Bio-Engineering-Economic Model for Shrimp Mariculture Systems, 1979

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ABSTRACT

A bio-engineering-economic computer model was developed to produce average annual budgets, monthly and annual cash flows, and sensitivity analysis for a commercial penaeid shrimp grow-out system design located on the Texas Gulf coast. Given the production data available, growth equations were simulated for various stocking densities. Sensitivity analysis was also performed on selected production variables and prices. A documentation of the program is presented in the Appendix along with a summary on how to run the program.

The resulting analysis of a hypothetical commercial production system gives estimates of the most likely type of operation that a potential investor would consider, that is, one that would capture most of the economies of size. An operation consisting of twenty-four 2.5-acre ponds was found to capture most economies of size.

The sensitivity analysis indicated that net returns for an operation consisting of twenty-four 2.5-acre ponds were most sensitive to changes in tail size and yield, respectively.

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LIST OF ABBREVIATIONS

Abbreviation	Description
BEE =	Bio-Engineering-Economic
BEP =	Break Even Price
IRR =	Internal Rate of Return
NR =	Net Revenue
SA =	Surface (Water) Acres
TA =	Total Acres
TC =	Total Cost
TFC =	Total Fixed Cost
TR =	Total Revenue
TVC =	Total Variable Cost

INTRODUCTION

The culture of aquatic organisms has long been a topic of interest in the United States. Whether for the purpose of supplementing natural stocks or supplementing man's diet, the practice has enjoyed increased support and made significant technological advances in the past few decades. For some vertebrate species, particularly freshwater and marine salmonids (trout and salmon), commercial culture has become an industry. One of the most popular efforts in aquaculture has been the creation of the commercial catfish farming industry in the southern United States. Production in 1977 was estimated to be 22 million processed pounds [5].

Recently the culture of marine invertebrates has received much attention as a new and possibly very lucrative industry, due to ever increasing demands and limited domestic and foreign natural resources. Much research has been devoted to molluscs (oysters, clams, and mussels) and crustaceans (shrimp, crawfish, crabs, and lobsters) by federal and state agencies as well as private industry Shrimp mariculture, in particular, has benefited from much interest and research, resulting in significant technological advances in the last decade. This interest and research in shrimp mariculture is partly due to the ever increasing demand for shrimp products, which far exceeds U.S. domestic production (48% of the 1977 shrimp product supply in the U.S. was imported), and to the very successful Japanese shrimp mariculture industry, where live shrimp bring $7-30 per kilogram on the retail market [42, 27].

Since 1969, when Texas A&M University first initiated research into penaeid shrimp mariculture, much effort has been devoted to the development of a technologically and commercially viable culture scheme. Thanks to extensive research efforts by private, university, and government facilities throughout the nation, concerning nutritional and habitat requirements, physiology, pathology, and life history of penaeid shrimp, the technological feasibility of penaeid shrimp farming in the Texas Gulf coastal region is almost a reality [9, 12, 14, 24, 28, 29, 31, 32, 45]. Additionally, considerable research has been directed toward penaeid shrimp mariculture in the Central American and Caribe regions [43].

In contrast to various trout and salmon programs, the methodology of culturing shrimp employed to date is rather unsophisticated due to the lack of control over many factors that constitute the culture process [6]. The lack of control is directly attributable to insufficient detailed knowledge of the component factors and their interaction in the culture system. Because the female of the native species in the Gulf of Mexico does not consistently mature sexually in captivity, gravid females must be obtained offshore during their natural spawning periods. This factor, coupled with limiting regional climatic conditions along the northern Texas Gulf coast, restricts culture to the late spring, summer, and early fall months. Eggs are obtained from females and reared through the larval stages in a hatchery where the environment is closely controlled. Current intensive hatchery-system techniques were developed by personnel at the National Marine Fisheries Service laboratory in Galveston, Texas.

These techniques are patterned after Japanese culture methods [11, 12, 26, 36]. Post-larvae are reared in extensive grow-out ponds until harvest. The entire process requires approximately 4.5 months for table shrimp (10 grams or more per tail) to be harvested [31]. The chief candidate for culture from 1972 until recently has been the native shrimp (Penaeus setiferus), with production of up to 1171 pounds per acre, at stocking densities of 40,000 per grow-out acre. Previous research with two other native commercial species, pink shrimp (P. duorarum) and brown shrimp (P. aztecus), demonstrated unacceptable production and survival potential [30]. Exotic species such as P. occidentalis, P. stylirostris and P. vannamei are presently being investigated, with the latter species showing the most promising results [31] Production has been up to 4696 pounds per acre of P. vannamei in a modified pond system.

Recent technological advancements have brought the commercial feasibility of shrimp mariculture to the threshold of reality. Contributing further to this status is the attainment of reproduction in captivity of certain penaeid species [4]. Before significant commercial investment in shrimp mariculture can be expected, however, economic relationships in addition to technical considerations must be better understood. Investors will want to know the vital biological and environmental elements of a shrimp culture system and how variation in those elements affects production. Investors will also want to know how much control over these critical elements can be exercised and at what cost. For penaeid shrimp mariculture to ultimately become an attractive commercial investment, these questions must be answered. In addition, the potential economic feasibility of such operations must be established and readily demonstrable to potential investors and creditors during their decision-making process.

To establish the feasibility of penaeid shrimp mariculture, much more research is needed in the areas of biology, engineering and economics. An integrated computerized biological-engineering-economic (BEE) model capable of assimilating the necessary budgeting and cash flows for various maricultural system designs, and of testing the sensitivity of parameters and input coefficients of such systems, is developed in this study (see Appendix for program documentation) [1]. The model uses detailed sensitivity analysis to provide insight into production dynamics. This model is useful in direct application, and also will provide guidelines for the direction of future research and assessment of advancing technology.

A model of this design is needed to provide a framework applicable to most land-based mariculture which involves the utilization of ponds, levees, and other modifications of land. Due to the nonrestrictive nature of the analysis format that is employed in the BEE model, many different maricultural systems geared to distinct production goals can be analyzed accurately. The BEE model developed in this study will serve as a more thorough tool and aid for the potential mariculturist to optimally allocate his monetary resources and to better assess his investment opportunities. Creditors must also have a comprehensive understanding of the financial and economic aspects of the operation to better evaluate investment loan applications. This model will serve as an avenue through which these tasks can be more meaningfully accomplished.

The use of computerized budget simulators has been demonstrated as a very effective tool in aiding agricultural producers to efficiently

allocate their limited resources among various alternative enterprises. The budget simulator developed at Oklahoma State University by Kletke [22] for use on livestock and crops has been employed extensively by over 30 agencies in the United States for research, extension and teaching purposes. That particular simulator provides a means of inputting basic budget data, performing the necessary computations and printing the results in convenient form.

Investment and feasibility analyses have been performed on a variety of aquacultural systems other than penaeid shrimp mariculture [10, 13, 18, 20, 25, 38, 39, 40]. The majority of these analyses have involved the derivation of various financial indicators from cash-flow studies for a particular operation with little attention given the more useful aspects of budgeting and sensitivity. The present state of technology in each of these areas of aquaculture has resulted in the relative lack of in-depth economic research.

Anderson and Tabb [3] constructed cash flows over a 16-year period for hypothetical bait and table shrimp farms of various sizes. A 1973 Texas A&M study was focused on the economic feasibility of commercial shrimp farming [46]. The analytical model developed was a format for calculating net present value and return on equity for a small operation. The Williams model has served as a guideline for follow-up work on investment analyses of penaeid shrimp mariculture [15, 16, 33]. These studies, which represent investor interests, are limited to itemizing fixed and variable costs and calculating per unit production costs. A model containing relationships between biology and economics has not resulted to date.

In terms of aquacultural economics, the most advanced computerized budgeting research to date has been the development of a model for use with lobster (Homarus americanus) culture [2, 21]. Designed for application in the "technological assessment and the direction of future research," the model was used to assess the economic impact of variation of input coefficients and output relationships for lobster culture. Schurr, Allen and Botsford [37] also constructed an analytical computer model concerning the biological, physical and engineering aspects of lobster (H. americanus) culture. Biological parameters and physical factors critical to growth were used to mathematically describe lobster growth. The model of Schurr, Allen and Botsford then served as a basis from which three facility designs were derived and analyzed. As the case with the Johnston and Allen model [21], the direction of future research was an important incentative. Additionally, work has been done with computerized modeling on freshwater prawn population system [34].

The University of Arizona has begun implementation of computerized management tools in their intensive grow-out system for penaeid shrimp in Puerto Peñasco, Mexico [41]. Programs utilizing the APL language have been generated which are being directed toward the more efficient management of the shrimp farm. The programs assimilate current data as it is generated and provide guidelines for decision-making in terms of more efficient use of fixed resources and in terms of actual manipulation and management of a current shrimp crop.

The primary objective of this work is to construct a bio-engineering-economic model for a shrimp maricultural system by:

1. Assimilating past and current production data from studies of pond culture carried out by Texas A&M University.

2. Simulating growth equations consistent with empirical data from (1).
3. Building a budget-simulator computer program capable of the required budgetary output, cash-flow and sensitivity analysis.
4. Examining economies of size for the simulated maricultural system.
5. Examining the sensitivity of commercial feasibility to variations in selected prices and production coefficients.

ANALYTICAL FRAMEWORK AND ASSUMPTIONS

Analytical Framework

The basic tool for economic analysis utilized within the framework of this study is budget simulation. A budget simulator constructs budgets based on detailed itemization of cost and returns of a particular firm on a per technical unit basis. These values are presented to reveal the production, total revenue, units of variable input, variable costs, fixed costs, total costs and net revenue of the firm.

This study examines the financial feasibility of a one-crop operation for a given year within a planning horizon (grow-out season) of variable length. The basic format for analysis used in this study is budgeting on a per acre basis. The values produced are utilized to construct long-run average cost curves. The long-run cost curves are then used to examine economies of size for a given shrimp maricultural firm design.

Assumptions

Various assumptions have been made concerning prices, insurance, financing capital assets, and taxes. Each of these terms is presented below and geared to meet the needs of the firm under consideration, yet is flexible enough to allow convenient alteration in planning.

Fixed Input Prices

Actual 1978 unit prices for fixed items such as structural components, machinery, and equipment were obtained through correspondence with dealers in the area. The prices for a truck, tractor, trailer and feedblower were assumed to be $4000, $7500, $2370, and $5000, respectively. Pump and diesel driver prices were obtained from a major supplier of pumps to research and commercial maricultural operations. The price for pipe represents the 1978 price per linear foot for installed pipe with joints. The prices for pump, pump drivers and pipes were selected internally based on the demands of the facility design. Prices for miscellaneous equipment such as a pump shed, filter apparatus, walkway and drain valve are given as $100, $500, $50 and $500, respectively. A cost of $0.55 per cubic yard of levee and earthen foundation construction reflects a 1978 price for the coastal area of Texas. Crushed rock, used as a surface of the roaded levees to facilitate all-weather use, is $4.00 per cubic yard. Building structure cost of $15.00 per square foot represents metal frame construction, cement block walls, insulation, and minimal wiring and plumbing. Land value is assumed to be $500 per acre for Texas coastal land with sufficient water supply throughout the grow-out season.

Variable Input Prices

Representative 1978 unit prices were chosen for variable input and assumed to remain constant over the entire planning horizon of the firm. Hired labor for feeding, maintenance, and general management is assumed to be acquired at $3.00 per hour with overtime labor during harvesting to be at a $4.50 per hour rate. Management labor, that supplied by owner-operator, is charged at $8.00 per hour or $18,000 per year.

Fuel costs are delineated between truck, tractor and pump fuel. Truck fuel (gasoline) has a value of 51 cents per gallon. Tractor and pump fuel (diesel) is assigned a value of 41 cents per gallon.

Utility rates are assumed to be applicable to coastal utility companies in the state of Texas. Electricity is set at four cents per kilowatt hour. Water is set at $2.16 for the first 1000 gallons used, and $.57 for any 1000 gallons over the first 1000 gallons. Ice used during harvesting is crushed ice and a conservative price of three cents per pound is assumed. The cost for post-larvae is $2.50 per thousand.

Output Prices

The output prices utilized in this study are the appropriate ex-vessel prices for a count size range the boat operator receives dockside for his headed or unheaded catch. To estimate monthly 1978 ex-vessel prices, an arbitrary selection of one week from each month was selected from June to November for years 1976 and 1977 from the "yellow sheets" distributed by the National Fisheries Service. These

prices were averaged over the two years after subjecting the 1976 price to the average wholesale price index of the two years. The 1978 average weekly prices for the first week in June through November were obtained in this manner. The procedure is performed for all ten different count ranges for P. setiferus. The process results in a matrix of sixty ex-vessel prices projected for 1978.

Insurance

A firm such as the one under consideration in this study has an assortment of insurance needs. Insurance is required for the capital assets, property (buildings), and employees of the firm. The insurance needs in this analysis are itemized separately.

Buildings are insured at an annual 4.5 percent of appraised value to allow for fire, wind, storm, and extended coverage. Machinery such as trucks, pumps and valves, tractors and implements, and other machinery items are insured annually at .76 percent of replacement value.

Employee insurance (fringe benefits) is Workman's Compensation which is an annual rate of $8.17 per $100.00 of annual payroll.

Financing

Bank loan terms vary depending upon the capital asset involved. Provided in the finance terms are (1) percent salvage value, (2) total value of assets for operation, (3) percent of total value financed, (4) length of loan, (5) number of yearly payments, (6) interest rate, and (7) economic life of the asset. These terms can vary and are dependent upon the credit needs and investor demands. The following

items are treated as separate assets each with its own loan and financing terms:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Land	0.00	Varies with	.90	10 yrs	1	.10	10 yrs
Land Improvements	0.40	size of	.90	10	1	.10	10
Road Material	0.40	operation	.90	10	1	.10	10
Building	0.50	"	.90	10	1	.10	10
Truck(s)	0.00	"	.80	5	12	.12	7
Tractor(s)	0.00	"	.80	5	12	.12	7
Feed Blower(s)	0.00	"	.80	5	12	.12	10
Pumps	0.00	"	.80	5	12	.12	10
Drain Valves	0.00	"	.80	5	12	.12	10
Watergates, Filters	0.00	"	.90	10	1	.10	10
Pipe	0.30	"	.90	10	1	.10	10

Taxes

Depending upon the organizational alternative, a firm will incur an array of different taxes. This study assumes the organizational alternative to be the sole proprietorship. The taxes to be accounted for include real property taxes, social security taxes, unemployment taxes and federal income taxes.

Assuming that the operation is located in Brazoria County, Texas, a real property tax rate of $2.44 is applied to every $100.00 of 20 percent of the total value of buildings, machinery, equipment, and land with improvements.

Social Security tax is calculated as 8.1 percent of the firm's taxable income up to $17,700. Employee's social security taxes are 6.05 percent of employee's income with the tax for any one employee not to be applied to income over $17,000.

Unemployment taxes are derived by finding the product of each annual employee payroll and the employment tax rate. The current employee tax rate is .8 percent. This is applied to the first $6,000 of each employee's payroll.

To determine the amount of income taxes a firm must pay, the cash method of accounting is utilized which assumes all taxable income is included during the taxable year in which the payment is received [19]. Deductions for taxable income include cash operating expenses, interest on loans, depreciation, unemployment taxes, property taxes, insurance, and social security taxes. The tax schedule employed is for married individuals with no children, and filing joint returns. The importance of accurate cost accounting for income tax purposes can be seen when one realizes the progressive nature of the tax schedules employed.

GROWTH SIMULATION

Included in this study is the development of a model which adequately describes the growth process of shrimp in the grow-out ponds. In developing this growth model, simulation techniques are applied in a restricted fashion, due to limiting factors induced by the data. Thus, an algorithm sufficient in generating growth over time is derived.

This study concerns only individual shrimp in the growth simulation process. Linear and nonlinear equations are employed in deriving growth over time. Estimates related to growth on the population level are then extrapolated from this information.

Growth Data and Limitations

Data collected in 1972-1977 for Texas A&M's research facility in Brazoria County consist of length-weight data at weekly intervals. Length-weight data consist of a mean length (mm) and weight (grams) for 25 specimens from each pond. Water chemistry data consist of temperature, salinity, pH, and dissolved oxygen. Also included in the data are the daily feed per pond and the feeding schedule, whether it be regular or intermittent.

Irregularities in the collection of data and deviation from planned experimental design did occur. Ponds that experienced die-offs before termination of the grow-out experiment, or had their densities otherwise altered after stocking, are eliminated from further consideration in this study. The lack of adherence to original experimental designs due to factors beyond the control of researchers restricted the applicability of results of this analysis to the years 1972 and 1977.

Only data representing the native species *P. setiferus* are used for this analysis, due to the relatively consistent nature of the growth of that species. That consistency has led to the selection of *P. setiferus* as the chief candidate for culture among the three native species. Exotic species have shown better survival and growth; however, limited supplies of post-larvae have restricted their use in production research.

In 1972, there were six half-acre ponds that produced growth information under a common experimental design (Table 1). These six ponds were all stocked with 20,000 post-larvae per pond (40,000 per acre). The shrimp were reared for 15 weeks (three ponds) and for 17 weeks (three ponds). All pond data exhibit linear growth patterns of shrimp although extreme variations in feeding rates were coincident. In 1977, there were thirteen ponds that followed a common experimental design. Ten of these ponds were stocked at 40,000 per pond and three were stocked at 36,500 per pond. Due to these stocking densities being so close, they are grouped together into one density class (80,000 per acre). These shrimp were reared for 24 weeks (2 ponds) and for 27 weeks (11 ponds). Data for 1977 resemble the 1972 data in that the growth is fairly linear and continuous. However, the coincident feeding data are most erratic and are not correlated with growth.

