (11) refri-eration, (12) offal disposal and 3) welfare and offices. In many stances, alternative technology available for individual phases the processing cycle. A cost com-arison of alternative technology as used as a basis for determining e most efficient equipment avail-ble for each phase of processing.[3] he text that follows discusses alter-ative technologies available for iven phases and the technology hosen for inclusion in the study. quipment requirements and associated costs are presented in Appendix Tables 1-4.

Receiving

The equipment requirements for the receiving area include an over-head track system with a track scale for weighing catfish. A steel track is attached to the metal trusses of the building, and an electrical hoist and trolley maneuver baskets of fish along this track. The hoist and trolley should have a capacity of about 10,000 pounds. Receiving baskets, which usually are made of stainless steel mesh with a drop bottom, also are needed to hold the fish during movement through the receiving area.

When the receiving baskets of fish reach the entrance to the eviscerating room, a holding struc-ture and an electrical shock system are needed. The catfish are trans-ferred from the receiving baskets into the holding structure and are then conveyed through an electrical shock system to immobilize them.

Heading and Eviscerating

Head removal generally can be done by one of two methods---a handfed meat type bandsaw or an automated system. The bandsaw line, more commonly referred to as a headsaw line, is highly labor intensive, requiring more than twice the labor of an automated line. However, the capacity of the head-saw line is greater than that of the automated line.

The annual ownership and operat-ing costs of the two systems are very close. A comparison indicated that the headsaw line is slightly more cost efficient under the produc-tion, wage and interest rates used. The eviscerating machine, which

[3] Detailed cost analyses are contained in Fuller, Marty J., "Cost-Size Relationships in the Processing of Farm-Raised Catfish in the Delta Area of Mississippi," Unpublished Ph.D. Dissertation, Department of Agricultural Economics, Mississippi State University, May 1984.

removes the entrails, sometimes creates a bottleneck in the automated line and slows production; whereas, conventional evisceration methods have no apparent problems. If the eviscerating machine could be modified to keep up with the header of the automated system, it undoubtedly would be the more efficient of the two technologies.

Based on the cost comparisons of the two systems and the present problem with the automated eviscerating machine, the headsaw line was chosen for use in this study. The equipment requirements for this particular line include (1) a distribution conveyor, (2) two layup tables, (3) two headsaws, (4) a belly-split table, (5) a six-station vacuum eviscerating system, (6) a two-tier conveyor and (7) a stainless steel belt conveyor. A schematic of the two-headsaw line is shown in Figure 2.

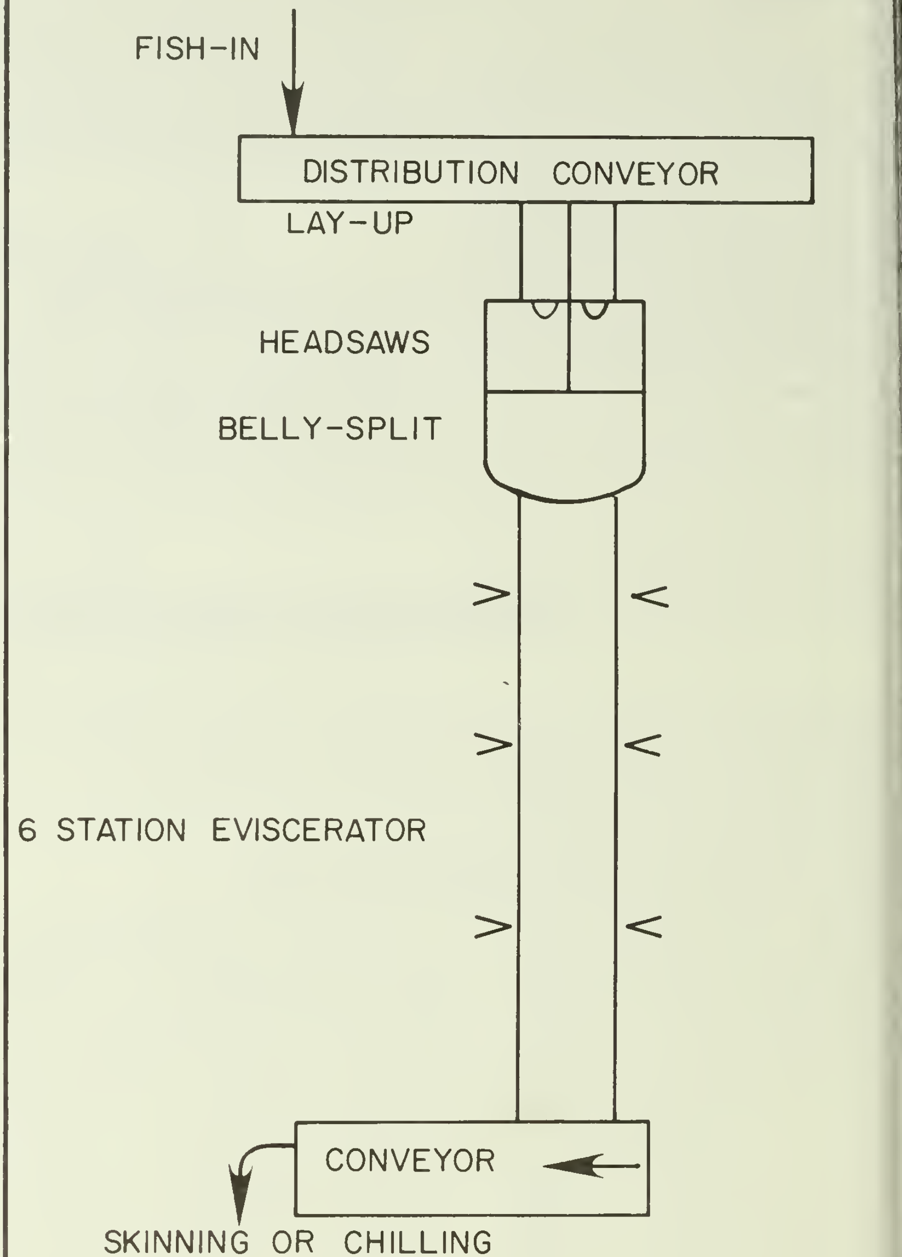

FIGURE 2. AN ILLUSTRATION OF THE TWO-HEADSAW CATFISH PROCESSING LINE.