In summary, the growth data over time for both years exhibit linearity. It is interesting to note that the linear nature of the data persists throughout the grow-out season. Correlation with growth and the intuitively expected responses in growth to changes in feeding and water chemistry are found to be absent. Obviously, feeding rates and water chemistry play an important part in the growth of cultured shrimp; however, due to the low correlation shown by the data, these relationships cannot be quantified. Also, due to the limited amount of data that can be utilized and the limited number of "treatments" employed, i.e., stocking density and harvest density, the derivation of an appropriate growth model is severely constrained.

The data are further limited by the confounding of years and stocking densities within each year. In other words, the effect of

Table 1. Results Obtained with Hatchery-Reared *Penaeus setiferus* From .5-acre Ponds in Brazoria County, Texas During 1972 and 1977.

	Pond Number	Stocking Density	Duration of Experiment (Days)	Pounds Harvested Per Acre	Length (mm)	Weight (g)	Percent Survival	Food Conversion Ratio	Tail Count
1972	2	20,000	99	347	120	12.2	65	1.9:1	62
	5	20,000	99	329	120	12.2	62	1.8:1	62
	6	20,000	98	154	122	12.4	25	2.3:1	61
	11	20,000	112	318	120	12.8	56	2.9:1	59
	16	20,000	113	253	125	14.4	40	3.0:1	53
	17	20,000	113	227	123	13.9	37	2.7:1	54
1977	2	40,000	158	1038	102	7.0	84	2.1:1	108
	4	40,000	162	1186	100	6.4	105	1.7:1	118
	5	40,000	175	1034	110	8.5	69	2.4:1	90
	6	40,000	175	910	106	7.6	68	2.4:1	100
	11	40,000	178	1148	95	5.9	110	1.9:1	128
	12	40,000	179	880	92	5.4	92	2.7:1	138
	13	40,000	179	966	92	4.9	112	2.2:1	155
	14	40,000	176	1148	105	7.0	93	2.2:1	108
	15	40,000	175	802	108	8.2	55	3.5:1	92
	16	40,000	178	928	99	6.7	78	3.2:1	113
	18	36,500	176	966	104	7.0	85	2.8:1	108
	19	36,500	178	872	99	6.5	83	2.6:1	115
	20	36,500	176	892	105	7.6	73	2.8:1	98

Source: TAES annual report--shrimp culture demonstrations during 1972 and 1977.

years has not been identified. Had each two stocking densities been examined during each year, the effect of years (weather, management, technological advances) might have been quantified. Conclusions drawn from this data must recognize these limitations.

Derivation of Growth Equations

In modeling the physical system for penaeid shrimp, a growth model for the shrimp in the grow-out ponds must be included. The present study simulates growth of the shrimp on an individual basis and extrapolates up to the population level. The system (capacity) determines growth (production) rather than growth determining the system. The latter is the case in the Allen and Johnson model [2]. Due to the limitations induced by the data, growth is expressed only as a function of time and stocking density.

Although the data exhibit linearity over the grow-out periods for 1972 and 1977, it is assumed that after a length of time the growth curve must begin to increase at a decreasing rate, indicating the animals' approach toward the asymptotic weight (common maximum weight an animal is known to be able to achieve). Therefore, for the purposes of this study, the growth curve is assumed to have a linear and a curvilinear section. The linear portion being described by the data, the curvilinear portion being intuitive and supported by the literature [7, 8]. For the curvilinear portion the classical von Bertalanffy growth equation (Figure 1) gives as

$$w_t = W\infty[1 - e^{-k(t-t_o)^3}] \qquad (1)$$

is suitable for describing growth of this nature. In this equation w_t is weight at time t, $W\infty$ is the asymptotic weight, k is a catabolic coefficient, and t_o is the time period in which weight is assumed to be zero.

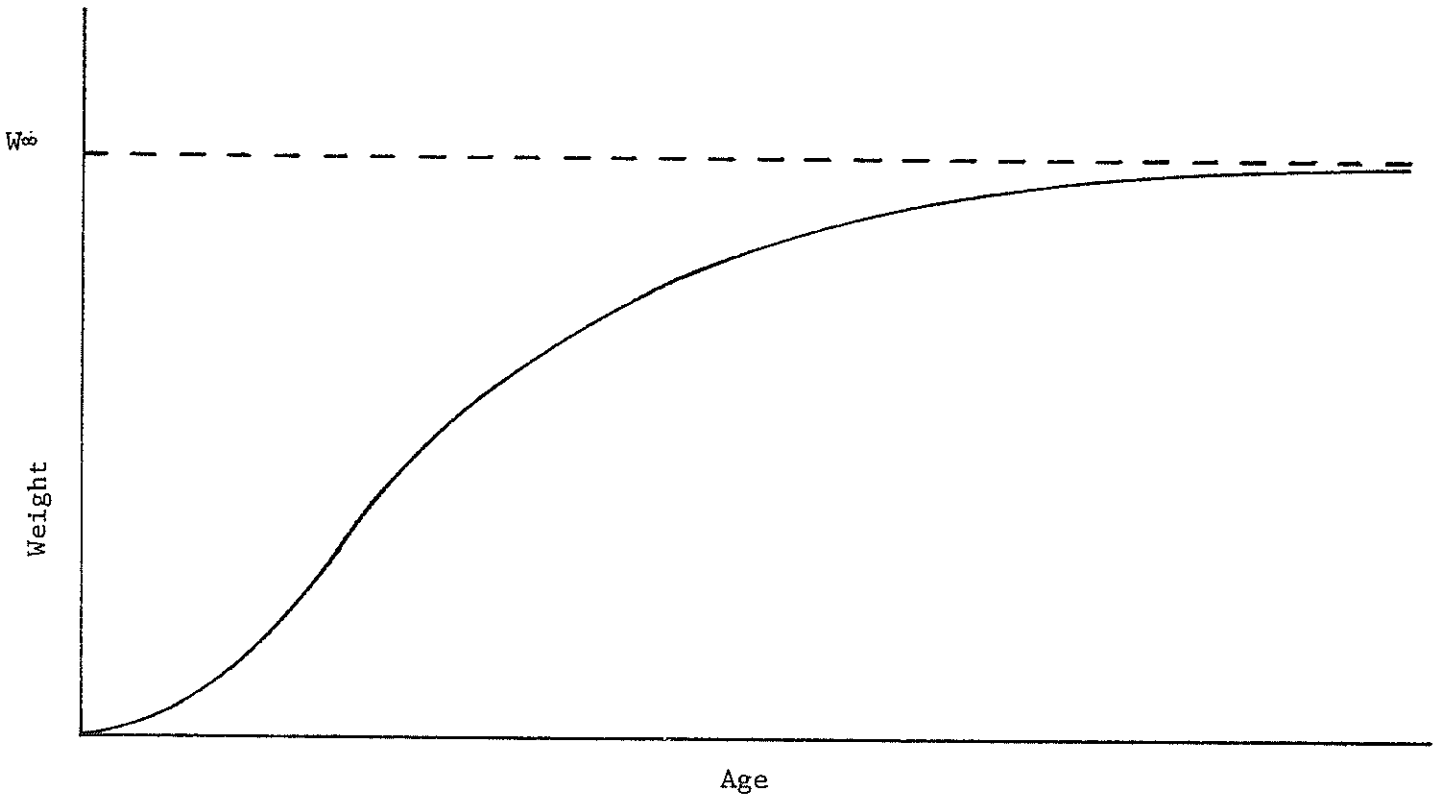

Figure 1: The general form of the curve given by the von Bertalanffy equation for growth in weight of an organism depicting the characteristic sigmoid-shape which approaches an asymptotic weight (W_∞). Source: [7, 8].

The linear equations were estimated where weight (Y) in grams was a function of weeks (X).

$Y = -2.56 + 1.01\ X$	@	40,000/acre	(2)
$Y = -1.89 + .825X$	@	50,000/acre	(3)
$Y = -1.28 + .65\ X$	@	60,000/acre	(4)
$Y = .66 + .475X$	@	70,000/acre	(5)
$Y = .18 + .3\ X$	@	80,000/acre	(6)

For 1972, the estimated regression equation is given in equation (2). The regression began in time period (week) 4 and ended at time period 17 when the shrimp were 128 days old (time in pond). For 1977, the regression is given in equation (6). The regression began at time period 3 and ended at time period 26 with the shrimp being 190 days old. All coefficients were significant at the 5 percentage level. The coefficients of determination (R-square) for both equations was of 0.98 which exhibits the extremely linear nature of the data over the range of the grow-out period.

Based on the regression equations (2) and (6), linear equations (3), (4), and (5) are interpolated for stocking densities of 50,000, 60,000, and 70,000 per acre pond respectively. These three equations are forced through the point (3.5, 1.0) which represents a weight (Y) of 1.0 gram at 3.5 weeks of age (X) which is assumed common to all stocking densities during the early grow-out period.

The estimation of the curvilinear segments of these growth equations beyond week 18 is accomplished by forcing the von Bertanlanffy equation through values of weight generated by each linear equation for weeks 4 and 18. Time period 18 is assumed to be the maximum time period in which weight is generated by the linear equation. The resulting curvilinear

equations are then attached onto the "end" of each linear equation after time period 18 (Figure 2). The curvilinear equations with their appropriate stocking densities are given in equations (7) through (11).

$$w_t = 87[1 - e^{-.04(t - (-2.0))^3}] \quad @ \quad 40{,}000/\text{acre} \quad (7)$$

$$w_t = 87[1 - e^{-.034(t - (-3.5))^3}] \quad @ \quad 50{,}000/\text{acre} \quad (8)$$

$$w_t = 87[1 - e^{-.029(t - (-4.9))^3}] \quad @ \quad 60{,}000/\text{acre} \quad (9)$$

$$w_t = 87[1 - e^{-.023(t - (7.0))^3}] \quad @ \quad 70{,}000/\text{acre} \quad (10)$$

$$w_t = 87[1 - 3^{-.019(t - (7.5))^3}] \quad @ \quad 80{,}000/\text{acre} \quad (11)$$

The asymptotic weight $W\infty$ is supported through work by Klima on Gulf shrimp growth [23]. Although the asymptotic weight of 87 grams may very well be too high for pond-reared shrimp, lack of any valid estimation for cultured shrimp warranted its use.

To estimate the biomass of a population over time, the number of individuals and rate of attrition from the population over time must be estimated. At the time of this study, there was no satisfactory method for accurate estimation of survival of shirmp in research ponds at a given point in time prior to harvest. Survival at harvest represents the only data available on survival. Average harvest survival percentages are 48 and 76 for 1972 and 1977 data, respectively. From an intuitive biological standpoint and from unpublished data [30], survival is assumed to be 75 percent inclusive of weeks 1 through 17 and 66 percent after week 17.

FACILITY DESIGN AND ENGINEERING ASPECTS

The system design in this application of the BEE model represents an attempt to duplicate as a commercial operation the present research facility operated by the Texas A&M Extension Service. However, there are some dif-

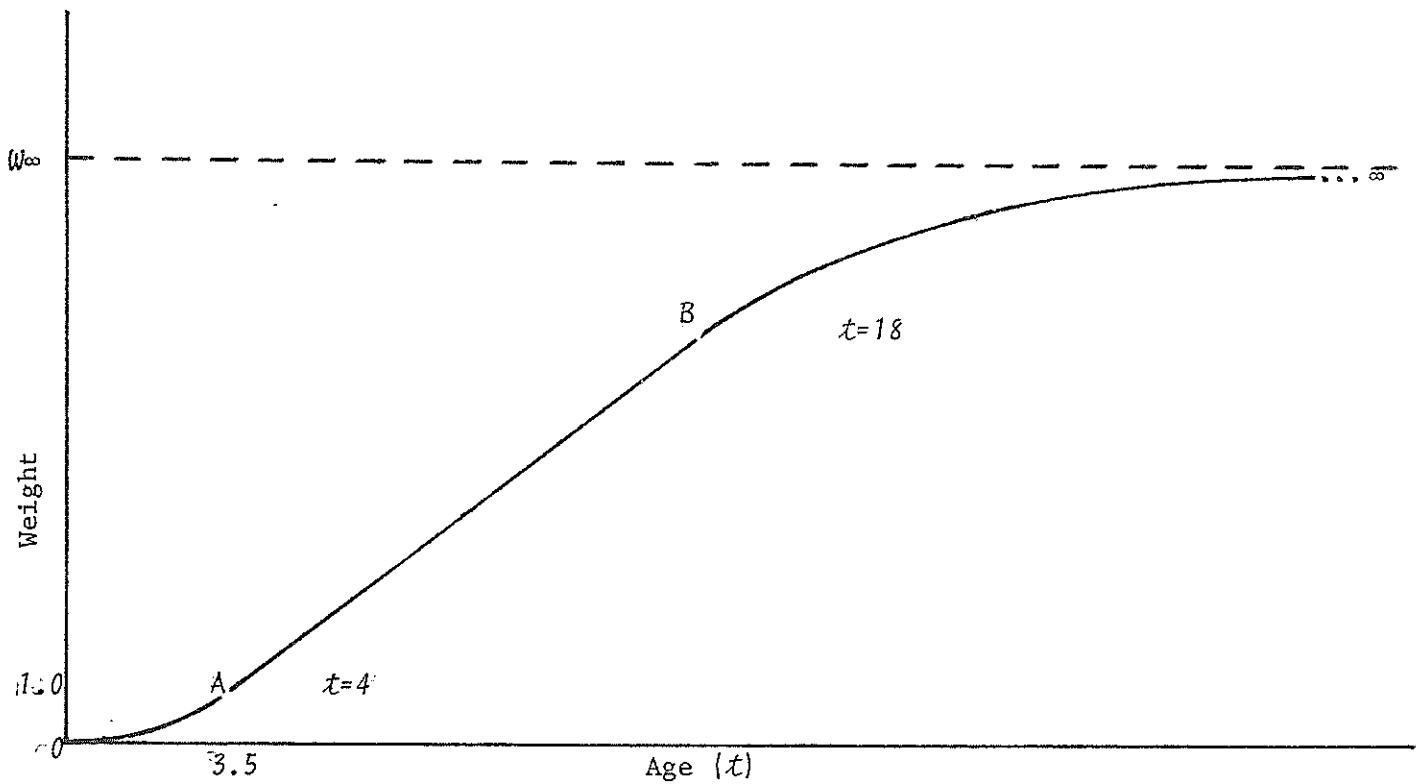

Figure 2 : Derived hypothetical growth curve consisting of a linear segment $\widehat{AB}$ supported by data and a curvilinear segment $\widehat{B\infty}$ given by the von Bertalanffy equation

ferences between the simulated and the actual system.

The research system consists of a series of individual ponds aligned in two equal rows. A central reservoir, into which water is pumped from an outside source, is located between the two rows of ponds. Once the water is pumped into the central reservoir it is gravity-fed into each pond. A selected flow-through is achieved by allowing water to escape from a pond by an adjustable valve extending through the outside levee.

The levees utilized for the research ponds are of two types: those forming the perimeter of the pond system and surrounding the reservoir with a roaded top and those found between the ponds without a roaded top. The longest dimension of the pond is oriented along the latter levee. The bottom of the pond has a gentle slope toward the reservoir to facilitate better drainage during harvesting. Harvesting is accomplished by opening a valve on the reservoir end of the pond and allowing the water to drain through the levee into a net. A single pump and engine provide the necessary power to supply water to the reservoir. The difference between the water level in the ponds and the reservoir provides enough head to facilitate adequate gravity flow into the ponds. There also exists a portable office trailer and sufficient machinery and labor to run the operation in a research capacity.

The system developed by the BEE model has the pond units oriented with the long side against the roaded levee (Figure 3). This arrangement is to allow better dispersal of feed over the entire pond surface. The levees surrounding the reservoir are higher than those forming the perimeters of the ponds. Also, the water level in the reservoir is two feet higher than the water level in the ponds. This allows for greater head

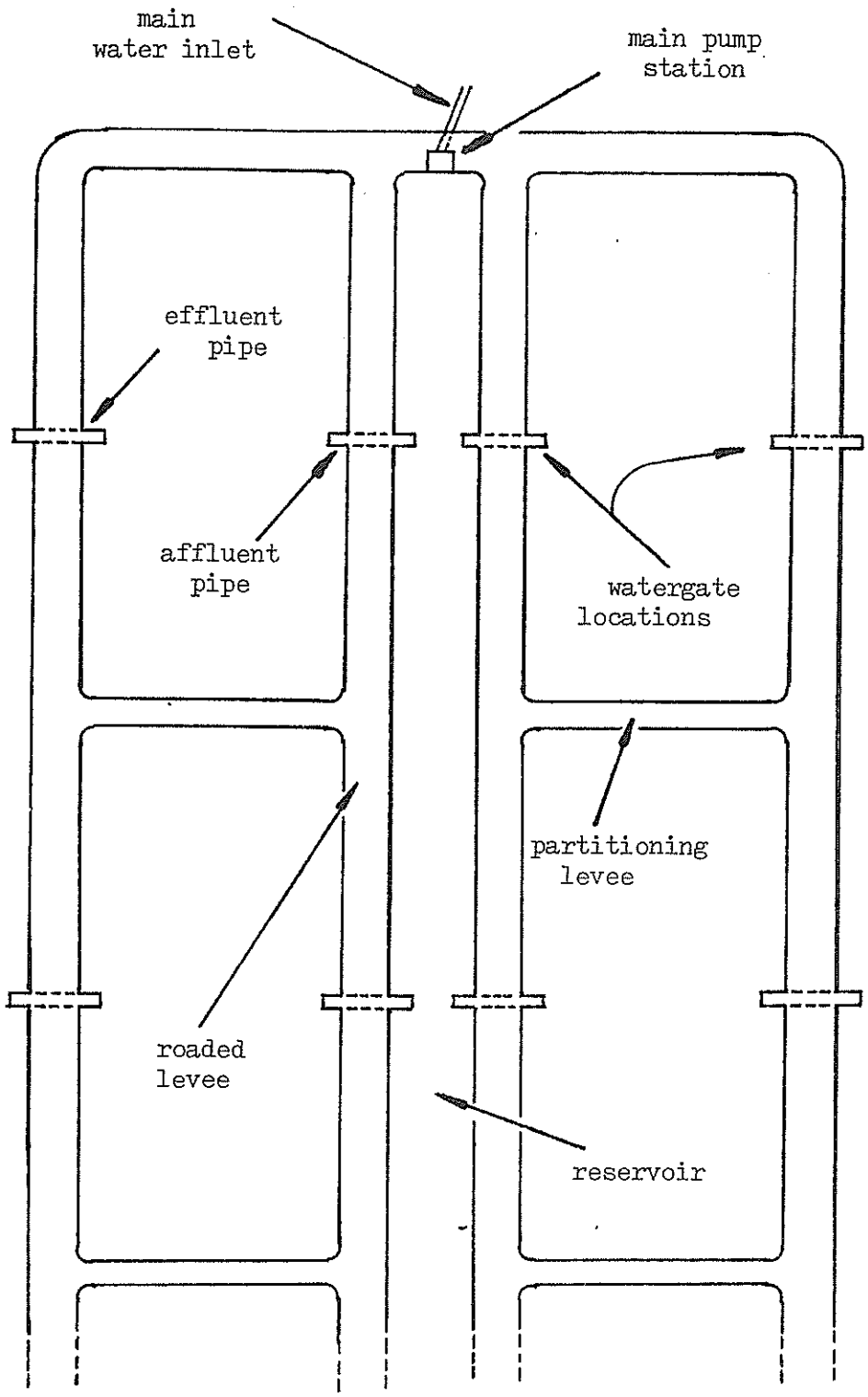

Figure 3: System Design - Pond Layout

and an increased rate of gravity flow into the pond.

The BEE model has the ability to "build" an operation of the Brazoria County facility design consisting of any number and size of ponds. Given the dimensions of the levees and the pond perimeter, the model generates the volume of dirt needed to construct the levees, the water-surface acreage and the total acreage for the facility.

In selecting a pumping system, consideration must be given to the amount of water which must be exchanged through the system every day. The BEE model accomplishes this by estimating the volume of water in the system (acre-feet times the pond depth) and applying the appropriate maximum daily exchange rate. A gallon-per-minute value (Q) is obtained from

$$Q = \frac{A \times B \times D \times R \times N}{192.5} \tag{12}$$

where A is the pond unit length in feet, B is the pond unit width in feet, D is the depth of the water in the pond unit in feet, R is the maximum daily rate of exchange necessary, and N is the number of pond units. The denominator is a constant which converts the numerator to gallons per minute. The appropriate pump size is then selected based on the maximum gallon-per-minute capacity of the pump and the maximum gallon-per-minute requirements of the system.

Once the volume of water exchange and the appropriate pump size are selected, the size of pipe appropriate for handling the designated water volume is derived. Assuming that the length of the pipe between the reservoir and pond is minimal and effectively negates any head loss due to inside friction of the pipe surface, the first step is to estimate the velocity flow (free flow) for water given the asssumed head of

the system design. The velocity flow of water is therefore given as

$$V = (2\ \Delta H\ 32.27)^{1/2} \tag{13}$$

where V is the velocity flow in feet per second, ΔH is the head in feet, 2 is a constant, and 32.27 is the gravitational constant [44]. By assuming that there will be no pumps forcing reservoir water into each individual pond, and having determined the velocity flow of water flowing freely from the reservoir into the ponds, the model then computes the diameter of pipe that will allow the desired gallons-per-minute to free-flow into the ponds at the computed flow velocity. The pipe diameter is therefore given as

$$D = [(.4085\ Q)/V]^{1/2} \tag{14}$$

where D is the diameter of the pipe in inches, .4085 is a constant, Q is the computed gallons-per-minute, and V is the velocity flow [44].

One of the major variable expense items is fuel cost. Given that the system is a mariculture operation, large quantities of salt water must continually flow through the system to maintain the proper water quality. Therefore, the fuel cost for the pump driver is substantial. This model determines fuel requirements for the pump driver on a per hour basis, when engineering coefficients associated with the pump, pump driver, and type of fuel used are specified. Water horsepower or the power needed to move a given volume of water at a given rate is given as

$$WHP = Q(\Delta H)/3960$$

where 3960 is a conversion constant. The fuel required (gal/day) is given as

$$PF = \frac{WHP(24)\ 2547}{E_p E_{pd}\ BTU} \tag{15}$$

where PF is the gallons of pump driver fuel per day, 24 is hours per day, 2547 is a constant in BTU/HP-Hour units, E_p is the pump efficiency, E_{pd} is the pump driver power unit efficiency and BTU is the BTU's per gallon of fuel. The daily volume of fuel is then multiplied by the current price per gallon of fuel to obtain the final cost for the facility in a given day. The pump is assumed to run continuously with programmed alteration in the daily exchange rate.

RESULTS

The following analysis yields information concerning the most likely production level and size of operation which captures most economies of size when employing the basic system design of the Brazoria County facility. The analysis proceeds in an iterative fashion, initially indicating the per surface acre stocking density which exhibits the most profits or the least amount of loss, then suggesting the appropriate pond size to employ and finally determining the number of ponds of the appropriate size which capture most economies of size. This latter step yields a likely size operation of the assumed design. In arriving at the latter value, projections on internal rates of return (IRR) on equity and total investment and estimation of payback period are provided. Sensitivity analysis is performed on the final operation yielded. It must be emphasized that this procedure is not intended to be an optimization plan. This model is capable of costs and returns budgeting, but is not designed to find the optimum operation size and production level as are other techniques (i.e., linear programming).

Aside from the underlying assumptions discussed earlier, additional assumptions have been established and held throughout the following analysis. The analysis assumes a grow-out period that begins on day 125 (May 5) and ends on day 308 (November 4), which is the length of the grow-out season (approximately six months) that can be expected for the northern Texas Gulf coast, given normal climatic conditions. It is assumed that viable eggs can be obtained approximately two weeks prior to stocking through sourcing offshore for gravid female shrimp.

Incrementing Stocking Density

The twenty half-acre ponds (size of the research facility) are subjected to analysis for each stocking density, in terms of per water surface acre (SA) and total acre (TA) yield, total variable cost (TVC), total fixed cost (TFC), total cost (TC), total revenue (TR), break-even price (BEP) and net revenue (NR).

Yield S/A increases from 929 pounds to 964 pounds for the 40,000 and 50,000 stocking densities, respectively (Figure 4). Yield declines to 932 pounds at 60,000 stocking density, then decreases rapidly for higher stocking densities. The 40,000 stocking density has a more rapid growth rate, as is evident with the largest tail size, yet produces less total biomass or yield than the 50,000 and 60,000 stocking densities due to a given survival percentage being applied across all stocking densities for any time period.

TC/SA increases slightly at a constant rate as stocking density increases. The increase is due to an increase in the amount of feed needed to supply the population of each stocking density. As the stocking density increases, the average individual weight of the shrimp decreases. As the individual weight decreases, the percentage amount

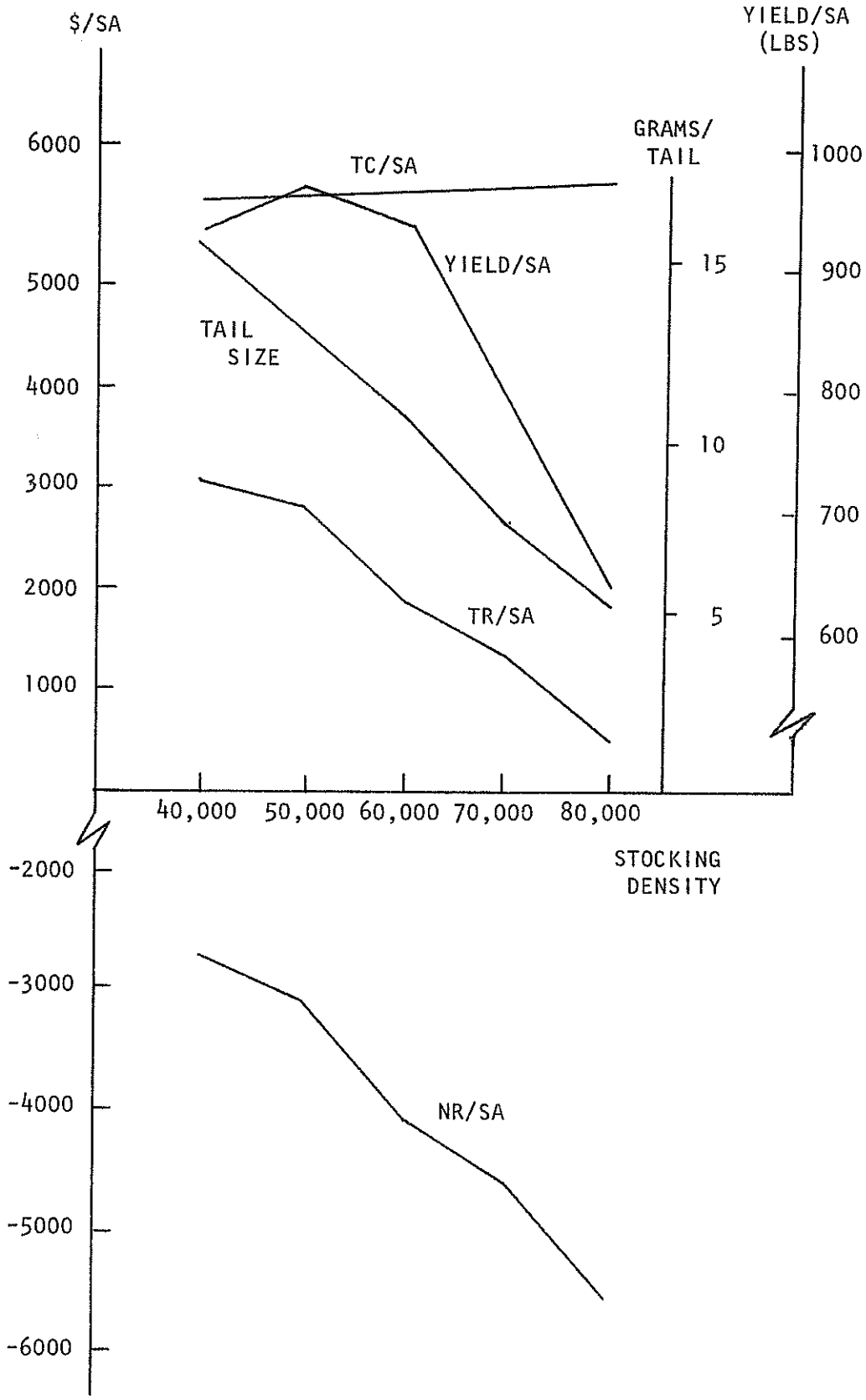

Figure 4: Average Annual Costs and Returns and Yield for an Operation Consisting of Twenty .5-Acre Ponds by Stocking Density

of feed allocated per shrimp is increasing. This results in a net increase in feed as stocking density is increased.

TR/SA declines as the stocking density increases. This trend is attributable to the lower stocking density producing larger size shrimp which demand a higher price. The 40,000 stocking density produces 26.6 gram shrimp (heads-on) which demand an ex-vessel price of $3.25 per pound of tails, and the 80,000 stocking density produces 9.1 gram shrimp at $0.79 per pound of tails. TR/SA falls from $3016 at the 40,000 stocking density to $500 at the 80,000 stocking density. The stocking density of 40,000 realizes the least amount of loss with NR/SA of -$2789. The NR/SA decreases to -$5549 for the 80,000 stocking density.

The analysis reveals the 40,000 stocking density to be the "best" of the available stocking densities to use since it exhibits the least amount of loss. This relationship is assumed to be linear as the pond size increases. The 40,000 stocking density, the accompanying price per pound and size of harvested shrimp will be used through the remainder of this analysis.

Incrementing Pond Size - Twenty Ponds

Economies of size imply that the long-run average cost of production decreases over a given range of output, resulting in cheaper, more efficient (in terms of input) production [17]. A unit of output in this study can be expressed as yield per SA since output per SA is held constant. If economies of size exist, an investor will increase the size of this operation to take advantage of these decreasing costs per unit of output, that is, yield per SA.

The size of the operation (acres of land) can be increased in one of two ways. Either increase the pond size while holding the number of ponds

fixed or vice-versa. Both situations will be examined. Once the pond size that captures most of the economies of size has been determined, the number of ponds of that particular size will be incremented.

Figure 5 expresses the TC and TR curves for a 20-pond operation over the pond size range of .5 to 5.0 acres. These values represent the TC and TR of the entire operation. The TC curve tends to increase at a slightly increasing rate over the range of pond sizes. The TR curve increases linearly. Figure 6 exhibits the nature of the "average cost" curve (TC/SA) for this range of pond sizes. This curve is analogous to the classical long-run average cost curve expressed over a given range of output. The TC/SA curve decreases at a decreasing rate partially because of fixed costs.

Fixed costs per SA for the operation are dependent upon the ratio of SA to TA of the operation. This ratio increases at a decreasing rate as the pond size increases. For most machinery and equipment (which includes trucks, tractors, pumps, etc.) costs will decrease per SA as pond size increases. Also land improvement cost per SA decreases since levees, roads, and earthen foundations decrease as a percentage of TA as TA is increased. Finally, TC/SA is influenced by TVC which is due to labor being used much more efficiently as pond size increases. With TR being linear through the origin, the TR/SA ("average revenue") is constant at $3017.

TC/SA decreases rapidly from .5-acres per pond through 1.5-acres per pond. At approximately this point, a break-even situation occurs (TC = TR). At the 2.5-acre pond size, the TC/SA has decreased to $2446. This value

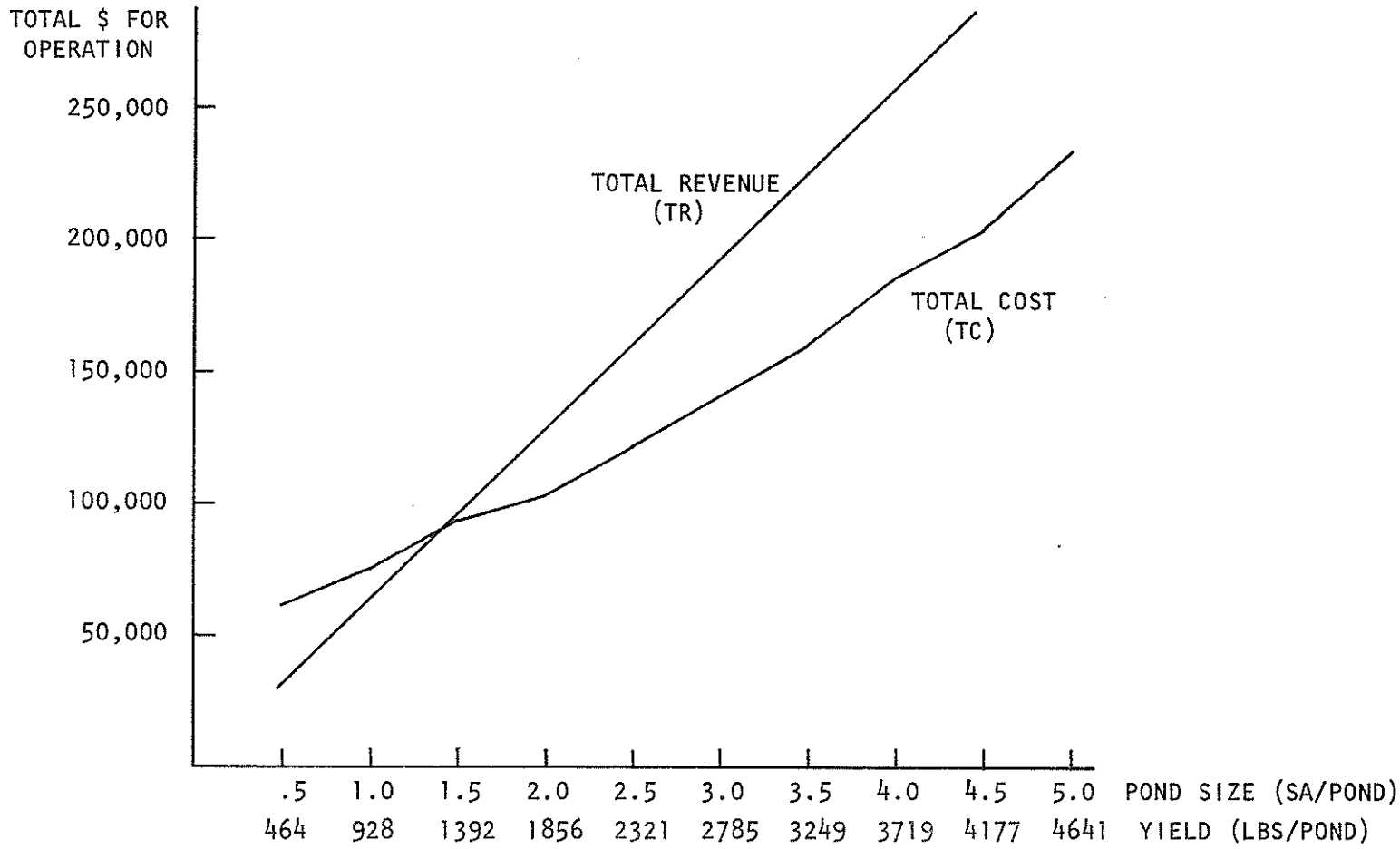

Figure 5: Average Annual Total Costs and Total Revenue for a Twenty-Pond Operation by Pond Size and Yield Per Pond.