Skinning

Skinning of whole catfish is accomplished by a mechanical skinner. The fish are passed by hand over a rotary drum and knife mechanism and the skin is pulled from the fish. Machines in use at present were developed for skinning other products and have been adapted for skinning catfish. Skinning costs used in this study were based on the predominant skinning machine used in the industry. Automated equipment is available for skinning fillets, but not whole catfish.

Chilling

The chilling phase of the processing cycle involves reducing the temperature of the beheaded, eviscerated and skinned fish to a temperature of 39° to 40°F. Alternatives available for chilling include ice-bath chillers and refrigerated jacketed chillers. In both instances, the fish are conveyed and dropped into the entrance end of the chiller, are moved by a network of paddles to the other end and are conveyed out of the chiller.

The ice-bath chiller is basically a large stainless steel tub that contains water and requires ice to kee[p] the water cold. The jacketed chill[er] requires ice only at start-up an[d] refrigeration cools the water for th[e] remainder of the processing da[y]. The trade-off between the tw[o] systems is relatively high initi[al] ost of the jacketed system against he relatively high operating cost ce requirements) of the ice-bath hiller. Based on a total cost comarison of the two systems, the acketed chiller was chosen for the nodel plants.

orting

Individual sorting allows the proessor to divert fish of different size the proper processing areas. For nstance, the smaller to mediumize fish usually go to whole fish rocessing while the larger fish enerally are processed as steaks r fillets. Further sorting usually is equired after the fish reach a esignated processing area. Most arm-raised catfish product forms re packaged in two-ounce increnents, and it is important that hese packaging increments be accuate. Thus, individual weighing of he various product forms is required.

Hand sizing and automated sizing re the two main alternatives availble to the processor. A cost comparion indicated that an automatic ystem supplemented with hand zing would be more cost-effective the model plants.

illeting

Filleting of catfish can be done y hand or by automated equipment. Hand filleting is highly labor intenive while automatic filleting is ighly capital intensive. Factors ther than the labor-capital tradeff between automated and hand illeting are involved in comparing he two approaches. First, based on imited data, it appears that the ercentage yield of shank fillet iffers by method. Second, a true ugget is obtained from hand filleting while the automatic equipment oes not produce a nugget per se. The meat left on the frame is wasted unless it is separated from the frame and sold in minced form. Therefore, the selling prices of shank fillets, nuggets and possible minced product enter into the comparison of the two methods.

A cost and returns comparison based on the limited data available revealed that hand filleting is slightly more cost-effective than is the automatic equipment under the assumed production, wage and interest rates used in the study. However, small changes in wages, performance rates, dressing percentage of shank fillets, interest rates or any combination of the above may alter the economics of hand versus machine filleting.

Steaking

Catfish are cut into steaks by a bandsaw. The operator feeds the fish along a guide that is set according to desired thickness and the steaks are channeled to the proper packing area.

Automatic steaking machines are available, but the standard bandsaw was used for purposes of this study. The quantity of steaks produced with the product mix used for this study was not sufficient to justify the automatic equipment for any of the model plants.

Ice Packing

Ice packing of catfish is a relatively straightforward procedure. Ice is conveyed by an auger from the ice room to suspended ice drops that deposit pre-measured amounts of ice into ice-pack boxes. After fish are placed into the boxes and covered with ice, the boxes are topped, strapped and conveyed to a holding cooler.

The necessary equipment includes a screw auger, ice drops and an ice machine. The auger and drops are included in the building construction.

Tray Packing

Most tray packing is done by machine. A liner is placed in the bottom, and the fish are placed in the tray. It is then conveyed into a machine that wraps and seals a plastic film around the product. The tray-packed fish then can pass through a pricing machine where it is weighed and priced according to pricing information that can be preprogrammed into the machine. Comparisons of two major brands of tray-packing systems revealed little difference in costs.

Individual Quick Freezing

Catfish are quick frozen, as a general rule, by carbon dioxide (CO_2). The CO_2 is used to freeze the individual pieces of fish quickly to retain product quality. Other methods, such as liquid nitrogen and mechanical freezing, are available, but their costs were not determined because of limited data.

The individual pieces of catfish are placed on a conveyor that runs through a CO_2 tunnel or spiral freezer. A dwell time of about 10-20 minutes can reduce the core temperature of the fish to about -40°F. The fish are conveyed out of the tunnel or spiral into a water-glaze bath that protects and preserves the frozen fish. The frozen products are then boxed and sent to the freezer as expeditiously as is possible.

Differences in efficiencies of spiral and tunnel freezers were noted by some industry personnel. Some believed that the CO_2 cost/lb was lower for the spiral freezer than for the tunnel freezer. A cost comparison based on data obtained from manufacturers of both tunnels and spirals suggests the spiral CO_2 freezer is more efficient.

Refrigeration

Refrigeration systems required in

modern catfish processing plants are among the more costly equipment items. The refrigeration area is composed of a cooler, a freezer and a blast freezer. The cooler, which is maintained at 28°F, is used primarily for ice-packed and chill-packed products. The freezer, maintained at about 0°F, is for the frozen product forms. The blast freezer has special functions, such as timed use for crust freezing of chill-packed product and, in some instances, an intermediate stop for frozen products. The size of the system necessary for each model plant was based on a holding capacity of two weeks inventory.

Refrigeration alternatives considered were the conventional freon system and an ammonia-type system. The ammonia system has an initial cost about twice that of the freon system but has a longer expected life and, on large systems, operates more efficiently. Nevertheless, the freon-type system was selected here because the model plants do not require refrigeration systems sufficiently large to justify the ammonia system.

Offal

As a general rule existing processing plants do not render their offal. Offal is generally conveyed from the eviscerating and processing rooms into holding tanks and transported to an off-site rendering plant. Also, the waste water is usually put through a strainer system to recover solids from the water. This reduces costs of transportation and rendering, as well as the load placed on the lagoon. Ther fore, a straining system was incorp rated in the model plants of th study.

Welfare and Offices

Office equipment requirement were based on the number of offic personnel and the respective need of each. The welfare area need were based on federal inspectio guidelines which require facilitie such as lockers and toilets. A employee break/lunch room wa included for each plant. The siz and components of this room, suc as tables and chairs, were estimate based on the number of employee in the respective plants.

Investment Requirements and Costs

Estimated investment requirements pertain only to the given product mix used in this study. Variations in the product mix may change the equipment and/or facility make-up and in turn alter the investment requirements. Furthermore, the total investment estimates (Table 4) do not include investment in harvesting and hauling equipment for live fish and distribution equipment (trucks) for processed products.

Building costs represent a major portion of the total investment, ranging from 52 to more than 54% of the total (Table 5). Processing room equipment comprises the second major cost item, ranging from 18 to more than 20% of total investment. Investment in the remaining necessary items varied from less than 1 to slightly more than 7% of the total.

Table 4. Estimated investment requirements for four model catfish processing plants, Delta area of Mississippi, 1983

Item	Plant Size: Model I	Model II	Model III	Model IV
	----------dollars----------			
Land	29,356	38,781	44,139	53,803
Waste treatment facility	80,000	110,000	160,000	200,000
Buildings	840,780	1,222,740	1,579,050	2,286,225
Receiving equipment	16,780	19,780	22,780	35,560
Eviscerating room	89,308	139,020	187,732	302,776
Processing room	323,101	448,239	537,982	854,604
Refrigeration	61,032	96,172	120,578	179,236
Material handling	21,605	22,085	39,840	61,925
Cleanup	11,935	13,870	15,805	27,740
Furniture	25,350	36,421	45,120	53,064
Miscellaneous equipment	67,851	88,460	110,876	175,896
Waste handling	31,625	32,300	47,300	62,050
Total	1,598,723	2,267,868	2,911,202	4,292,879

Table 5. Estimated investment requirements expressed as a percentage of total investment for four model catfish processing plants, Delta area of Mississippi, 1983

Item	Plant Size			
	Model I	Model II	Model III	Model IV
	percent			
Land	1.84	1.71	1.52	1.25
Waste treatment facility	5.00	4.85	5.50	4.66
Buildings	52.59	53.92	54.24	53.26
Receiving equipment	1.05	.87	.78	.83
Eviscerating room	5.59	6.13	6.45	7.05
Processing room	20.21	19.76	18.48	19.91
Refrigeration	3.82	4.24	4.14	4.18
Material handling	1.35	.97	1.37	1.43
Cleanup	.75	.61	.54	.65
Furniture	1.59	1.61	1.55	1.24
Miscellaneous equipment	4.24	3.90	3.81	4.10
Waste handling	1.98	1.42	1.62	1.45
Totals[1/]	100.0	100.0	100.0	100.0

[1/]May not add due to rounding.

)wnership Costs

Ownership costs (fixed costs) of ırable assets occur even if the ssets are not used. These costs ıclude depreciation, interest, taxes ıd insurance. Procedures employ- l in calculating the annual owner- ıip cost estimates (Table 6) for the ur model plants are as follow:

Depreciation

Depreciation was calculated by the straight-line method based on estimated useful life of each piece of equipment (Appendix Tables 1-4). A zero salvage value was assumed for all buildings, facilities and equipment because little is known about salvage values of much of the equipment used in catfish processing.

Interest

Interest at a rate of 12% was charged on one half of the original investment in depreciable items such as buildings and equipment. Non-depreciable items, such as land and lagoons, were charged at an interest rate of 11.5% on the full inventory value.

Table 6. Estimated annual costs for four model catfish processing plants, Delta area of Mississippi, 1983

Item	Plant Size			
	Model I	Model II	Model III	Model IV
	--------dollars--------			
Annual Ownership Costs				
Depreciation	99,523	140,705	182,298	280,315
Insurance	28,000	44,289	61,992	108,247
Interest	101,940	143,654	185,902	271,186
Taxes	10,761	15,265	19,595	28,895
Sub-Total	240,224	343,913	449,787	688,643
Annual Operating Costs				
Personnel				
Wages	604,043	967,325	1,429,260	2,152,977
Salaried	467,112	779,052	990,570	1,255,360
Utilities				
Electricity	35,050	54,224	66,879	107,145
Water	3,756	9,132	14,508	25,260
Telephone	41,143	54,857	82,286	96,000
Repairs and Maintenance	41,680	59,004	74,457	118,199
Supplies and Services				
CO_2	77,986	155,971	233,957	389,928
Packaging	202,560	405,120	607,680	1,012,800
Misc. Supplies & Services[a]	21,060	36,120	51,182	81,302
General Office Overhead	28,696	47,120	64,607	93,226
Sub-Total	1,523,086	2,567,925	3,615,386	5,332,197
Interest on Operating Capital	65,151	125,519	185,914	302,922
Total Annual Operating Costs	1,588,237	2,693,444	3,801,300	5,635,119
Total Costs	$1,828,461	$3,037,357	$ 4,251,087	$ 6,323,762
Cost per Pound[b]	.4691	.3896	.3636	.3245

[a] Includes private laboratory fees, chemicals, fillet knives, uniforms, assorted tools and supplies for maintenance, and bathroom supplies.

[b] Based on pounds processed annually (dressed weight) from Table 1.

Insurance

Insurance coverage for each of the model plants includes fire, vandalism and malicious mischief and extended coverage. Extended coverage includes hail, windstorm, smoke, riot or civil commotion and explosion. A base rate of $1.60 per $100 of buildings and equipment was used for a plant of 7500 square feet. An excess area charge amounting to 2 1/2 cents per 1000 square feet was used to calculate the additional rate per $100 of buildings and equipment for the four model plants.

Taxes

Property taxes are considered ırt of annual ownership costs, ıd an average rate applicable to e Delta area of Mississippi was ed. The standard assessment is ısed on the appraised value of nd, buildings, equipment and the erage inventory on January 1 of ch year. The appraised value was sumed to be original cost, and the erage inventory was assumed to two weeks production at capacity. ıe value of the inventory was timated as 15% of the appraised ılue of land, buildings and equipent. The average tax rate used to termine annual taxes incurred the model plants was 58.53 mills.

perating Costs

Operating costs (variable costs) clude labor, utilities, repairs and aintenance and necessary ıpplies such as CO_2 gas, boxes, ays, film, general office overhead ıd interest on operating capital 'able 6).

Personnel

Labor requirements for the four odel plants were estimated on the ısis of each plant's level of output, anufacturers' specifications, engieering studies, personal interviews ith plant personnel and, in some ıses, time-motion studies of partiılar phases of processing. The ourly employee requirements for ıch model plant are presented by hase of operation in Appendix able 5.

The average wage rate used for rocessing labor was $3.71 per hour. /age rates for maintenance and ecurity personnel were set at $5.00 er hour. These rates are representave of wages paid in 1983 in Missisippi catfish processing plants. /age rates were increased by 15% ɔ cover fringe benefits for the ourly employees.