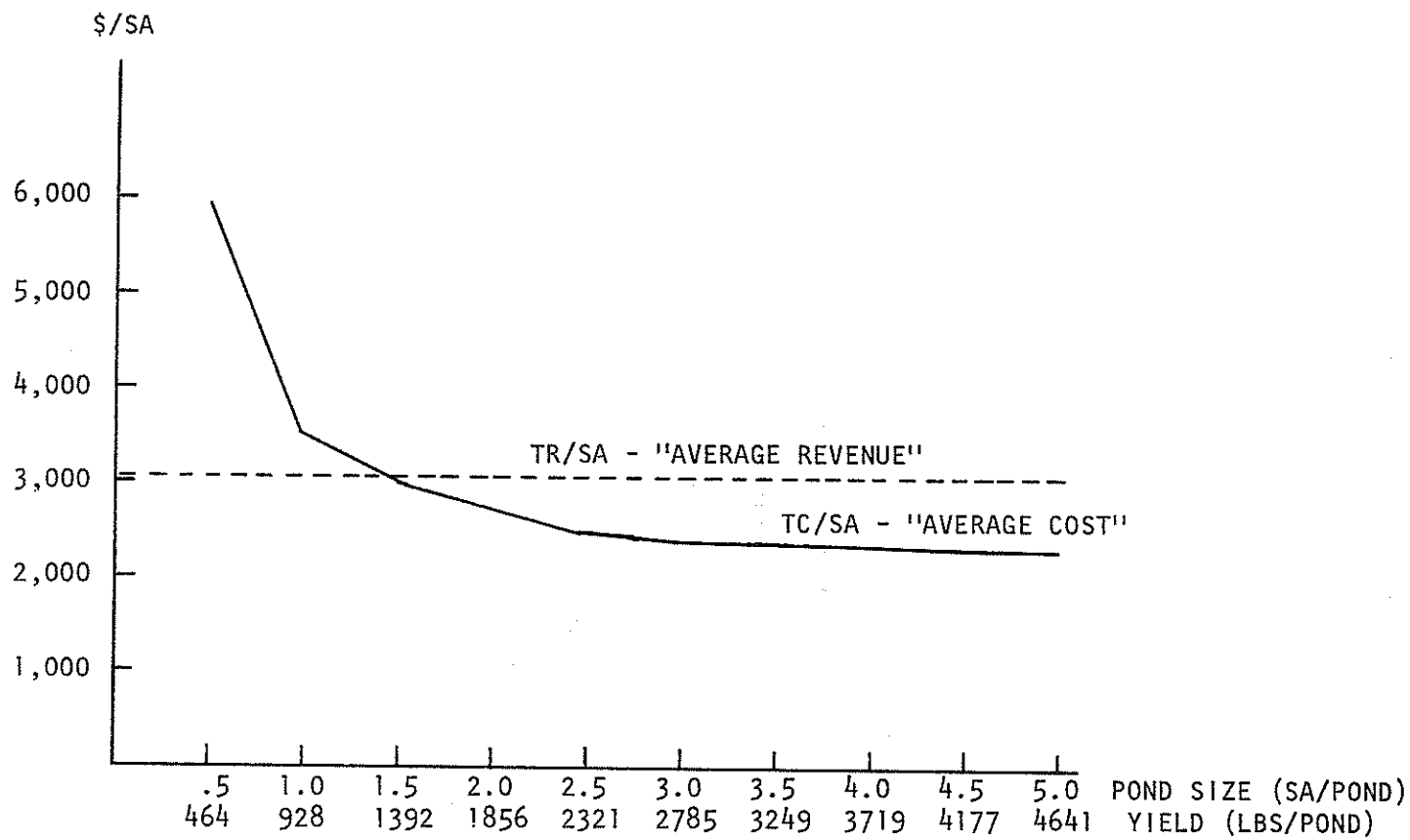

Figure 6: Annual "Average Revenue" and Long-Run "Average Cost" Per SA for a Twenty-Pond Operation by Pond Size and Yield Per Pond.

then decreases slightly until a value of $2311 is reached at the 5.0-acre pond size, a decrease of only 4 percent relative to the overall decline from the 2.5-acre pond size. Therefore, most economies of size have been "captured" by the 2.5-acre pond size.

Note that the TC/SA curve in Figure 6 remains nearly constant over the range of pond sizes of 2.5 to 5.0 acres. The analysis was terminated at the 5.0-acre pond size; however, classical theory suggests the TC/SA curve may eventually begin increasing as the firm gets increasingly larger and the effects of negative economies of size begin to outweigh those of positive economies of size. This may become apparent in a reduction of management efficiency as pond sizes increase. Also, application of machinery may become less efficient as pond size is continually increased. Those relationships, however, have not been quantified and applied in this study.

Having determined the size of the individual pond which captures most economies of size, the next section deals with deciding how many of these ponds capture most economies of size.

Incrementing Number of 2.5-Acre Ponds

By increasing the number of 2.5-acre ponds, the response of TC/SA to an increase in number of ponds can be observed. This will provide the number of 2.5-acre ponds which capture most economies of size. The total number of ponds is increased from 8 to 48.

In Figure 7, the 24-pond operation (96 total acres) is seen to capture most economies of size when employing 2.5-acre ponds. At this point the firm's marginal decrease in TC/SA is nearing zero. Any further

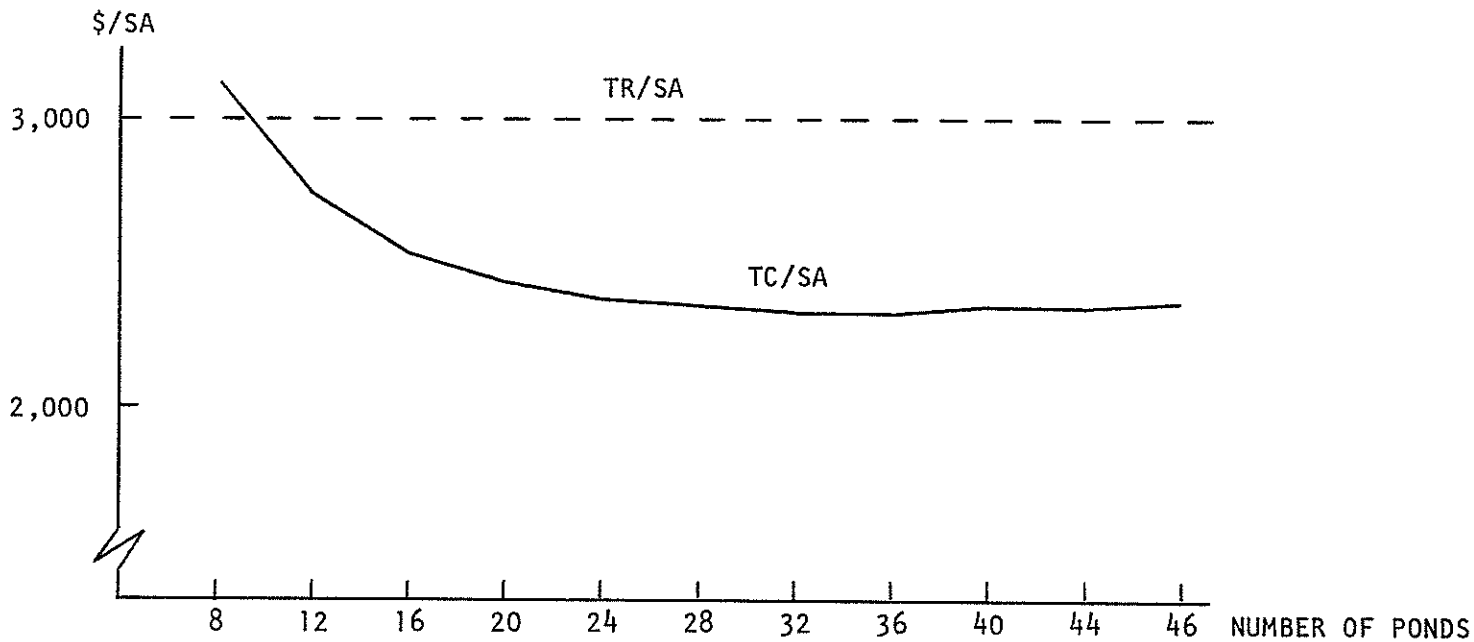

Figure 7: Annual "Average Revenue" and Long-Run "Average Cost" Per SA for an Operation Employing 2.5-Acre Ponds by Number of Ponds.

addition of 2.5-acre pond units results in a very slight decrease in TC/SA relative to the decrease in TC/SA prior to the 24-pond operation. The operation would have an IRR to equity of 71 percent, an IRR to total investment of 17 percent and a payback period of two years. As stated earlier in terms of pond size, this does not represent the optimum operation size, but rather a likely operation size for commercial purposes for minimum investment into a new high-risk venture.

At the 96-acre operation, an average year would require an ex-vessel price of $2.60 to break even (Table 2). Within the cost per pound of production, feed can be seen to be the major cost per pound of tails (26 percent of TC/pound of tails). Labor is the second most important variable cost item.

Reductions in variable cost items such as feed cost per pound and post-larvae cost per thousand could reduce per pound cost of tails. Reductions in labor expenses (more efficient utilization of resources and not per hour cost) would have even a larger impact. However, this model assumes a minimal labor application. In summary, TVC is a larger part of the cost of producing a pound of tails than is TFC.

In terms of fixed expenses (46 percent of TC/pound) depreciation is the largest cost item. Income and property taxes are the second largest cost, followed by interest. Major fixed expenses (depreciation) could possibly be reduced for this and larger operations through increased economies of size for machinery (more efficient application). However, machinery investments are a small percentage of total capital investment for the 96-acre operation (approximately 16 percent). Reductions in the major depreciation item, land improvements, would not be expected.

Table 2: Cost Constituents of Break-Even Price (Cost of Production by Pound of Tails) for an Operation Employing Twenty-Four 2.5-Acre Ponds.

	($)	(% of Total)
Variable Costs		
Hired Labor	.15	6
Management Labor	.32	12
Feed	.68	26
Fertilizer	.01	1
Fuel	.03	1
Machinery Maintenance	.01	1
Utilities	.03	1
Ice	.02	1
Postlarvae	.11	4
Payroll Taxes	.04	1
Sub Total	$ 1.40	54%
Fixed Costs		
Insurance	.03	1
Depreciation	.51	20
Interest	.31	12
Income and Property Taxes	.35	13
Sub Total	$ 1.20	46%
Total (BEP and Cost of Production)	$ 2.60	

SENSITIVITY ANALYSIS

By looking at the responsiveness of a firm's NR/TA to a change in various selected input prices and production variables, a firm's manager may, by assessing this responsiveness or sensitivity to change, alter his production scheme. By taking advantage of the sensitivity for an appropriate input coefficient, the production process may become more efficient in terms of input/output.

The following sensitivity analysis examines the change in NR/SA relative to change in certain management and non-management variables for an operation design consisting of twenty-four 2.5-acre ponds (60 SA and 96 TA) in Brazoria County, Texas. Management variables can be altered or substantially influenced by the manager. Non-management variables are determined by outside factors (market and economic conditions) which are beyond the direct and immediate control and influence of the firm manager or are predetermined by the production scheme. The management variables subjected to change were stocking density per SA and length of the production period (grow-out season). Non-management variables include size of tails at harvest, total yield/SA, hourly wage for hired labor per hour, price per pound of feed, and price per pound (ex-vessel) of harvested tails. Tables 3 and 4 serve as summaries of the responses of NR/SA to a change in a single variable or price with all other values held constant.

Management Variables

Stocking Density Per SA (Base Value: 40,000)

NR/SA are extremely sensitive to stocking density. However, recall

that the assumptions held in terms of growth rate and survival substantially affect this level of sensitivity. Regarding each increase as 25 percent increments, NR/SA is decreasing due to the slower growth rates at high densities (Table 3). The slower growth rates result from various biological and environmental interactions found in populations at higher densities. The limited biological data suggest that these interactions have a negative effect on shrimp growth. The highest stocking density results in a 400 percent decrease in NR/SA from the base value of $608 per TA. Increase in the basic understanding of underlying factors influencing populations of different densities may result in higher yields at higher densities. The implications to NR/SA are obvious.

Length of Grow-Out Season (Base Value: Six Months)

The length of the base grow-out season is dictated by the climatic conditions of the area, especially for extensive culture where controls on environmental parameters are limited. The northern Texas Gulf coast experiences a decrease in the ambient temperature consistently in late October or early November. This decrease is such that shallow bodies of water (such as ponds) will cool very quickly. Lethal minimum temperatures are reached soon and this signals the end of the grow-out season. April is assumed to be the earliest month at which the ambient temperature will allow growth for juvenile white shrimp.

Assuming this grow-out season could be extended for one month, which is highly unlikely unless the operation was moved to an area more

tropical in climate, NR/SA would increase by 46 percent (Table 3). The longer grow-out season would produce a larger, more premium priced shrimp product. The more likely situation is that, due to an early onset of fall temperatures, or a late spring, or a delay in larval acquisition, the grow-out season may be shortened. A reduction of the grow-out season by one month results in a dramatic decrease in NR/SA. This decrease is much greater relative to a one-month increase in the grow-out season. Reducing the grow-out season to 4 months, however, decreases NR/SA by a lesser amount.

The grow-out season length may be increased by employment of heating devices, pond covers, or heated effluent from an industrial source, such as a power plant. An effective method of insulating or otherwise controlling the ambient pond water temperature may dictate higher TFC. This model does not assume the operator has the ability to option for these facilities.

Non-Management Variables

Yield Per SA (Base Value: 590 lbs.)

Yield is strictly dependent, given an assumed growth equation, upon the two control management variables. A change in technology might produce greater consistency in production, reductions in mortality, increased growth rates at higher stocking densities and increased number of crops of smaller shrimp. This analysis examines an increase and decrease in Yield/SA. A commercial operation, at present, would not have total control over production and may experience variability of yield about an expected level. A 10 percent increase (or decrease) in Yield/SA will produce a more than double that percentage

Table 3. Percentage Response of NR/SA to Change in Management Variables.

Control Variables	Increase of Production Variables				Base* NR/SA	Decrease of Production Variables		
Stocking Density/SA	80,000	70,000	60,000	50,000				
- % Change from Base NR/SA	400	251	161	28				
- Resulting NR/SA	$-1,813	$-918	$-371	$435	$608			
Length of Grow-Out Season (Months)				7 mon.		5 mon.	(1972)**	4 mon.
- % Change from Base NR/SA				46		153	206	216
- Resulting NR/SA				$990	$608	$-323	$-642	$-702

*Base NR/SA represents NR/SA value expected when control variables are held at originally assumed values.

**The data for 1972 represents a grow-out season length of 128 days (4 months - 8 days).

increase (or decrease) in NR/SA. With an improvement in technology toward increased or controlled Yield/SA (production consistency at higher yield levels), substantial gains would be expected.

Size of Harvested Tails (Base Value: 15.6 Grams)

Given an expected growth rate and grow-out season, an unexpected tail size higher or lower at harvest can have substantial impact on NR/SA (Table 4). In fact, a percentage increase in tail size without reduction in mortality within a pond increases NR/SA by a greater percentage than an increase in the number of shrimp of a given size within a pond. This points out that the marginal contribution to financial feasibility of decreasing mortality is less than that of increasing the growth rate for a given amount of feed, labor, etc. The larger shrimp will draw a higher price. Increasing the tail size has a greater impact on NR/SA than does the increase in NR/SA from an increase in sheer biomass.

The drastic decreases in NR/SA, with decreases in tail size, indicate the impact of a percentage decrease in tail size. Consistent growth, and thus, consistent tail size, for shrimp in the production season, will certainly be reflected as greater predictability of NR/SA.

Cost Per Hour For Hired Labor (Base Value: $3.00)

The second largest cost item for a shrimp mariculture operation is that of labor. This cost is greater per SA for smaller operations than it is for larger ones. As the size of the operation increases the operation becomes less labor intensive and more efficient. The decrease in NR/SA as the wage rate is increased is very slight due to

Table 4. Percentage Response of NR/SA to Percentage Change in Non-Management Variables.

Selected Variables	Percentage Increase of Selected Variables			Base* NR/SA	Percentage Decrease of Selected Variables		
	30%	20%	10%		10%	20%	30%
Yield (Lbs. Tails/SA)							
- % Change from Base NR/SA	63	44	23		23	47	93
- Resulting NR/SA	992	874	746	608	453	261	45
Tail Size (Grams)							
- % Change from Base NR/SA	77	57	23		57	156	224
- Resulting NR/SA	1078	954	746	$608	259	-338	-755
Hired Labor ($/Hr)							
- % Change from Base NR/SA	4	3	1				
- Resulting NR/SA	584	606	600	608			
Feed ($/Lb)							
- % Change from Base NR/SA		9	5		5	10	
- Resulting NR/SA		$544	$576	608	637	667	
Ex-Vessel Price/Lb of Tails							
- % Change from Base NR/SA					26	58	93
- Resulting NR/SA				$608	$451	258	$42

*Base NR/SA represents NR/SA value expected when selected variables are held at originally assumed values.

labor already becoming a less important component of TVC for the operation (11 percent of TVC for the 96-acre operation consisting of 24 2.5-acre ponds). The percentage decrease in NR/SA is much less than the percentage increase in hourly wage rates. This would not be the case for a smaller operation where hired labor comprises a greater percentage of TVC/SA.