Numbers of salaried personnel and salary levels were estimated using data obtained from personal interviews with managers of existing processing plants. Salaried personnel requirements for each model plant are presented in Appendix Table 6. A rate of 20% was used for fringe benefits for salaried personnel. Appendix Table 7 shows salary costs by position.

Utilities

Electricity Requirements and Costs---Electricity is used in catfish processing primarily for lighting and for operating electric motors. Survey of existing processors revealed that the refrigeration equipment consumed about one-fourth of the total electricity required. Once the electrical consumption for refrigeration equipment was determined, the consumption was quadrupled to reflect the needs of the entire plant.

Electricity requirements for refrigeration in the model plants were calculated on the basis of the horsepower necessary to run the equipment. Efficiency of motors of different sizes used was obtained from engineering studies. The cost of electricity was estimated for the respective model plants by applying the November 1983 Mississippi Power and Light Company rates for the Delta area of Mississippi to the estimates of consumption.

Water Requirements and Costs---Large amounts of water are needed by catfish processing plants. Water is needed for holding vats, processing equipment, clean-up, ice making and for use by plant personnel. Consumption requirements for the model plants were based on actual use by existing plants. Water consumption by the industry averages 2 gallons of water per liveweight pound of fish.

The cost of water consumed by each of the model plants was determined by applying the 1983 average water rates existing in the study area to the estimates of consumption. Rates used were $215 for the first one million gallons plus $.35 per 1,000 gallons in excess of one million gallons.

Telephone Service and Costs---Monthly service and equipment charges for each of the model plants were estimated according to the number of salaried personnel and the number of lines, intercoms and related equipment for each model plant. Long distance billing was based on the industry average prevailing at the time of the study.

Repairs and Maintenance

Annual repairs and maintenance for the four model plants were computed from estimates of average repairs over the life of the component as a percentage of the estimated purchase price. Estimated life and repair and maintenance costs were obtained from manufacturers' specifications, dealer estimates and estimates from processing plant personnel.

Supplies and Services

The total cost of CO_2 used to quick-freeze individual pieces of catfish in each plant was based on a cost of 3.85 cents per pound of frozen fish. Packaging supplies for processed catfish vary according to product forms. The major items include boxes for ice-packed, individually quick-frozen and chill-packed products and trays, pads, film, stickers and tape. Costs of packaging supplies were estimated to be 5 cents per pound of processed fish (average of all product forms). Office supplies and general overhead were estimated as slightly less than 2% of annual operating cost.

The major items in miscellaneous supplies and services are chemicals for the tri-phosphate injector, cleaning systems and chlorination of water. Also included in the estimate is a charge for private laboratory services. The amount and cost of injection solutions were obtained from dealers. Fees for private laboratory work were obtained from processing plant personnel.

Interest on Operating Capital

Interest on operating capital was based on an annual rate of 12%. It was assumed that the operating capital necessary for the plant was one-twelfth of total annual operating cost plus the cost of live catfish F.O.B. processing plant for one month. A price of 65 cents per pound live-weight was assumed as the purchase price.

Total Costs

Ownership costs ranged from 10.58% of total cost in Model III to 13.14% of total cost in Model I (Table 7). Depreciation and interest were the major ownership cost items and ranged from almost 9 to slightly more than 11% of total annual cost.

Annual operating cost was about 88% of total cost. Personnel cost ranged from slightly more than 53% to slightly more than 58% of total cost. No other operating cost accounted for more than 16.02% of total cost, and most other items accounted for less than 5% of total cost.

Table 7. Estimated annual cost components expressed as a percentage of total costs for four model catfish processing plants, Delta area of Mississippi, 1983

Item	Plant Size			
	Model I	Model II	Model III	Model IV
	---------------percent---------------			
Annual Ownership Costs				
Depreciation	5.44	4.63	4.29	4.43
Insurance	1.53	1.46	1.46	1.71
Interest	5.58	4.73	4.37	4.29
Taxes	.59	.50	.46	.46
Sub-Total	13.14	11.32	10.58	10.89
Annual Operating Costs				
Personnel				
Wages	33.04	31.85	33.62	34.05
Salaried	25.55	25.65	23.30	19.85
Utilities				
Electricity	1.92	1.79	1.57	1.69
Water	.21	.30	.34	.40
Telephone	2.25	1.81	1.94	1.52
Repairs and Maintenance	2.28	1.94	1.75	1.87
Supplies and Services				
CO_2	4.27	5.14	5.50	6.17
Packaging	11.08	13.34	14.29	16.02
Miscellaneous Supplies	1.15	1.19	1.20	1.29
General Office Overhead	1.57	1.55	1.52	1.47
Interest on Operating Capital	3.56	4.13	4.37	4.79
Sub-Total	86.86	88.68	89.42	89.11
Total[1/]	100.0	100.0	100.0	100.0

[1/]May not add due to rounding.

Annual total costs were [illegible]1,828,461, $3,037,357, $4,251,087 [a]nd $6,323,762 for Models I, II, III, [a]nd IV, respectively (Table 6). Cost [p]er pound of processing catfish were [.]4691, $.3896, $.3636 and $.3245 for [th]e respective models, evincing sub[st]antial decreases in per-unit costs [a]s plant size increased.

More than one half of the operat[in]g cost for each model plant was [fo]r wages and salaries. Labor and [s]alary costs per pound decreased as plant size increased. Wages and salaries totaled more than 27 cents per pound in Model I and decreased to 22.4, 20.7 and 17.5 cents per pound in successive models (Table 8). Much of this decrease is explained by the fact that numbers of management and supervisory personnel do not increase in proportion to increases in size of plant.

The estimated total, ownership and operating costs per pound reveal substantial economies of size in processing farm-raised catfish (Figure 3).

Effects of Varying Wage Rates

To determine the effects of higher wages on total annual costs of processing for each of the model plants, the effective hourly wage rate was increased from $3.71 to $4.96 in increments of 25 cents. Fringe benefits for each of the wage rates were

Table 8. Estimated annual cost components expressed in cents per pound for four model catfish processing plants, Delta area of Mississippi, 1983

Item	Plant Size			
	Model I	Model II	Model III	Model IV
	cents			
Annual Ownership Costs				
Depreciation	2.55	1.80	1.56	1.44
Insurance	.72	.57	.53	.55
Interest	2.62	1.84	1.59	1.39
Taxes	.28	.19	.17	.15
Sub-total	6.16	4.41	3.85	3.53
Annual Operating Costs				
Personnel				
Wages	15.50	12.41	12.22	11.05
Salaried	11.99	9.99	8.47	6.44
Utilities				
Electricity	.90	.70	.57	.53
Water	.10	.12	.12	.13
Telephone	1.06	.71	.71	.49
Repairs and Maintenance	1.07	.76	.64	.61
Supplies and Services				
CO_2	2.00	2.00	2.00	2.00
Packaging	5.20	5.20	5.20	5.20
Miscellaneous Supplies	.54	.46	.44	.42
General Office Overhead	.74	.60	.55	.48
Interest on Operating Capital	1.67	1.61	1.59	1.55
Sub-Total	40.75	34.55	32.51	28.92
Total[1/]	46.91	38.96	36.36	32.45

[1/]May not add due to rounding.

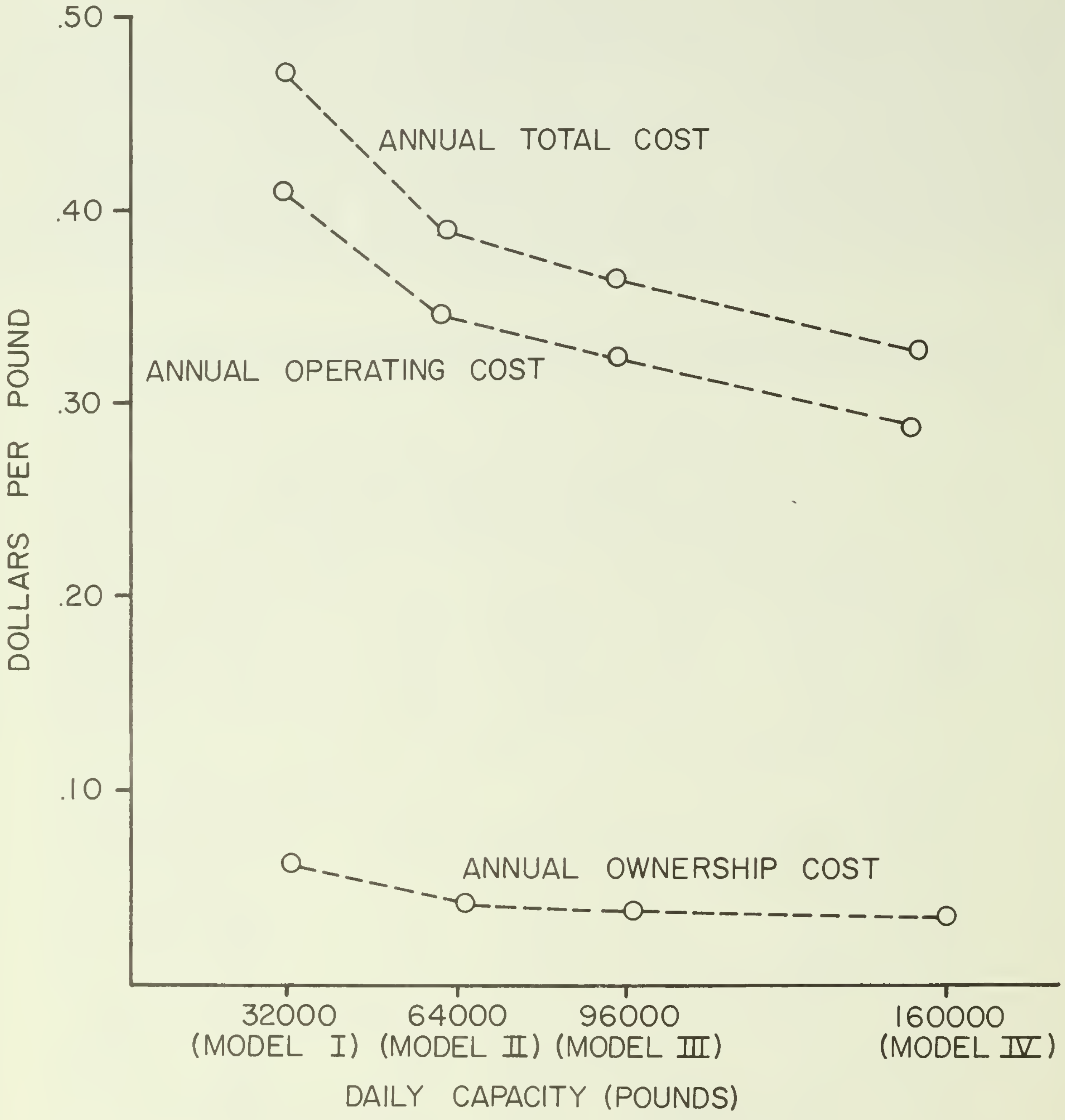

FIGURE 3. TOTAL, OPERATING AND OWNERSHIP COSTS PER POUND OF PROCESSING CATFISH, BY SIZE OF PLANT.

sumed to be 15%. Generally, with ces of other inputs held constant, ch 25 cent increase in the wage e increased total cost from .74 to 4 cents per pound, depending on int size (Table 9). This may not appear dramatic in this context, but, when viewed from the total annual cost basis, the effects are more readily observable. For instance, a 1 cent cost increase per pound results in increases in total cost, ranging from $38,976 for Model I to $194,880 for Model IV. Thus, a small variation in the wage rate has a significant impact on total cost of processing.

Table 9. Estimated total cost per pound of processing catfish at selected wage rates, four model catfish processing plants, Delta area of Mississippi, 1983

Wage Rate	Plant Size Model I	Model II	Model III	Model IV
	dollars			
$3.71	.4691	.3896	.3636	.3245
3.96	.4795	.3980	.3718	.3319
4.21	.4899	.4064	.3800	.3393
4.46	.5003	.4148	.3882	.3467
4.71	.5107	.4232	.3964	.3541
$4.96	.5211	.4316	.4046	.3615

Summary, Conclusions and Limitations

An economic-engineering proach was used to estimate instment requirements and costs of ocessing catfish in the Delta of ississippi. Performance rates of e most efficient technologies available for heading and eviscerating erations were used to synthesize ants with daily processing capaies of 32,000, 64,000, 96,000 and 0,000 pounds of catfish (liveeight). For the analysis, the plants ere designated Models I-IV.