Feed Price Per Pound (Base Value: $0.15)

The cost of feed is the largest single variable cost item per SA for the mariculture operation regardless of size. The percentage response in NR/SA for a given percentage change in feed price is relatively the same, whether the change be an increase or decrease in feed price. Even though feed is the major variable cost item, the percentage response in NR/SA is much less than the percentage change in price per pound of feed. Given the feeding schedule applied in this study, the reduction of price per pound of feed should be a priority item in terms of future research directed toward reducing operating costs.

Ex-Vessel Price Per Pound of Tails (Base Value: $3.25)

Historically, the ex-vessel price received for shrimp tends to be erratic in nature. Since the price of $3.25 produces considerable profits for the 96-acre operation, this analysis examined the effects of only a price decrease from 10 to 30 percent. The decrease in NR/SA due to percentage decreases in the ex-vessel price for tails of the assumed size is substantial. However, even the 30 percent price reduction still shows a positive NR/SA for the operation. This study assumes that the level of output from a mariculture firm will not alter the current market supply enough to influence price.

Sensitivity Summary

The sensitivity analysis indicates the marginal impact on NR/SA for each production variable and price exhibits assuming all others are held constant at their base value. Of the management variables, length of grow-out season is the most influential on NR/SA. Ranking the non-management prices and variables in order of the magnitude of their impact on NR/SA yields the following: (1) tail size, (2) ex-vessel price of tails, (3) yield, (4) feed price, and (5) hired labor wage rate. Note that the percentage response of NR/SA due to change in yield and ex-vessel price are virtually the same. By definition, TR/SA (yield times ex-vessel price) minus TC/SA gives NR/SA. Therefore, a given change in yield or ex-vessel price (given one of the two remains constant) will result in equal responses in NR/SA.

SUMMARY, LIMITATIONS, AND CONCLUSIONS

The computer model developed in this study is capable of budgetary and cash flow analyses. Based on costs and returns generated by the model, economies of size were examined by incrementing pond size and then the number of ponds for a given facility design. Sensitivity analyses were performed to provide information concerning the responsiveness of net revenues to change in selected production variables and prices.

The results and analysis in this study are dependent entirely upon the assumptions and relationships integrated into the program. Future research will provide the information needed for updating and modification of the model. Based upon assumptions established and maintained with the framework of the model, large-scale penaeid shrimp maricultural operations of the assumed design and located in Brazoria County, Texas, could be profitable.

An operation containing 96 TA, 60 SA of which consist of twenty-four 2.5-acre ponds, would expect to have an average annual net return of $608 per SA over a ten-year planning horizon. The operation would have an IRR to equity of 71 percent, and IRR to total investment of 17 percent and a pay-back period of two years. This production system would represent a size operation that would capture most of the economies of size, thus establishing a point of reference to potential investors for minimum capital investment.

Much improvement can be made on the BEE model by integrating more accurately descriptive algorithms and functional relationships in an attempt to better represent actual operation and production of a proposed system. Assumptions established which limit the model and need to be improved upon through future research include:

1. Better understanding and description of the growth functions of individual shrimp and of the entire population. Biological parameters such as dissolved oxygen, temperature, and nitrogeneous wastes and fluctuations in their levels over time must be understood. Methods of controlling the parameters (i.e., water exchange) and the marginal impact upon growth relative to change in the value of any parameter need to be better qualified and incorporated into the growth function. More descriptive data concerning growth and impinging factors need to be generated.
2. Predicting survival over time more accurately in order to provide valid assessments of biomass of the population at a given time prior to harvest. At present, very little is known about survival within a pond except at the time of harvest. Costs related to standing crop, such as feed and feeding labor, would be more accurately quantified with an understanding of survival.

3. Documentation of input, in terms of physical units (i.e., machinery and equipment, labor and management), for a commercial operation. At present, these values in the model are represented by non-documented values which represent current opinion of research personnel generated through on-going research efforts.
4. Development of other facility designs to be inserted into the model to provide design alternatives oriented toward current investor interests. The model is flexible enough to allow the inclusion of other system designs generated through advancing technology.
5. Integrating a hatchery system into the model. At present, no hatchery facility is included in the model. The necessary post-larvae are assumed to be obtained from a local hatchery.

Future research should be directed toward the area which will have the greatest impact on advancing technology per research dollar. In an attempt to relax assumptive rigidity, the sensitivity analysis in the study suggests that sucsessful research efforts into increasing the control on yield (pounds of tails) will have a large impact on an economically feasible system. At present, production of the Brazoria County facility is plagued by variability from pond to pond from year to year, which in large part is unexplained. As revealed by the sensitivity analysis, a much better understanding of influencing factors involved and how to control these factors is of utmost importance. Based on the sensitivity analysis, the crux of future research should be understanding factors influencing production consistency (total yield and tail size for a given stocking density and grow-out season) and being able to accurately predict and manipulate these factors with a certain degree of confidence and, thus, demonstrate control over production.

Until further research is accomplished toward various biological and production-oriented factors involved in penaeid shrimp mariculture along the northern Texas Gulf coast, the risk involved possibly outweighs the anticipated high returns. Many biological relationships relative to the entire culture system need to be more accurately identified and quantified in order to provide potential investors a more valid insight into production potential. The profit potential of penaeid shrimp mariculture is evident. In recognition of the recent advances made in production and maturation technology, the economic feasibility of penaeid shrimp mariculture is indeed on the threshold of reality. However, as long as the potential investor faces a relatively high level of uncertainty regarding production, and the extent of control over production in comparison with other investment alternatives remains low, commercial investment in the Brazoria County facility design along the northern Texas Gulf coast may well be limited.

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APPENDIX

PROGRAM DOCUMENTATION

The softwear (computer program) for the BEE model is written in Fortran for a WATFIV compiler. Maximum portability from system to system can only be achieved by recognizing the special extensions to the Fortran language of WATFIV (format free input-output, character variables, expressions in output lists, etc.). The program is written for use on the OS version of the WATFIV compiler on the Texas A&M University Data Processing System. This version allows the user to exercise extended I/O capabilities. Storage area of 320K bytes is required for a program run.

The following sections discuss the actual program, input requirements to make a run, and the possible output from the program. Refer to pages 63 to 109 for the source and data deck listings of the program.

Source Deck

Lines 1-2316

The programming found in this line range is the program source deck. Lines 1-123 are the main program. This is where the storage matrices are established in core and the necessary data is read into the storage space. Lines 70-121 call subroutines in the proper order of execution to produce the desired output. It is possible to skip certain subroutines but the order in which they are called and executed can never be altered. Lines 124-2315 contain the program subroutines. Each subroutine has a specific function as denoted by comment statements immediately preceding each subroutine.

Data Deck - Input Requirements

The data deck contains character and numeric data. All numeric data is read in format free and can be changed to meet the individual user's

input needs; however, real data must remain real and integer data must remain integer. Character data can be altered relative to format guidlines established in lines 6-8 and 44-49 of the source deck.

Lines 2317-2374 (HEADER, TITLE, LABEL)

The character data found in this line range are used for row headings in Tables A1 to A7.

Lines 2376-2378

This information refers to specific times in the production season. Line 2376 refers to the day of the year that stocking occurs (SDATE). Line 2377 refers to the day of the year that harvest occurs (HDATE). Line 2378 refers to the number of days after stocking that feeding is begun (NFPO.

Line 2379 (MONTH)

Contains the days of the years for each month. These values are stored for use in subroutine MATRIX.

Lines 2381-2395 (INPUT)

These lines provide space for miscellaneous information to be used throughout the program. At present, only eight lines in the range contain data. Line 2383 refers to the estimated hours of maintenance labor per linear foot of levee. Line 2386 gives the combined number of pounds of fertilizer used per surface acre in a full and partial application. Lines 2387 and 2388 provide the pounds per surface acre for a full and partial application, respectively. Lines 2389 and 2390 refer to the expected miles per gallon fuel usage for the trucks and tractors, respectively. Line 2393 gives the kwh of electricity used by the office building in summer (the other seasons are programmed in as a percentage of this). Line 2394 is the number of gallons of city water used to rinse each vehicle after a day of work. Line 2395 is blank storage area.

Lines 2397-2399

The information contained in lines 2397, 2398 and 2399 allows variable amounts of information to be stored in FXPRIC, VPRIC and VAR arrays, respectively.

Lines 2401-2402 (FXPRIC)

These two lines contain the per unit prices for the fixed input. The items for which the prices apply are listed in order as follows:

- Land per acre
- Cost to move a cubic yard of dirt for roaded levee construction
- Cost to move a cubic yard of dirt for non-roaded levee construction
- Crushed rock per cubic yard
- Office building per square foot
- Cost to move a cubic yard of dirt for raised earthen office foundation
- Truck per unit
- Tractor and accessories per unit
- Trailer per unit
- Feed blower per unit
- Appropriate size extended shaft pump w/diesel driver per unit
- Pump shed per unit
- Filter and apparatus
- Lumber walkway per unit
- Drain valve per unit
- 4-inch pvc pipe linear foot
- Appropriately size concrete pipe per linear foot

Lines 2404-2423 (VPPRIC)

This range of lines contains the per unit prices for the variables. inputs found in output Tables A2 and in the detailed annual budget. The expenses for which the prices apply are given in order as follows:

- Hired labor per hour employed for feeding
- Hired full-time labor per hour
- Hired labor per hour employed for maintenance of ponds
- Management salary (on a per hour basis) employed for maintenance of ponds
- Hired overtime labor per hour employed for harvesting
- Management salary (on a per hour basis) employed for harvesting
- Management salary (on a per hour basis)
- Feed (25% protein) per round
- Fertilizer (46-0-0), (0-46-0)
- Gasoline per gallon (consignee bulk-rate)
- Gasoline per gallon (consignee bulk-rate)
- Diesel per gallon (consignee bulk-rate)
- Diesel per gallon (consignee bulk-rate)
- Diesel per gallon (consignee bulk-rate)
- Diesel per gallon (consignee bulk-rate)
- Diesel per gallon (consignee bulk-rate)
- Diesel per gallon (consignee bulk-rate)
- Electricity per kilowatt hour
- No information found here - price for water is found in next group of information
- Crushed ice per pound
- Post-larvae each

Line 2425-2457 (VAR)

The data found in this range are for a variety of computations in the program. Lines 2435, 2437, 2441, 2447 to 2449 and 2452 will be discussed separately. Line 2425 is the number of pond units the operation has. Line 2426 is a constant; the number of square feet to an acre. Line 2427 is the length to width ratio of a pond unit. Lines 2428 and 2430 are constants -

cubic feet per linear foot roaded and non-roaded levee, respectively. Line 2431 and 2432 refer to machine efficiencies - pump and power unit efficiency, respectively. Line 2433 represents the BTU's per gallon of diesel fuel. Line 2434 represents the total dynamic head of the system design. Line 2436 is the stocking density per water surface acre. Line 2438 is a blank storage location. Lines 2439 and 2440 represent price for city water - price per gallon for first 1000 gallon quantity and price per gallon for the following quantities Lines 2442 to 2446 contain values pertaining to the design of levees. Lines 2442-2443 refer to the side lengths of non-roaded and roaded levees, respectively. Line 2444 refers to the base width of a roaded levee. Lines 2445 and 2446 refers to the top widths of roaded and non-roaded levees, respectively. Line 2450 refers to the depth of water desired in each pond unit. Line 2451 refer to the system type the user wished to specify (to be explained later). Line 2453 represents the length of pipe necessary to extend through the levee bottom approximately one foot above the pond bottom. Lines 2454 and 2455 refer to daily exchange rates (percentages) - minimum and maximum daily exchange rates, respectively. Line 2456 represents the Hasen-Williams roughness coefficient for pipe employed in the system. Line 2457 refers to the system design chosen if an alternative system design is selected (to be explained later).

Lines 2459-2502 (LOAN)

This range of lines contains the necessary information for loan calculations on each item on which a loan is carried. Every four lines contain a complete set of loan information on each item concerned. Line 2460 is assigned in the program the original value that is assumed as a salvage value. Line 2462 contains the years of expected life, percent financed, contractual interest rate on the loan, number of payments per year, and years in the payment period of the loan, respectively.

Line 2503-2510 (INSUR)

The information contained in this line range represents the data necessary to complete property and employee insurance costs for the operation. Line 2503 is a code for type of employee insurance provided: 1 - Farmer's Liability or 2 - Workman's Compensation. Line 2504 refers to the annual percentage rate of replacement value on insured machinery. Line 2505 refers to flat rate expense of insurance on property for Farmer's Liability and applied to operation size of 0-160 acres. Lines 2506-2507 are the same as 2505 except the values apply to operation sizes of 161-500 and 500 - ∞ acres, respectively. Line 2508 refers to the cost ($) per $100 of payroll for Farmer's Liability coverage. Line 2509 refers to the percentage rate of building values for full coverage. Line 2510 refers to the cost ($) per $100 of payroll for Workman's Compensation coverage.

Lines 2511-2517 (TAX)

The information contained in this range of lines represents the data required to determine the appropriate income, payroll, and property taxes for the operation. Line 2511 refers to the percenage rate of social security tax per employee's annual wages. Line 2512 refers to the maximum annual income per employee that is subject to social security taxes. Line 2513 is the maximum annual income per employee that is subject to unemployment taxes. Line 2514 is the unemployment tax rate per employee. Line 2515 is the percentage of real property (buildings and machinery) value that is subject to local real property taxes. Line 2516 is the local tax constant multiplied by every $100 of the preceding taxable value. Line 2517 provides the social security rate on owner operator's income (sole proprietor net income) up to the maximum taxable income value stored in line 2512.

Line 2518

This value is displayed in Table A1 as the units of land per acre.

Line 2519 (YEAR)

This is the object year of the analysis desired by the user.

Line 2521-2523 (PUMPVL)

The values stored in these two lines are the price for the pumps from which the programmer selects. The respective GPM's for the pumps can be found in lines 361-369 of the source deck for extended shaft pumps and lines 392-398 of the source deck for Hydroflow pumps. All of the prices in line 2521 and the first price in line 2522 apply to extended shaft pumps. The remaining prices in line 2522 apply to Hydroflow pumps.

Lines 2523-2527 (VMAX, SOIL, Z, ST, FB)

The data in this range of lines deals with the engineering aspects considered in the computation of pump, pipe, and pumping fuel costs for alternative designs not considered in the scope of this paper.

Line 2528 (HEAD)

This value is the head from reservoir surface to pond surface.

Line 2529 (MTYPE)

This value is a code designating which alternative system is to be utilized. These systems are beyond the scope of this paper.

Line 2530 (DIAM2)

The values found in this line are the fifteen different concrete pipe diameters (inches) that the system has to select from.

Line 2531 (PIPEVL)

These values are the corresponding prices per linear foot installed for the above concrete pipe sizes.

Lines 2532-2537 (VALUE)

This array represents the sixty ex-vessel prices for the months of

June (Line 2532) through November by the ten different tail count sizes. From leftmost: >15/lb., 15-20, 21-25, 26-30, 31-35, 36-40, 41-50, 51-60, 61-70 and ≥71.

Line 2538 (RATE)

The value found here represents the opportunity cost assumed in this study. This value is given as a percentage and is used to calculate the "Required Return to Equity Capital" found in Tables A6 and A7.

These remaining lines serve only to delineate one group of data from another. They contain no data.

Desired Output

There are certain lines found in the data set that are reserved for codes that request certain output from the program. A code is established where a 1.0 requests output and a 2.0 suppresses the output. The following lines (along with the applicable output) are reserved for that information:

Line 2435 - Table A1

Line 2437 - Tables A2 and A3

Line 2441 - Tables A4 and A5

Line 2447 - Table A6

Line 2448 - Table A7

Line 2449 - Table A8

Line 2452 - Table A9

Summary - How To Run The Program

Prior to making a run with the program, the user should review the values entered in for lines 2376-2538. The user should be in aggreement with these values. Most of these values can be accepted as applicable to a typical situation. However, it is recommended that the user specifically check the following lines to be sure the model incorporates the critical values the user wishes to employ.