The product mix, derived from dustry averages adjusted for excted near-future change, was 60% hole fish, 35% fillets and 5% steaks. ne half of each product volume was to be processed as fresh fish, the remainder as frozen. The fresh fish were divided equally between ice-packed and chill-packed (tray-packed). Data for selecting the most efficient method and equipment for each processing operation were obtained from processors' records, manufacturers' specifications, dealer estimates and in some instances, time and motion studies.

Estimated investment requirements at 1983 prices ranged from $1.6 million for the least of the four plants to about $4.3 million for the largest. In each instance, building cost amounted to slightly more than one half of the total investment requirement, and equipping the eviscerating and processing room amounted to another one fourth.

Estimates of total annual costs in the four synthesized establishments ranged from $1.8 million to $6.3 million. Estimates of ownership costs (depreciation, interest on investment, taxes and insurance) ranged from $240,224 to $688,643. Annual operating cost estimates ranged from about $1.6 million to $5.6 million and accounted, on average, for about 88% of total annual costs.

At these costs and processing volumes, processing costs per pound (unit costs) were 46.91¢ in Model I (the least-volume plant); 38.96¢ in Model II; 36¢ in Model III and 32.45¢ in Model IV (the largest plant). Ownership costs (fixed costs) declined sharply---from 6.16¢ to 3.53¢---as plant size (volume) increased. Operating costs per pound decreased from 40.75¢ in Model I to 28.92¢ in Model IV, indicating major economies in size of processing in larger plants.

A drop in salary and labor costs from 27.49¢ to 17.49¢ per pound of processing fish over the range of plant sizes indicates increases in efficiency in the use of both salaried personnel and laborers. Even small increases in labor efficiency have significant impact on unit costs because cost of hourly labor comprise 31-34% of total costs. Conversely, small increases in wage rates can increase unit costs appreciably. Indications are that a 25 cent increase in wage rates, other things being equal, would result in processing cost increases ranging from .74¢ in the largest plant to 1.04¢ per pound in the smallest.

The largest plant studied achieved the most economies of size, and it is possible that even larger plants may have lower costs. For example, some processing technologies, such as automated steaking and ammonia refrigeration systems, were not included in the model plants because of insufficient volume to justify these technologies. Also, it is likely that per-unit cost reductions associated with marketing and distribution of product from larger plants will more than offset additional per-unit procurement costs as plant size increases.

Costs of livehauling fish to the plant and distribution costs of the processed product were not included in the study. Also, some marketing costs, such as advertising and brokerage, were not included. More research is needed to determine cost-size relationships associated with procurement and marketing and distribution of farm-raised catfish.

The lack of data relating to some alternative equipment items caused the omission of these items from cost comparisons with their counterparts. Alternative technology exists for a particular phase of processing in some instances, but adequate data could not be obtained. Therefore, change to a more efficient piece of equipment for a given phase could slightly alter the cost of processing figures derived in this study.

Additionally, when comparing alternative technologies for a given phase, dressing percentages and product prices in some instances played a major role in the determination of the most efficient technology. Slight changes in dressing percentage, relative product prices, interest rate and wage rate could modify the equipment make-up formulated for the plants in this study. In turn, the cost of processing coefficients would be altered, and the cost-size relationships dicussed in this study possibly may be affected.

The model catfish processing plants are highly labor intensive. If wage rates should increase relative to interest rates, more automation would be included in the processing plants, and in turn, the cost of processing estimates would be altered. It is likely that the economies outlined in this study could be affected by this relative change.

Cost estimates derived in this study are consistent with the underlying assumptions made and may not reflect actual cost of any one plant existing in the study area. For example, at the time of this study, some plants were not operating at one-shift capacity and may have costs higher than those reported here.

Appendix Tables

Table 1. Estimated land, building and equipment requirements, initial investment, expected life and associated annual costs, Model Plant I, Delta area of Mississippi, 1983

Item	Quantity	Estimated New Cost	Expected Life	Annual Repairs	Annual Interest	Annual Depreciation
		($)	(Years)	($)	($)	($)
Land	Lot	29,356	--	--	3,376	--
Waste treatment facility	Lot	80,000	--	--	9,200	--
Buildings	Lot	840,780	25	8,408	50,447	33,631
Receiving area						
Shock system	1	4,000	5	200	240	800
Basket holding structure	1	4,000	20	--	240	200
Haul baskets	2	6,000	20	--	360	300
Overhead track scales	1	2,780	5	139	167	556
Eviscerating room						
Layup tables	2	1,200	15	--	72	80
Belly split tables	1	600	15	--	36	40
Headsaw	3	6,912	6	1,152	414	1,152
Vacuum eviscerator	1	9,000	6	675	540	1,500
Freon chiller	1	33,200	10	1,328	1,992	3,320
Automatic skinner	4	29,000	5	4,352	1,740	5,800
Two tier conveyor	1	4,116	5	412	247	823
Transfer conveyor	1	2,000	3	200	120	667
Elevating conveyor	1	3,280	5	230	197	656
Processing room						
Automatic sorter	1	62,555	10	1,251	3,753	6,256
Roller conveyor	1	1,260	15	--	76	84
Sort/pack tables	4	4,000	15	--	240	268
Electronic scales	4	10,056	5	504	604	2,012
Fillet table	1	17,000	8	850	1,020	2,125
Tray pack system	1	29,480	5	2,948	1,769	5,896
CO_2 freezer	1	108,350	15	4,334	6,501	7,223
CO_2 tank	1	30,000	15	--	1,800	2,000
Tri-phosphate injector	1	42,500	15	5,950	2,550	2,833
Box taping system	1	4,400	10	110	264	440
Ice machine	1	13,500	10	675	810	1,350
Material handling						
Fork truck	1	17,275	15	864	1,037	1,152
Walkie	1	3,850	15	385	231	257
Floor pallet mover	1	480	15	48	29	32
Clean-up						
Foam cleaning system	1	1,935	10	48	116	194
High pressure washdown	1	10,000	10	500	600	1,000
Office furniture & equip.	Lot	25,350	1/	--	1,521	2,768
Waste handling						
Offal tank	1	13,750	20	--	825	688
Offal strainer	1	7,875	10	788	473	788
Offal lift conveyor	1	10,000	15	500	600	667
Refrigeration	Lot	61,032	10	3,052	3,662	6,103
Miscellaneous	Lot	67,851	2/	1,777	4,071	5,708
Totals		1,598,723	--	41,680	101,940	99,523

1/ Office chairs have an expected life of 5 years. All other office furniture and equipment was assumed to have a 15 year life.

2/ Depending on function, expected life of miscellaneous equipment ranges from 10 to 15 years.

Table 2. Estimated land, building and equipment requirements, initial investment, expected life and associated annual costs, Model Plant II, Delta area of Mississippi, 1983

Item	Quantity	Estimated New Cost	Expected Life	Annual Repairs	Annual Interest	Annual Depreciation
		($)	(Years)	($)	($)	($)
Land	Lot	38,781	--	--	4,460	--
Waste treatment facility	Lot	110,000	--	--	12,650	--
Buildings	Lot	1,222,740	25	12,227	73,364	48,910
Receiving area						
Shock system	1	4,000	5	200	240	800
Basket holding structure	1	4,000	20	--	240	200
Haul baskets	3	9,000	20	--	540	450
Overhead track scales	1	2,780	5	139	167	556
Eviscerating room						
Distribution conveyor	1	2,000	3	200	120	667
Layup tables	4	2,400	15	--	144	160
Belly split tables	2	1,200	15	--	72	80
Headsaw	6	13,824	6	2,304	828	2,304
Vacuum eviscerator	2	18,000	6	1,350	1,080	3,000
Freon chiller	1	33,200	10	1,328	1,992	3,320
Automatic skinner	8	58,000	5	8,704	3,480	11,600
Two-tier conveyor	1	4,116	5	412	247	823
Transfer conveyor	1	3,000	5	300	180	600
Elevating conveyor	1	3,280	5	230	197	656
Processing room						
Automatic sorter	1	62,555	10	1,251	3,753	6,256
Roller conveyor	1	2,520	15	--	152	168
Sort/pack tables	6	6,000	15	--	360	402
Electronic scales	6	15,084	5	756	906	3,018
Fillet table	1	49,000	8	1,730	2,340	4,875
Tray pack system	1	29,480	5	2,948	1,769	5,896
CO_2 freezer	1	189,200	15	7,568	11,352	12,613
CO_2 tank	1	30,000	15	--	1,800	2,000
Box taping system	1	4,400	10	110	264	440
Tri-phosphate injector	1	42,500	15	5,950	2,550	2,833
Ice machine	1	17,500	10	875	1,050	1,750
Material handling						
Fork truck	1	17,275	15	864	1,037	1,152
Walkie	1	3,850	15	385	231	257
Floor pallet mover	2	960	15	96	58	64
Clean-up						
Foam cleaning system	2	3,870	10	96	232	388
High pressure washdown	1	10,000	10	500	600	1,000
Waste handling						
Offal strainer	1	8,550	10	855	513	855
Offal tank	1	13,750	20	--	825	688
Offal lift conveyor	1	10,000	15	500	600	667
Office furniture & equip.	Lot	36,421	1/	--	2,185	3,977
Refrigeration	Lot	96,172	10	4,809	5,770	9,617
Miscellaneous	Lot	88,460	2/	2,317	5,307	7,442
Totals		2,267,868	--	59,004	143,654	140,705

1/ Office chairs have an expected life of 5 years. All other office furniture and equipment was assumed to have a 15 year life.

2/ Depending on function, expected life of miscellaneous equipment ranges from 10 to 15 years.

Table 3. Estimated land, building and equipment requirements, initial investment, expected life and associated annual costs, Model Plant III, Delta area of Mississippi, 1983

Item	Quantity	Estimated New Cost	Expected Life	Annual Repairs	Annual Interest	Annual Depreciation
		($)	(Years)	($)	($)	($)
Land	Lot	44,139	--	--	5,076	--
Waste treatment facility	Lot	160,000	--	--	18,400	--
Buildings	Lot	1,579,050	25	15,791	94,743	63,162
Receiving area						
Shock system	1	4,000	5	200	240	800
Basket holding structure	1	4,000	20	--	240	200
Haul baskets	4	12,000	20	--	720	600
Overhead track scales	1	2,780	5	139	167	556
Eviscerating room						
Distribution conveyor	1	3,000	3	300	180	1,000
Layup tables	6	3,600	15	--	216	240
Belly split tables	3	1,800	15	--	108	120
Headsaw	9	20,736	6	3,456	1,242	3,456
Vacuum eviscerator	3	27,000	6	2,025	1,620	4,500
Freon chiller	1	33,200	10	1,328	1,992	3,320
Automatic skinner	12	87,000	5	13,056	5,220	17,400
Two-tier conveyor	1	4,116	5	412	247	823
Transfer conveyor	1	4,000	5	400	240	800
Elevating conveyor	1	3,280	5	230	197	656
Processing room						
Automatic sorter	2	125,110	10	2,502	7,506	12,512
Roller conveyor	1	3,780	15	--	228	252
Sort/pack tables	8	8,000	15	--	480	536
Electronic scales	8	20,112	5	1,008	1,208	4,0[illegible]
Fillet table	2	44,000	8	1,760	2,640	5,500
Tray pack system	1	29,480	5	2,948	1,769	5,896
CO_2 freezer	1	189,200	15	7,568	11,352	12,613
CO_2 tank	1	30,000	15	--	1,800	2,000
Tri-phosphate injector	1	42,500	15	5,950	2,550	2,833
Ice machine	1	37,000	10	1,850	2,220	3,700
Box taping system	2	8,800	10	220	528	880
Material handling						
Fork truck	2	34,550	15	1,728	2,074	2,304
Walkie	1	3,850	15	385	231	257
Pallet mover	3	1,440	15	144	87	96
Clean-up						
Foam cleaning system	3	5,805	10	144	348	582
High pressure washdown	1	10,000	10	500	600	1,000
Waste handling						
Offal strainer	1	9,800	10	980	588	980
Offal holding tank	2	27,500	20	--	1,650	1,376
Offal lift conveyor	1	10,000	15	500	600	667
Office furniture & equip.	Lot	45,120	1/	--	2,707	5,271
Refrigeration		120,578	10	6,029	7,235	12,058
Miscellaneous	Lot	110,876	2/	2,904	6,653	9,328
Totals		2,911,202	--	74,457	185,902	182,298

1/ Office chairs have an expected life of 5 years. All other office furniture and equipment was assumed to have a 15 year life.

2/ Depending on function, expected life of miscellaneous equipment ranges from 10 to 15 years.