Line 2376-2377	Length of grow-out period
Line 2401-2433, 2521-2522	
2531-2537	Current prices
Line 2425	Number of pond units
Line 2428	Water surface acres per pond
Line 2436	Stocking density per water surface acre
Line 2519	Object year of analysis
Line 2435, 2437, 2441	
2447, 2448, 2449, and	
2452	Desired output

Source and Data Deck - Bio-Engineering-Economic Model For
Penaeid Shrimp Mariculture Systems

```
C*****************************************************************
C
C       MAIN PROGRAM FOLLOWS
C
C*****************************************************************
      CHARACTER*70 HEADER(20)
      CHARACTER*10 TITLE(20)
      CHARACTER*30 LABEL(18)
      REAL RETCAS(30),ROCAOT(30),BLOSS(30),COCAOT(30),CETCAS(30)
      REAL PIPEVL(13), DOLPD(13), PUMPVL(16), VO1(30), VO2(30),
     .TOINT(30), TOPRN(30), MTHINT(11,30,12), MTHPRN(11,30,12),
     . INSUR(8), TAX(7), INCTAX(30), INPUT(15), MPADEX(40,12),
     . FXRPAC(40), FXPRIC(40), VPPRIC(40), VAR(50), MBAL(12),
     . MCMCAS(12), TOTLPA(40), TOTAL(40), LOAN(8,11), TMPRN(30,12),
     . TMINT(30,12),VALUE(10,6),TAXINC(30),SSTAX(30),WT(50)
      REAL MTHTOP(40,12), MTHTOC(40,12), MTHPAC(40,12),
     . OPTOTL(40),OPPATL(40), OPPHTL(40),MONTHT(12)
      REAL INVREQ(30), TOCAOT(30), NETCAS(30), CUMCAS(30)
      REAL EQSUM(30), INTSUM(30), PRINSM(30), REMBAL(30), BALSUM(30)
     .,TCAPP(30)
      REAL IRR, N, NN, NNN, NETRET, IPW, NTRLR, NTRUCK, NTRAC, NFEDBL,
     . NPSHD,IRRT,NETRT
      INTEGER PRIN(11,30), INT(11,30), EQUIT(11,30), BAL(11,30)
     ., CAPPUR(11,30), DIAM2(13), OBJYR(30), MONTH(12)
      INTEGER FINALY, FINYR, MAX, DEPR, TYPE, TLAND, WORK2, T, FILLUP,
     .HARTIM, YEAR
      INTEGER SDATE, HDATE, DOSM, DOHM, FP, ED, BD, DOM
      DATA RETCAS/30*0.0/,ROCAOT/30*0.0/,COCAOT/30*0.0/, CETCAS/30*0.0/
      DATA MBAL/12*0.0/,MCMCAS/12*0.0/,MONTHT/12 *0.0/,TMPRN/360*0.0/,
     . TMINT/360*0.0/, DOLPD/13*0.0/, TOINT/30*0.0/, TOPRN/30*0.0/
      DATA INVREQ/30*0.0/, TOCAOT/30*0.0/, NETCAS/30*0.0/,
     . CUMCAS/30*0.0/,WT/50*0.0/
      DATA MTHTOP/480*0.0/, MTHTOC/480*0.0/, MTHPAC/480*0.0/,
     . OPTOTL/40*0.0/, OPPATL/40*0.0/, OPPHTL/40*0.0/
      DATA LOAN/88*0.0/, PRIN/330*0  /, INT/330*0  /, EQUIT/330*0  /
     . ,BAL/330*0/, CAPPUR/330*0/
      DATA INPUT/15*0.0/, MONTH/12*0  /, MPADEX/480*0.0/
      DATA INSUR/8*0.0/, TAX/7*0.0/, INCTAX/30*0.0/,TAXINC/30*0.0/,
     .SSTAX/30*0.0/
      DATA FXRPAC/40*0.0/,FXPRIC/40*0.0/,VPPRIC/40*0.0/, VAR/50*0.0/,
     .TOTLPA/40*0.0/, TOTAL/40*0.0/, PUMPVL/16*0.0/
      DATA EQSUM/30*0.0/, INTSUM/30*0.0/, PRINSM/30*0.0/, REMBAL/30*0.0/
     . , BALSUM/30*0.0/, TCAPP/30*0.0/
      READ(5,502) HEADER
  502 FORMAT(A70)
      READ(5,501) TITLE
  501 FORMAT(A10)
      READ(5,500) LABEL
  500 FORMAT(A30)
      READ, SDATE, HDATE, NFP
      READ, (MONTH(I), I=1,12), (INPUT(I),I=1,15)
      READ,      M1,        M2,      M3
      READ,  (FXPRIC(I),I=1,M1),(VPPRIC(I),I=1,M2),(VAR(I),I=1,M3)
```

```
      READ, ((LOAN(I,J), I=1,8), J=1,11)
      READ, (INSUR(I),I=1,8), (TAX(I),I=1,7)
      TYPE = VAR(27)
      JJJJ=VAR(25)
      JJJJJ=VAR(28)
      READ(5,100) FXRPAC(1)
100   FORMAT(F2.0)
      READ, YEAR
      READ, (PUMPVL(I),I=1,16)
      READ, VMAX,SOIL,Z,ST,FB,HEAD
      READ,MTYPE
      READ,(DIAM2(I),I=1,13)
      READ,(PIPEVL(I),I=1,13)
      READ,((VALUE(I,J),I=1,10),J=1,6)
      READ, RATE
C
      CALL LEVEE(VAR, LEVEER, LEVEEP, ROADM, RDLV, IPW, EPL, ORW,
     .PL,OPW,TYPE,SPL,LPL,SPW,A,B,LPW,MTYPE,VMAX,SOIL,
     .Z,ST,FB,HEAD,PW,PW1,RDLV1,RDLV2)
      CALL LAND(VAR,EPL,ORW,OPW,PL,ACRES,TYPE,SPL,LPL,SPW,
     .PW,MTYPE,PW1)
      CALL PUMPS(A,B,PUMPVL,VAR,PUMPC,TWHP,FXRPAC,TYPE,SPL,LPL,SPW,
     .LPW,FILLUP,TPUMPS,ACRES,FXPRIC, MTYPE,HEAD,PL,
     .GPM,GPM2,PW,PW1,DIAM2,DOLPD,VPPRIC,PIPEVL,LOAN,DIAMT,PRICE5)
      CALL LEVEEC(LEVEER, LEVEEP, ROADM, ACRES, FXRPAC)
      CALL CNSTNT(ACRES,          NHIRE, NOPER, HARTIM, PFUEL,
     . RDLV, INPUT, AE,BE,T1, S, VAR, EPL, OPW, NN, NNN, NTRAC,
     .TOTALG,TYPE,SPL,LPL,SPW,T2,S1,RDLV1,RDLV2,MTYPE)
      CALL MACHIN(VAR, ACRES, TPUMPS, FXRPAC, NOPER, NHIRE,
     .NTRUCK,NTRAC,TYPE,MTYPE)
      CALL PIPE(VAR,ACRES,FXRPAC,TYPE,MTYPE,
     .FXPRIC,GPM,HEAD,PIPEVL,TOPIPE,GPM2,
     .DIAM2,DOLPD,VPPRIC,PL,LOAN,DIAMT,PRICE5)
      CALL STRUCT(VAR, ACRES, BLDGPA, FXRPAC, NTRUCK, NTRAC)
      CALL RITE(FXRPAC, FXPRIC, LABEL, ACRES, M1,   TOTLPA,
     .TOTAL,TYPE,TOPIPE,MTYPE,VAR)
      CALL PRODUC(VAR,ACRES,TLBS,TLBSPA,REVENU,INPUT,HDATE,SDATE,
     .VALUE,MONTH,WT)
      CALL MATRIX( INPUT, MONTH, ACRES, TITLE, MPAOEX,
     . SDATE, HDATE, NFP, VAR, T1, S, NN, NNN, AE,BE,
     . NTRUCK, NTRAC, TOTALG, FILLUP, NOPER , NHIRE, ED1, TYPE, T2, S1,
     .TLBSPA,TWHP,J2,MTYPE,WT)
      CALL ASSET(LOAN, PRIN, INT, EQUIT, TOTAL, FINYR,BAL, CAPPUR)
      CALL MONTHS(LOAN, TMPRN, TMINT, TOTAL, ACRES, TOINT, TOPRN)
      CALL MULT(VAR,VPPRIC,M2,ACRES,MPAOEX,MTHTOP,MTHTOC,MTHPAC,
     . OPTCTL,OPPATL, OPPHTL, CAOPEX,MONTHT)
      CALL INFO(INT,EQUIT,PRIN,LOAN,ACRES,EQSUM,INTSUM,PRINSM,
     . TEQREQ,REMBAL,TFINPA,TDEPPA,FINYR,BAL, BALSUM, CAPPUR,TCAPP)
      CALL COSTPA(TITLE,MTHPAC,ACRES,TYPE,OPPATL,OPPHTL,M2,MTYPE,VAR)
      CALL INSTAX(ACRES, TOTAL, MTHTOC, INSUR, TAX, INCTAX, NHIRE, FINYR
     .. REVENU, CAOPEX, TDEPPA, PAYTAX, SSTAX, TOTINS, INTSUM)
      CALL BUDGET(OPPHTL,VPPRIC,TLBSPA,TDEPPA,INTSUM,OPPATL,
     . TVARC,TOTINS,PAYTAX,SSTAX,TFIXC,TOCOST,NETRET,HEADER,TYPE,
     . ACRES,INPUT,INCTAX,M2,VINCOM,REVENU, YEAR,MTYPE,EQSUM,RATE,
```

```
     .TCAPP,PRINSM,CAOPEX,FINYR,VAR)
      GO TO (4000,4001), JJJJ
 4000 CONTINUE
      CALL CASHFL(INPUT,INVREQ,TCAPP,REMBAL,TLBSPA,REVENU,CAOPEX,
     . TOTINS,PRINSM,INTSUM,INCTAX,TOCAOT,PAYTAX,SSTAX,NETCAS,
     . CUMCAS,IRR,TAX,FINYR,ACRES,TYPE,OBJYR,BALSUM,MTYPE,IRRT,RETCAS,
     .ROCAOT)
 4001 CONTINUE
      GO TO (4002,4003), JJJJJ
 4002 CONTINUE
      CALL MCSHFL(MBAL,CUMCAS,YEAR,J2,INPUT,MONTHT,TMPRN,TMINT,TOTINS,
     .INCTAX,SSTAX,PAYTAX,BALSUM,REVENU,TLBSPA,REMBAL,INVREQ,TCAPP,
     .MCMCAS,TYPE,ACRES, TOINT, TOPRN, PRINSM, INTSUM,MTYPE)
 4003 CONTINUE
      STOP
      END
C*****************************************************************
C
C     DETERMINING LEVEE EXCAVATION REQUIREMENTS (CUBIC FEET)
C
C*****************************************************************
      SUBROUTINE LEVEE(VAR, LEVEER, LEVEEP, ROADM, RDLV, IPW, EPL,
     .ORW,PL,CPW,TYPE,SPL,LPL,SPW,A,B,LPW,MTYPE,VMAX,
     .SOIL,Z,ST,FB,HEAD,PW,PW1,RDLV1,RDLV2)
      REAL VAR(50), IPW
      INTEGER TYPE
      N = VAR(1)
      SQF = VAR(2) * VAR(4)
      IF(VAR(1).GT.4) X=VAR(1)-4.0
      IF(VAR(1).EQ.4) X=1
      IF(VAR(1).LT.4) X=0
      A = SQRT (SQF/VAR(3))
      B = SQF/A
      GO TO (1,2),TYPE
    1 CONTINUE
C   IPW IS THE STANDARD POND WIDTH
C   PL IS THE STANDARD POND LENGTH
C
C   OPW IS THE DISTANCE FROM THE MIDDLE OF THE OUTER LEVEE TO THE MIDDLE
C        OF THE NEAREST INNER LEVEE
C   EPL IS THE DISTANCE FROM THE MIDDLE OF THE END LEVEE TO THE MIDDLE
C        OF THE CLOSEST PARTIONING LEVEE
C   ORW IS THE WIDTH OF THE HOLDING RESERVOIR FROM EACH MIDDLE OF IT'S
C        TWO BORDERING LEVEES
C
      PL=B+((VAR(21)*.5)+(VAR(22)*.5))*2.0
      IPW=A+(VAR(18)*.5)*2.0
      OPW=A+((VAR(18)*.5)+(VAR(19)*.5))*2.0
      EPL=PL+((VAR(18)*.5)+(VAR(19)*.5)+(VAR(21)*.5)+(VAR(22)*.5))
      ORW = IPW/2.0
      RDLV = (4.0 * OPW) + (2.0 * ORW) + ((2.0 * X) *PL) + (8.0 * EPL)
      PLV = ( VAR(1) - 2.0 ) * IPW
      LEVEER=RDLV*(VAR(5)/27.0)
      LEVEEP=PLV*(VAR(6)/27.0)
```

```
      ROADM=RDLV/10.0
      GO TO 9
    2 CONTINUE
      GO TO (4,5,6), MTYPE
    4 CONTINUE
      SPW = A + VAR(29)
      SPL = B + VAR(29)/2 + 15
      SPP1 = SPW * 1.06 + VAR(29)
      SPP2 = SPL - SPP1 +  VAR(29)
      LPL = B + (B/12) + VAR(29)/2 + 15
      LPW = A - VAR(29)/2 + VAR(29)
      RL = VAR(29) + 30
      RDLV = N * (2*(SPW + SPL + LPW + SPP2 + (2 * LPL )) + RL + SPP1)
      PLV = N * (2 * LPW )
      GO TO 3
    5 CONTINUE
      PW=A+VAR(29)
      PL=B+VAR(29)/2+15
      RL=VAR(29)+30
      RDLV=((6*PL)+(4*PW)+RL)*N
      PLV=N*(2*PW)
      GO TO 3
    6 CONTINUE
      PW1=A+VAR(29)
      PL=B+VAR(29)/2+15
      GPM=PW1*PL*VAR(26)*VAR(31)*2/192.5
      Q=GPM/448.83
      ANGLE=ATAN(1/Z)
      A1=Q/VMAX
      D1=((2**.666*SOIL*Q*(TAN(ANGLE/2)+SQRT(Z**2+1))**.666)/
     .(1.486*(ST**.5)*(2*TAN(ANGLE/2)+Z)**2))**.5
      A2=(D1**2)*(2*TAN(ANGLE/2)+Z)
      IF(A2.GT.A1) GO TO 10
      IF(A2.LT.A1) GO TO 11
   10 BT=2*D1*TAN(ANGLE/2)
      AT=A2
      GO TO 12
   11 D=(Q/2/(2*TAN(ANGLE/2)+Z))**.5
      BT=2*D*TAN(ANGLE/2)
      AT=A1
   12 CONTINUE
      IF(BT.LT.2) BT=2
      D3=(AT/(2*TAN(ANGLE/2)+Z))**.5
      D2=D3/(1-FB)
      TOP=BT+(2*Z*D2)
      BASE=60+TOP
      PW2=PW1-(BASE/2)
      RL=VAR(29)+30
      RDLV1=((5*PL)+((2*PW1)+(2*PW2)+RL))*N
      RDLV2=PL*N
      PLV=N*(2*PW1)
      GO TO 3
    3 CONTINUE
      IF(MTYPE.NE.3) GO TO 7
```

```
      IF(MTYPE.EQ.3) GO TO 8
    7 CONTINUE
      LEVEER = RDLV*(VAR(5)/27.0)
      LEVEEP=PLV*(VAR(6)/27.0)
      ROADM = RDLV/10.0
      GO TO 9
    8 CONTINUE
      LEVEE1=RDLV1*(VAR(5)/27.0)
      LEVEE2=RDLV2*((360+TOP*10)/27.0)
      LEVEER=LEVEE1+LEVEE2
      LEVEEP=PLV*(VAR(6)/27.0)
      ROADM=(RDLV1+RDLV2)/10.0
    9 CONTINUE
C
C  RDLV IS THE NUMBER OF LINEAR FEET OF LEVEES WITH ROAD NECESSARY
C  PLV IS THE NUMBER OF LINEAR FEET OF NON-ROAD LEVEES NECESSARY
C
      RETURN
      END
C*****************************************************************
C
C     CALCULATING ACREAGE REQUIREMENTS (TOTAL ACRES OF OPERATION)
C
C*****************************************************************
      SUBROUTINE LAND(VAR, EPL, ORW, OPW, PL, ACRES, TYPE,
     .SPL,LPL,SPW,PW,MTYPE,PW1)
      REAL VAR(50)
      INTEGER TLAND, TYPE
      N = VAR(1)
      GO TO (1,2),TYPE
    1 CONTINUE
      LENGTH = (EPL * 2.0) + (PL * (( VAR(1)/2.0) - 2.0))
      WIDTH = ((OPW * 2.0) + ORW)
      GO TO 3
    2 CONTINUE
      GO TO (10,11,12), MTYPE
   10 CONTINUE
      C = SPL + LPL + VAR(29)
      D = (SPW * 2) + (VAR(29) * 2)
      E =((SPL + LPL + VAR(29))* 2 + 30)
      IF(MOD(N,2).NE.0) E=((SPL+LPL+VAR(29))*2+30)+C
      F = ((SPW * 2) + VAR(29) + 30 ) * (N / 2)
      GO TO 9
   11 CONTINUE
      C=2*PL+VAR(29)
      D=(PW*2)+VAR(29)
      E=((2*PL+VAR(29))*2+30)
      IF(MOD(N,2).NE.0) E=((2*PL+VAR(29))*2+30)+C
      F=(PW*2+VAR(29)+30)*(N/2)
      GO TO 9
   12 CONTINUE
      C=2*PL+VAR(29)
      D=(PW1*2)+VAR(29)
      E=((2*PL+VAR(29))*2+30)
```

```
      IF(MOD(N,2).NE.0) E=((2*PL+VAR(29))*2+30)+C
      F=(PW1*2+VAR(29)+30)*(N/2)
    9 CONTINUE
      IF(N.EQ.1) LENGTH = C
      IF(N.EQ.1) WIDTH = D
      IF(N.GE.2) LENGTH = E
      IF(N.GE.2) WIDTH = F
    3 CONTINUE
      ACRES1= (LENGTH*WIDTH)/VAR(2)
      TLAND1 = ACRES1 + 10.0
      TLAND = TLAND1
      IF(TLAND1 - TLAND.GE.0.5) GO TO 4
      ACRES = TLAND
      GO TO 5
    4 ACRES = TLAND + 1.0
    5 RETURN
      END
C*****************************************************************
C