Table 4. Estimated land, building and equipment requirements, initial investment, expected life and associated annual costs, Model Plant IV, Delta area of Mississippi, 1983

Item	Quantity	Estimated New Cost	Expected Life	Annual Repairs	Annual Interest	Annual Depreciation
		($)	(Years)	($)	($)	($)
Land	Lot	53,803	--	--	6,187	--
Waste treatment facility	Lot	200,000	--	--	23,000	--
Buildings	Lot	2,286,225	25	22,862	137,174	91,449
Receiving area						
Shock system	2	8,000	5	400	480	1,600
Basket holding structure	1	4,000	20	--	240	200
Haul baskets	6	18,000	20	--	1,080	900
Overhead track scales	2	5,560	5	278	334	1,112
Eviscerating room						
Distribution conveyor	1	4,000	3	400	240	1,333
Layup tables	10	6,000	15	--	360	400
Belly split tables	5	3,000	15	--	180	200
Headsaws	15	34,560	6	5,760	2,074	5,760
Vacuum eviscerator	5	45,000	6	3,375	2,700	7,500
Two-tier conveyor	1	4,116	5	412	247	823
Freon jacketed chiller	1	52,500	10	2,100	3,150	5,250
Automatic skinners	20	145,000	5	21,760	8,700	29,000
Transfer conveyor	1	5,320	5	532	319	1,064
Elevating conveyor	1	3,280	5	230	197	656
Processing room						
Automatic sorter	4	250,220	10	5,004	15,013	25,022
Roller conveyor	1	5,670	15	--	340	378
Sort/pack tables	11	11,000	15	--	660	733
Electronic scales	11	27,654	5	1,386	1,659	5,531
Fillet table	3	83,000	8	3,490	4,980	10,375
Tray pack system	2	58,960	5	5,896	3,538	11,792
CO_2 freezer	1	235,400	15	9,416	14,124	15,693
CO_2 tank	1	30,000	15	--	1,800	2,000
Box taping system	3	13,200	10	330	792	1,320
Ice machine (20 ton)	1	37,000	10	1,850	2,220	3,700
Ice machine (10 ton)	1	17,500	10	875	1,050	1,750
Tri-phosphate injector	2	85,000	15	11,900	5,100	5,666
Material handling						
Fork truck	3	51,825	15	2,592	3,111	3,456
Walkie	2	7,700	15	770	462	51[illegible]
Floor pallet mover	5	2,400	15	240	144	160
Clean-up						
Foam cleaning system	4	7,740	10	192	116	128
High pressure washdown	2	20,000	10	1,000	1,200	2,000
Waste handling						
Offal strainer	1	10,800	10	1,080	648	1,080
Offal holding tank	3	41,250	20	--	2,475	2,064
Offal lift conveyor	1	10,000	15	500	600	667
Office furniture & equip.	Lot	53,064	1/	--	3,184	6,317
Refrigeration	Lot	179,236	10	8,962	10,754	17,924
Miscellaneous	Lot	175,896	2/	4,607	10,554	14,798
Totals		4,292,879	--	118,199	271,186	280,315

1/ Office chairs have an expected life of 5 years. All other office furniture and equipment was assumed to have a 15 year life.

2/ Depending on function, expected life of miscellaneous equipment ranges from 10 to 15 years.

Table 5. Hourly labor requirements by phase of operation for four model processing plants, Delta area of Mississippi, 1983

Equipment	Plant Size			
	Model I	Model II	Model III	Model IV
	---------------	Quantity	------------------	
Receiving	2	2	3	4
Eviscerating room				
Headers	2	4	6	8
Layup	2	4	6	8
Belly split	3	6	9	12
Conveyor operator	--	1	1	1
Eviscerators	5	10	15	20
Skinners	6	12	18	30
Inspect/wash	1	2	3	5
Sub-total	21	41	61	88
Processing room				
Icore loaders	2	2	3	7
Hand sort	--	1	--	--
Icore pan handlers	3	3	6	11
Filleters	13	26	39	65
Fillet pan handlers	1	2	3	5
Icers	2	2	4	6
Ice packers/boxers	2	3	5	7
Box strapper	1	1	2	2
Fillet sorters	2	3	4	6
Steakers	1	1	1	2
Pan handler	1	1	1	2
Tray packers/boxers	4	6	8	12
Sub-total	32	51	76	125
IQF belt loaders	2	3	4	6
Sorters	2	2	3	5
Boxers	2	3	4	6
Strappers	1	1	1	2
Cooler/freezer	1	1	2	2
Pallet handler	2	3	4	7
Sub-total	10	13	18	28
Clean-up	4	5	6	7
Maintenance	2	3	4	5
Security guards	3	3	6	6
Sub-total	9	11	16	18
Total hourly labor	72	116	171	259

Table 6. Estimated salaried personnel requirements for four model plants, Delta area of Mississippi, 1983

Equipment	Model Plant			
	Model I[a]	Model II	Model III	Model IV
	---Quantity---			
President	--	1	1	1
Marketing director	1	1	1	1
Comptroller	--	1	1	1
Distribution manager	1	1	1	1
Plant manager	1	1	1	1
Production superintendent	4	6	7	9
Bookkeeper	1	1	2	2
Secretary	3	5	6	7
Personnel manager	--	1	1	1
Quality control	1	1	1	2
Salesman	2	3	4	5
Customer service	1	1	2	2
Federal inspector[b]	1	1	1	1
Total salaried personnel requirements	15	23	28	33

[a] In Model Plant I, the duties of more than one position may be assigned to an employee. For example, an employee may serve as president and marketing director of the model plant.

[b] The federal inspector is paid on a half-time basis. This position is not included in the calculation of total salaried personnel requirements.

Table 7. Estimated salary costs by position for four model processing plants, Delta area of Mississippi, 1983

Position	Plant Size			
	Model I[a]	Model II	Model III	Model IV
	---dollars---			
President	61,200	67,320	74,052	81,457
Marketing director	61,200	67,320	74,052	81,457
Comptroller	46,200	50,820	55,902	61,492
Distribution manager	46,200	50,820	55,902	61,492
Plant manager	39,600	43,560	47,916	52,708
Production supervisor	26,400	29,040	31,944	35,138
Bookkeeper	19,800	19,800	19,800	19,800
Secretary	12,000	12,000	12,000	12,000
Personnel manager	33,000	36,300	39,930	43,923
Quality control	39,600	43,560	47,916	52,708
Salesman	33,000	36,300	39,930	43,923
Customer service	33,000	36,300	39,930	43,923
Federal inspector[b]	20,112	20,112	20,112	20,112

[a] Includes fringe benefits.

[b] Half-time.

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