C     DETERMING DIAMETER OF PIPES NECESSARY TO HANDLE FLOW RATES
C
C*****************************************************************
      SUBROUTINE DIAMET(DIAM2,DOLPD,VPPRIC,GPM ,PL,PIPEVL,LOAN,DIAMT,
     .PRICE5,VAR)
      INTEGER DIAM2(13)
      REAL VPPRIC(40),LOAN(8,11), DOLPD(13), PIPEVL(13),VAR(50)
      GPM1=GPM/(VAR(1)*VAR(33))*2
      DO 1 N=1,13
      DOLPD(N)=.03215394*(VPPRIC(14)*(GPM1**2.85)*PL*(100.0/VAR(32))
     .**1.85)/(VAR(7)*VAR(8)*VAR(9)*(DIAM2(N)**4.8655))+(PIPEVL(N)+
     .PL)/(LOAN(4,11)*365.0)
    1 CONTINUE
      SMALL=DOLPD(1)
      DIAMT=DIAM2(1)
      PRICE5=PIPEVL(1)
      DO 2 N=1,13
      IF(DOLPD(N).LT.SMALL) GO TO 7
      GO TO 8
    7 SMALL=DOLPD(N)
      DIAMT=DIAM2(N)
      PRICE5=PIPEVL(N)
    8 CONTINUE
    2 CONTINUE
      RETURN
      END
C*****************************************************************
C
C     CALCULATING CAPACITY AND NUMBER OF PUMPS TO HANDLE FLOW RATE
C            (FLOW RATE IS ALSO BEING DETERMINED)
C
C*****************************************************************
      SUBROUTINE PUMPS(A,B,PUMPVL,VAR,PUMPC,TWHP,FXRPAC,TYPE,SPL,LPL,SPW
     .,LPW,FILLUP,TPUMPS,ACRES,FXPRIC, MTYPE,HEAD,PL,
     .GPM,GPM2,PW,PW1,DIAM2,DOLPD,VPPRIC,PIPEVL,LOAN,DIAMT,PRICE5)
```

```
      REAL VAR(50),FXRPAC(40),PUMPVL(16), FXPRIC(40)
      INTEGER DIAM2(13)
      REAL LCAN(8,11), DOLPD(13), VPPRIC(40), PIPEVL(13)
      INTEGER TYPE
      INTEGER FILLUP
      PONDVL= 326000 * VAR(4)  * VAR(26)
      GO TO (1,2) , TYPE
1     GPM = A*B*VAR(26) * VAR(31) * VAR(1) / 192.5
      TOTALG = PONDVL * VAR(1)
      GO TO 3
2     CONTINUE
      GO TO (12,13,14), MTYPE
12    CONTINUE
      GPM=(SPL+LPL)*(     LPW)*VAR(26)*VAR(31)*VAR(1)        *2/192.5
      TOTALG = PONDVL * VAR(1) * 4
      GO TO 3
13    GPM=(2*PL)*PW*VAR(26)*VAR(31)*VAR(1)*2/192.5
      TOTALG=PONDVL*VAR(1)*4
      GO TO 3
14    GPM=PW1*(2*PL)*VAR(26)*VAR(31)*VAR(1) *2/192.5
      TOTALG=PONDVL*VAR(1)*4
3     CONTINUE
      N = 1
      GPM1=GPM
4     CONTINUE
      IF(GPM1.GT.70000) GO TO 6
      WHP=GPM1*VAR(10)/3960
      GO TO 5
6     CONTINUE
      N = N + 1
      GPM1=GPM/N
      GO TO 4
5     CONTINUE
      NPUMPS=N
      SPUMPS=N
      LPUMPS=N
      TPUMPS=N*2
      IF(GPM1.LE.2000) PUMPC=PUMPVL(1)
      IF(GPM1.GT.2000.AND.GPM1.LE.4200) PUMPC=PUMPVL(2)
      IF(GPM1.GT.4200.AND.GPM1.LE.7500) PUMPC=PUMPVL(3)
      IF(GPM1.GT.7500.AND.GPM1.LE.12000) PUMPC=PUMPVL(4)
      IF(GPM1.GT.12000.AND.GPM1.LE.16500) PUMPC=PUMPVL(5)
      IF(GPM1.GT.16500.AND.GPM1.LE.27000) PUMPC=PUMPVL(6)
      IF(GPM1.GT.27000.AND.GPM1.LE.40000) PUMPC=PUMPVL(7)
      IF(GPM1.GT.40000.AND.GPM1.LE.50000) PUMPC=PUMPVL(8)
      IF(GPM1.GT.50000.AND.GPM1.LE.70000) PUMPC=PUMPVL(9)
      TPUMPC=TPUMPS*PUMPC
      PUMPPA=TPUMPC/ACRES
      FXPRIC(11)     = PUMPC
      FXRPAC(11) = TPUMPS / ACRES
      IF(TYPE.EQ.1) GO TO 7
      IF(TYPE.EQ.2) GO TO 8
7     TWHP=WHP*N
      FXPRIC(12)     = 0
```

```
      FXRPAC(12) = 0
      GO TO 9
8     IF(MTYPE.NE.2) GO TO 10
      IF(MTYPE.EQ.2) GO TO 11
10    TWHP=WHP*N
      FXPRIC(12)     = 0
      FXRPAC(12) = 0
      GO TO 9
11    CONTINUE
      CALL DIAMET(DIAM2,DOLPD,VPPRIC,GPM,PL,PIPEVL,LOAN,DIAMT,PRICE5,
     .VAR)
      GPM2=(GPM/(VAR(1)*VAR(33))*2)
      HF=0.002083*(PL     )*(GPM2**1.85)/DIAMT**4.8655
      WHP2=GPM2*VAR(1)*(HF)/3960
      IF(GPM2.LE.2000) PUMPCH=PUMPVL(10)
      IF(GPM2.GT.2000.AND.GPM2.LE.3500) PUMPCH=PUMPVL(11)
      IF(GPM2.GT.3500.AND.GPM2.LE.6000) PUMPCH=PUMPVL(12)
      IF(GPM2.GT.6000.AND.GPM2.LE.11000) PUMPCH=PUMPVL(13)
      IF(GPM2.GT.11000.AND.GPM2.LE.16000) PUMPCH=PUMPVL(14)
      IF(GPM2.GT.16000.AND.GPM2.LE.26000) PUMPCH=PUMPVL(15)
      IF(GPM2.GT.26000.AND.GPM2.LE.45000) PUMPCH=PUMPVL(16)
      TWHP=WHP*N+WHP2
      FXPRIC(12)     = PUMPCH
      HPUMPS=VAR(1)
      FXRPAC(12) = HPUMPS/ACRES
9     CONTINUE
      A1=GPM*1440*TPUMPS
      FILLUP = TOTALG/A1
      RETURN
      END
C*********************************************************************
C
C     DETERMING PER TOTAL ACRE LEVEE REQUIREMENTS FOR COST CALCULATION
C
C*********************************************************************
      SUBROUTINE LEVEEC(LEVEER, LEVEEP, ROADM, ACRES, FXRPAC)
      REAL FXRPAC(40)
      FXRPAC(2) = LEVEER/ACRES
      FXRPAC(3) = LEVEEP/ACRES
      FXRPAC(4) = ROADM/ACRES
      RETURN
      END
C*********************************************************************
C
C     CALCULATING VARIOUS CONSTANTS FOR LATER USE
C
C*********************************************************************
      SUBROUTINE CNSTNT(ACRES,          NHIRE, NOPER, HARTIM, PFUEL,
     . RDLV, INPUT, AE,BE,T1, S, VAR, EPL, OPW, NN, NNN, NTRAC,
     .TOTALG,TYPE,SPL,LPL,SPW,T2,S1,RDLV1,RDLV2,MTYPE)
      INTEGER TYPE, T, FILLUP, HARTIM
      REAL  VAR(50), INPUT(15), NTRAC, N, NN, NNN
      T = 0
      DO 4 J=50,3000,50
```

```
      T=T + 1
      IF(ACRES.LE.J) GO TO 5
    4 CONTINUE
    5 NOPER = 1
      NHIRE = (T/2) + 1
      PARTIM = (T/2) * 7.0
      GO TO (1,2) , TYPE
    1 CONTINUE
      HOURS = (EPL + OPW ) * INPUT(3) * 2
      T1= RDLV/5280.0/INPUT(9)
      S= RDLV/5280.0/INPUT(10)
      GO TO 3
    2 CONTINUE
      IF(MTYPE.NE.3) GO TO 6
      IF(MTYPE.EQ.3) GO TO 7
    6 HOURS = RDLV / VAR(1) * INPUT(3)
      T1 = RDLV / 5280.0 / INPUT(9)
      S = RDLV /      5280.0 / INPUT(10)
      GO TO 3
    7 HOURS=(RDLV1+RDLV2)/VAR(1)*INPUT(3)
      T1=(RDLV1+RDLV2)/5280.0/INPUT(9)
      S=(RDLV1+RDLV2)/5280.0/INPUT(10)
    3 CONTINUE
      N = NOPER + NHIRE
      NN = HOURS * ((N-1) / N ) * VAR(1)
      NNN = HOURS / N * VAR(1)
      T2 = T1/2
      S1 = S/2
      AE = INPUT(13)
      BE = INPUT(13) / 2
      A1=VAR(1) * VAR(33) * (.04 * VAR(4)) / 8
      N1 = A1
      IF(A1 - N1.GT.0) NTRAC = N1 + 1
      RETURN
      END
C*********************************************************************
C
C     CALCULATING MACHINE AND EQUIPMENT REQUIREMENTS
C
C*********************************************************************
      SUBROUTINE MACHIN( VAR, ACRES, TPUMPS, FXRPAC,
     . NOPER,NHIRE,NTRUCK,NTRAC,TYPE,MTYPE)
      REAL VAR(50), FXRPAC(40)
      REAL NTRLR, NTRUCK, NTRAC, NFEDBL, NPSHD
      INTEGER TYPE
      NN1 = NHIRE/2
      NTRUCK = NOPER + NN1
      FXRPAC(7) = NTRUCK/ACRES
      FXRPAC(8) = NTRAC/ACRES
      NTRLR = NTRAC
      FXRPAC(9) = NTRLR/ACRES
      NFEDBL = NTRAC
      FXRPAC(10) = NFEDBL/ACRES
      NPSHD = TPUMPS
```

```
      FXRPAC(13) = NPSHD/ACRES
      FXRPAC(14) = 1.0/ACRES
      GO TO (1,2) , TYPE
    1 CONTINUE
      WALK = VAR(1) * 2
      DRNV = VAR(1) * 2
      GO TC 3
    2 CONTINUE
      IF(MTYPE.EQ.1) GO TO 4
      WALK=VAR(1) * 19
      DRNV=VAR(1)*19
      GO TO 3
   4  WALK=VAR(1)*21
      DRNV=VAR(1)*21
    3 CONTINUE
      FXRPAC(15) = WALK /ACRES
      FXRPAC(16) = DRNV/ACRES
      RETURN
      END
C*********************************************************************
C
C     DETERMINING PIPE REQUIREMENTS
C
C*********************************************************************
      SUBROUTINE PIPE(VAR,ACRES,FXRPAC,TYPE,
     .MTYPE,FXPRIC,GPM,HEAD,PIPEVL,TOPIPE,GPM2,
     .DIAM2,DOLPD,VPPRIC,PL,LOAN,DIAMT,PRICE5)
      REAL VAR(50), FXRPAC(40), FXPRIC(40), PIPEVL(13),
     . LOAN(8,11), DOLPD(13), VPPRIC(40)
      INTEGER TYPE, DIAM1, DIAM2(13)
      IF(TYPE.EQ.1) GPM1=GPM/(VAR(1)*VAR(33))
      IF(TYPE.EQ.2) GPM1=GPM/(VAR(1)*VAR(33))/2
      V=SQRT(2*HEAD*32.27)
      DIAM1=SQRT(.4085*GPM1/V)
      IF(DIAM1.LE.16) PRICE1=PIPEVL(1)
      IF(DIAM1.GT.16.AND.DIAM1.LE.18) PRICE1=PIPEVL(2)
      IF(DIAM1.GT.18.AND.DIAM1.LE.20) PRICE1=PIPEVL(3)
      IF(DIAM1.GT.20.AND.DIAM1.LE.24) PRICE1=PIPEVL(4)
      IF(DIAM1.GT.24.AND.DIAM1.LE.30) PRICE1=PIPEVL(5)
      IF(DIAM1.GT.30.AND.DIAM1.LE.36) PRICE1=PIPEVL(6)
      IF(DIAM1.GT.36.AND.DIAM1.LE.42) PRICE1=PIPEVL(7)
      IF(DIAM1.GT.42.AND.DIAM1.LE.48) PRICE1=PIPEVL(8)
      IF(DIAM1.GT.48.AND.DIAM1.LE.54) PRICE1=PIPEVL(9)
      IF(DIAM1.GT.54.AND.DIAM1.LE.60) PRICE1=PIPEVL(10)
      FXPRIC(18)=PRICE1
      GO TO (1,2), TYPE
    1 CONTINUE
      PVC = VAR(1) * (VAR(20) + 15.0)
      PIPESM=VAR(20)+10.0
      PIPEX=PIPESM
      CONCRT=VAR(1)*(PIPESM+PIPEX)
      COST1=PIPESM*PRICE1
      COST2=PIPEX*PRICE1
      TOPIPE=(COST1+COST2)/ACRES*VAR(1)
```

```
      GO TO 3
    2 CONTINUE
      GO TO (4,5,6), MTYPE
    4 CONTINUE
      PVC = 0.0
      PIPESM = 13 * 50
      PIPEBG = 12 * 4
      PIPERS = (6 * 50) + (2 * 75)
      CONCRT =(PIPESM + PIPEBG + PIPERS) * VAR(1)
      COST1=PIPESM*PIPEVL(4)
      COST2=PIPEBG*PIPEVL(2)
      COST3=PIPERS*PRICE1
      TOPIPE=(COST1+COST2+COST3)/ACRES*VAR(1)
      GO TO 3
    5 CONTINUE
      CALL DIAMET(DIAM2,DOLPD,VPPRIC,GPM,PL,PIPEVL,LOAN,DIAMT,PRICE5,
     .VAR)
      PVC=0.0
      PIPESM=13*50
      PIPEBG=12*4
      PIPER=4*35
      PIPERS=2*50
      MPIPE=PL
      CONCRT=(PIPESM+PIPER+PIPERS+PIPEBG+MPIPE)*VAR(1)
      COST1=PIPESM*PIPEVL(4)
      COST2=PIPEBG*PIPEVL(2)
      COST3=PIPERS*PRICE1
      COST4=PIPER*PRICE1
      COST5=MPIPE*PRICE5
      TOPIPE=(COST1+COST2+COST3+COST4+COST5)/ACRES*VAR(1)
      GO TO 3
    6 CONTINUE
      PVC=0.0
      PIPESM=13*50
      PIPEBG=12*4
      PIPERS=2*50
      PIPER=4*35
      CONCRT=(PIPESM+PIPEBG+PIPERS+PIPER)*VAR(1)
      COST1=PIPESM*PIPEVL(4)
      COST2=PIPEBG*PIPEVL(2)
      COST3=PIPERS*PRICE1
      COST4=PIPER*PRICE1
      TOPIPE=(COST1+COST2+COST3+COST4)/ACRES*VAR(1)
      GO TO 3
    3 CONTINUE
      FXRPAC(17) = PVC/ACRES
      FXRPAC(18) = CONCRT/ACRES
      RETURN
      END
C*****************************************************************
C
C     CALCULATING OFFICE AND GARAGE BUILDING AREA
C
C*****************************************************************
```

```
      SUBROUTINE STRUCT(VAR, ACRES, BLDGPA, FXRPAC, NTRUCK, NTRAC)
      REAL VAR(50), FXRPAC(40), NTRUCK, NTRAC
      BLDGP = 1000.0 + (200.0*(NTRUCK + NTRAC))
      BLDGPA = BLDGP/ACRES
      FXRPAC(5) = BLDGPA
      FOUND = (BLDGP * 3.0) /27.0
      FXRPAC(6) = FOUND/ACRES
      RETURN
      END
C*****************************************************************
C
C     DETERMING PER TOTAL ACRE MACHINERY REQUIREMENTS AND
C      WRITING THE MATRIX OUT
C
C*****************************************************************
      SUBROUTINE RITE(FXRPAC, FXPRIC, LABEL, ACRES, MI,   TOTLPA,
     .TOTAL,TYPE,TOPIPE,MTYPE,VAR)
      REAL TOTLPA(40), TOTAL(40), FXRPAC(40), FXPRIC(40),VAR(50)
      INTEGER TYPE
      CHARACTER*30 LABEL(18)
      IIII=VAR(11)
      GO TO (5,6),IIII
    5 CONTINUE
      WRITE(6,101)
  101 FORMAT('1',45X,'UNITS OF FIXED PHYSICAL (RESOURCE) INPUT')
      WRITE(6,102) ACRES
  102 FORMAT(' ',47X,'FOR A',2X,F5.1,2X,'ACRE GROW-OUT OPERATION')
      GO TO (1,2) , TYPE
    1 CONTINUE
      WRITE(6,106)
  106 FORMAT(' ',55X,'OF SIMPLE SYSTEM DESIGN')
      GO TO 3
    2 CONTINUE
      WRITE(6,111)
  111 FORMAT(' ',54X,'OF MODULAR SYSTEM DESIGN')
      WRITE(6,1000) MTYPE
 1000 FORMAT(' ',61X,'SYSTEM',1X,I1)
    3 CONTINUE
      WRITE(6,103)
  103 FORMAT(/////)
      WRITE(6,104)
  104 FORMAT(' ',35X,'UNITS/ACRE',10X,'PRICE/UNIT',10X,'TOTAL/ACRE',
     .10X,'TOTAL FOR OPERATION')
      WRITE(6,105)
  105 FORMAT(' ',35X,'----------',10X,'----------',10X,'----------',10X,
     . '--------------------')
    6 CONTINUE
      GTPA = 0.0
      GTOP = 0.0
      DO 4 M=1,M1
      TOTLPA(M) = FXRPAC(M) * FXPRIC(M)
      IF(M.EQ.18) TOTLPA(M)= TOPIPE
      TOTAL(M)=TOTLPA(M)*ACRES
      GTPA = GTPA + TOTLPA(M)
```

```
      GTOP = GTOP + TOTAL(M)
      GO TO (7,8),IIII
    7 CONTINUE
      WRITE(6,107) LABEL(M), FXRPAC(M), FXPRIC(M)    ,
     . TOTLPA(M), TOTAL(M)
  107 FORMAT('0',A30,5X,F10.3,10X,F10.2,10X,F10.2,10X,F15.2)
    8 CONTINUE
    4 CONTINUE
      GO TO (9,10),IIII
    9 CONTINUE
      WRITE(6,109)
  109 FORMAT(' ',75X,'----------',10X,'------------------')
      WRITE(6,110) GTPA, GTOP
  110 FORMAT('0',55X,'GRAND TOTALS',8X,F10.2,10X,F15.2)
   10 CONTINUE
      RETURN
      END
C*****************************************************************
C
C     CALCULATING YIELD BASED UPON GROWTH EQUATIONS
C
C*****************************************************************
      SUBROUTINE PRODUC(VAR,ACRES,TLBS,TLBSPA,REVENU,INPUT,HDATE,SDATE,
     .VALUE,MONTH,WT)
      INTEGER MONTH(12),W
      REAL VAR(50), INPUT(15), VALUE(10,6), WT(50)
      INTEGER HDATE, SDATE
      DAYS=HDATE-SDATE
      W=DAYS / 7
      DO 1 N=1,18
      IF(VAR(12).EQ.40000) WT(N)=1.01*N -2.56
      IF(VAR(12).EQ.50000) WT(N)=.825*N -1.89
      IF(VAR(12).EQ.60000) WT(N)=.65*N-1.28
      IF(VAR(12).EQ.70000) WT(N)=.475*N-.66
      IF(VAR(12).EQ.80000) WT(N)=.3*N-.18
    1 CONTINUE
      IF(W.LT.19) GO TO 3
      DO 2 N=19,W
      IF(VAR(12).EQ.40000) WT(N)=87*(1-2.7182818**(0-.04*(N+2.0)))**3
      IF(VAR(12).EQ.50000) WT(N)=87*(1-2.7182818**(0-.034*(N+3.5)))**3
      IF(VAR(12).EQ.60000) WT(N)=87*(1-2.7182818**(0-.029*(N+4.69)))**3
      IF(VAR(12).EQ.70000) WT(N)=87*(1-2.7182818**(0-.023*(N+7.0)))**3
      IF(VAR(12).EQ.80000) WT(N)=87*(1-2.7182818**(0-.019*(N+7.5)))**3
    2 CONTINUE
    3 CONTINUE
      COUNT=454.0/(WT(W)*.60)
      IF(COUNT.LE.15) I=1
      IF(COUNT.GT.15.AND.COUNT.LE.20) I=2
      IF(COUNT.GT.20.AND.COUNT.LE.25) I=3
      IF(COUNT.GT.25.AND.COUNT.LE.30) I=4
      IF(COUNT.GT.30.AND.COUNT.LE.35) I=5
      IF(COUNT.GT.35.AND.COUNT.LE.40) I=6
      IF(COUNT.GT.40.AND.COUNT.LE.50) I=7
      IF(COUNT.GT.50.AND.COUNT.LE.60) I=8
```

```
      IF(COUNT.GT.60.AND.COUNT.LE.70) I=9
      IF(COUNT.GT.70) I=10
      MOH=0
      DO 6 J=1,12
      MOH=MONTH(J) + MOH
      IF(MOH.GT.HDATE) GO TO 7
    6 CONTINUE
    7 CONTINUE
      IF(J.GT.11) J=11
      IF(J.LT.6) J=6
      J=J-5
      PRICE=VALUE(I,J)
      INPUT(15)=PRICE
      IF(W.LE.7) SURVIV=1.00*VAR(12)
      IF(W.GT.7.AND.W.LE.17) SURVIV=.75*VAR(12)
      IF(W.GT.17) SURVIV=.66*VAR(12)
      Y=WT(W)*SURVIV
      LBS=Y/454.0
      TLBS = LBS * VAR(1) * VAR(4) * VAR(33) * .60
      TLBSPA = TLBS / ACRES
      REVENU = TLBSPA * INPUT(15)
      RETURN
      END
C*****************************************************************
C
C     WRITING OUT MONTHLY ITEMIZED VARIABLE COST MATRIX
C
C*****************************************************************
      SUBROUTINE MATRIX( INPUT, MONTH, ACRES, TITLE,
     . MPAOEX, SDATE, HDATE, NFP, VAR,
     . T1, S, NN, NNN, AE,BE,NTRUCK, NTRAC, TOTALG, FILLUP,
     .NOPER,NHIRE,ED1,TYPE,T2,S1,TLBSPA,TWHP,J2,MTYPE,WT)
      CHARACTER*10 TITLE(20)
      INTEGER TYPE, SDATE, HDATE, DOSM, DOHM, FP, ED, BD, DOM,
     .MONTH(12), FILLUP
      REAL NTRUCK, NTRAC, N, NN, NNN, INPUT(15), MPAOEX(40,12),
     .VAR(50),WT(50)
C
      IIII=VAR(13)
      N = VAR(1)
      MOS = 0
      DO 1 J=1,12
      MOS = MONTH(J) + MOS
      IF (MOS.GT.SDATE) GO TO 3
    1 CONTINUE
    3 DOSM = MOS - SDATE
      J1 = J
      MOH = 0
      DO 2 J=1,12
      MOH = MONTH(J) + MOH
      IF(MOH.GT.HDATE) GO TO 4
    2 CONTINUE
    4 MOH = MOH - MONTH(J)
      DOHM = HDATE - MOH
```

```
      J2 = J
C
C
      DO 5 J = 1,12
      DOM = MONTH(J)
      IF(J.LT.J1.OR .J.GT.J2) FUEL1= S1
      IF(J.LT.J1.OR.J.GT.J2) FUEL = T2
      IF(J.LT.J1.OR .J.GT.J2) ELEC = BE
      IF(J.LT.J1.OR .J.GT.J2) D = 3
      IF(J.GE.J1.AND.J.LE.J2) FUEL = T1
      IF(J.GE.J1.AND.J.LE.J2) FUEL1 = S
      IF(J.GE.J1.AND.J.LE.J2) ELEC = AE
      IF(J.GE.J1.AND.J.LE.J2) D = 1
      IF(J.EQ.J1) DOM = DOSM
      IF(J.EQ.J2) DOM = DOHM
      MPAOEX(10,J) = FUEL1* DOM / ACRES
      MPAOEX(11,J) = MPAOEX(10,J) * .15
      MPAOEX(12,J) = FUEL * DOM * 2 / ACRES
      MPAOEX(13,J) = MPAOEX(12,J) * .15
      MPAOEX(17,J) = ELEC / ACRES
      GAL = (((NTRUCK + NTRAC) * INPUT(14)) + 100) / D
      MPAOEX(18,J) = GAL * DOM / ACRES
    5 CONTINUE
C
      J = J1 - 2
      MPAOEX(3,J) = 80 * NHIRE / ACRES
      MPAOEX(4,J) = 80 / ACRES
C
      IF(MONTH(J2) - DOHM.GE.7) GO TO 10
      IF(MONTH(J2) - DOHM.LT.7) GO TO 8
    8 J3 = J2
      J4 = J2 + 1
      DO 9 J=J3,J4
      IF(J.EQ.J4) HARVES = 7 - (MONTH(J2) - DOHM)
      IF(J.EQ.J3) HARVES = MONTH(J2) - DOHM
      MPAOEX(5,J) = NHIRE * 8*HARVES / ACRES
      MPAOEX(6,J) = NOPER * 8*HARVES / ACRES
    9 CONTINUE
      GO TO 11
   10 J = J2
      MPAOEX(6,J) = NOPER * 8*  7     / ACRES
      MPAOEX(5,J) = NHIRE * 8*  7     / ACRES
   11 CONTINUE
C
      X = MOS - SDATE
      IF(MONTH(J1) - X.LT.10) J5=J1-1
      IF(MONTH(J1) - X.LT.10) J6=J1
      IF(MONTH(J1) - X.GE.10.AND.X.GE.4) GO TO 51
      IF(MONTH(J1) - X.GE.10.AND.X.LT.4) J5=J1
      IF(MONTH(J1) - X.GE.10.AND.X.LT.4) J6=J1 + 1
      DO 52 J=J5,J6
      IF(J.EQ.J5) GO TO 60
      GO TO 61
   60 IF(J5.EQ.J1-1.OR.J5.EQ.J1) FERT = INPUT(7) * VAR(33) * VAR(1)
```

```
     . * VAR(4)
      GO TO 62
61    IF(J6.EQ.J1.OR.J6.EQ.J1+1) FERT = INPUT(8) * VAR(33) * VAR(1)
     . * VAR(4)
62    CONTINUE
      MPAOEX(9,J) = FERT / ACRES
52    CONTINUE
      GO TO 53
51    FERT = INPUT(6) * VAR(33) * VAR(1) * VAR(4)
      J = J1
      MPAOEX(9,J) = FERT / ACRES
53    CONTINUE
C
      J = J2
      MPAOEX(19,J) = TLBSPA / 2.0
C
      J = J1
      MPAOEX(20,J) = VAR(1) * VAR(4) * VAR(33) * VAR(12) / ACRES
C
C
      J7 = J1
      FP = HDATE - SDATE - NFP
      IF(NFP.GT.DOSM) J7 = J7 + 1
      DOFM = MONTH(J7) - NFP + DOSM
C
C
      ED1 = 0
      BD1 = 0
      DO 50 J = J7,J2
      DOM = MONTH(J)
      IF(J.EQ.J7) DOM = DOFM
      IF(J.EQ.J2) DOM = DOHM
      ED1 = ED1 + DOM
      BD1 = ED1 - DOM + 1
50    CONTINUE
      RATIO=VAR(30)/VAR(31)
      WHP1=TWHP*RATIO
      WHP2=TWHP
      NOPUM1 = 75 - NFP
      NOPUM2 = (NOPUM1 + ED1) / 2
C
      ED = 0
      BD = 0
      A3 = VAR(4) * .04
      A4 = (VAR(4) * .06) - (VAR(4) * .04)
      K=NFP/7
      DO 12 J = J7,J2
      DOM = MONTH(J)
      IF(J.EQ.J7) DOM = DOFM
      IF(J.EQ.J2) DOM = DOHM
      ED = ED + DOM
      BD = ED - DOM + 1
      FEED = 0
      FEDL = 0
```

```
      DO 14 I=BD,ED
      IF(I/7*7.EQ.I) K=K+1
      IF(K.LE.7) SURVIV=1.00*VAR(12)
      IF(K.GT.7.AND.K.LE.17) SURVIV=.75*VAR(12)
      IF(K.GT.17) SURVIV=.66*VAR(12)
      IF(WT(K).LT.1.0) GO TO 21
      IF(WT(K).GE.1.0.AND.WT(K).LT.2.0) PERCNT=.10
      IF(WT(K).GE.2.0.AND.WT(K).LT.5.0) PERCNT=.07
      IF(WT(K).GE.5.0.AND.WT(K).LT.9.9) PERCNT=.05
      IF(WT(K).GE.9.9) PERCNT=.03
      FEED = (WT(K)*SURVIV*PERCNT)/454.0*VAR(33)*VAR(1)*VAR(4)+FEED
      GO TO 35
   21 FEED=5.0*VAR(33)*VAR(1)*VAR(4)+FEED
   35 CONTINUE
      FEDL = (A3 + A4/ED1 * I) * VAR(33) * VAR(1) + FEDL
   14 CONTINUE
      MPAOEX(8,J) = FEED / ACRES
      MPAOEX(1,J) = FEDL / ACRES
   12 CONTINUE
C
      ED=0
      BD=0
      DO 300 J=J7,J2
      DCM=MONTH(J)
      IF(J.EQ.J7) DCM=DCFM
      IF(J.EQ.J2) DCM=DOHM
      ED=ED+DCM
      BD=ED-DCM+1
      PFUEL=0
      DO 301 I=BD,ED
      IF(I.LT.NOPUM1) PFUEL=0
      IF(I.GE.NOPUM1.AND.I.LT.NOPUM2) PFUEL=WHP1*24*2547
     ./(VAR(7)*VAR(8)*VAR(9)) + PFUEL
      IF(I.GE.NOPUM2) PFUEL=WHP2*24*2547
     ./(VAR(7)*VAR(8)*VAR(9)) + PFUEL
  301 CONTINUE
      MPAOEX(14,J) = PFUEL/ACRES
  300 CONTINUE
      IF(MONTH(J1) - (DOSM + 10).LT.FILLUP.AND.MONTH(J1) - (DOSM + 10)
     . .GT.0) GO TO 15
      IF(MONTH(J1) - (DOSM + 10).LE.0) GO TO 75
      IF(MONTH(J1) - (DOSM + 10).GE.FILLUP) GO TO 17
   15 J5 = J1 - 1
      J6 = J1
      DO 16 J=J5,J6
      IF(J.EQ.J5) FLDAYS = FILLUP - (MONTH(J1) - (DOSM + 10))
      IF(J.EQ.J6) FLDAYS = MONTH(J1) - (DOSM + 10)
      MPAOEX(15,J) = WHP1*2*24*2547/(VAR(7)*VAR(8)*VAR(9)) *
     . FLDAYS/ ACRES
   16 CONTINUE
      GO TO 18
   17 J = J1
      MPAOEX(15,J) = WHP1*2*24*2547/(VAR(7)*VAR(8)*VAR(9))*FILLUP
     . /ACRES
```

```
      GO TO 76
   75 J = J1 - 1
      MPAOEX(15,J) = WHP1*2*24*2547/(VAR(7)*VAR(8)*VAR(9))*FILLUP
     . /ACRES
   76 CONTINUE
   18 CONTINUE
C
      DO 49 J=1,12
      MPAOEX(16,J) = (MPAOEX(14,J) + MPAOEX(15,J))*.15
   49 CONTINUE
      DO 70 J=J1,J2
      MPAOEX(2,J) = 2240 * NHIRE / 12 / ACRES -
     . (MPAOEX(1,J) + MPAOEX(5,J) / 2)
   70 CONTINUE
      DO 71 J=1,12
      MPAOEX(7,J) = 2240 / 12 / ACRES - (MPAOEX(4,J) +
     . MPAOEX(6,J))
   71 CONTINUE
C
C
C
      GO TO (22,23), IIII
   22 CONTINUE
      WRITE(6,112)
  112 FORMAT('1',42X,'UNITS OF VARIABLE PHYSICAL (RESOURCE) INPUT')
      WRITE(6,113)
  113 FORMAT(' ',47X,'ON A PER ACRE AND PER MONTH BASIS')
      WRITE(6,114) ACRES
  114 FORMAT(' ',45X,'FOR A',2X,F5.1,2X,'ACRE GROW-OUT OPERATION')
      GO TO (54,55), TYPE
   54 CONTINUE
      WRITE(6,115)
  115 FORMAT(' ',52X,'OF SIMPLE SYSTEM DESIGN')
      GO TO 56
   55 CONTINUE
      WRITE(6,120)
  120 FORMAT(' ',51X,'OF MODULAR SYSTEM DESIGN')
      WRITE(6,1000) MTYPE
 1000 FORMAT(' ',58X,'SYSTEM',1X,I1)
   56 CONTINUE
      WRITE(6,116)
  116 FORMAT(/////)
      WRITE(6,117)
  117 FORMAT(' ',17X,'JAN',7X,'FEB',7X,'MAR',7X,'APR',7X,'MAY',7X,'JUN',
     .7X,'JUL',7X,'AUG',7X,'SEP',7X,'OCT',7X,'NOV',7X,'DEC')
      WRITE(6,118)
  118 FORMAT(' ',17X,'---',10(7X,'---'),7X,'---')
      DO 6 I=1,20
      WRITE(6,111) TITLE(I), (MPAOEX(I,J),J=1,12)
  111 FORMAT('0',A10,12(2X,F8.2))
    6 CONTINUE
   23 CONTINUE
      RETURN
      END
```

```
C*********************************************************************
C
C      DETERMING LOAN INFORMATION ON CAPITAL ASSETS
C
C*********************************************************************
      SUBROUTINE ASSET(LOAN, PRIN, INT, EQUIT, TOTAL, FINYR,BAL,
     .CAPPUR)
      REAL TOTAL(40), LOAN(8,11)
      INTEGER MAX, DEPR, PRIN(11,30), INT(11,30), EQUIT(11,30), FINALY,
     . FINYR, BAL(11,30), CAPPUR(11,30)
      LOAN(2,1) = TOTAL(1)
      LOAN(2,2) = TOTAL(2) + TOTAL(3)
      LOAN(2,3) = TOTAL(4)
      LOAN(2,4) = TOTAL(5) + TOTAL(6)
      LOAN(2,5) = TOTAL(7)
      LOAN(2,6) = TOTAL(8)
      LOAN(2,7) = TOTAL(9)
      LOAN(2,8) = TOTAL(10)
      LOAN(2,9) = TOTAL(11) + TOTAL(12)+ TOTAL(13)
      LOAN(2,10) = TOTAL(14) + TOTAL(15) + TOTAL(16)
      LOAN(2,11) = TOTAL(17) + TOTAL(18)
      MAX = 0
      DO 8 J=1,11
    8 IF(LOAN(4,J).GT.MAX) MAX = LOAN(4,J)
      FINYR = MAX + 1
      DO 6 J=1,11
      K = J
      FINALY = LOAN(4,J)
      N = 1
      IF(N.EQ.1) GO TO 9
    7 CONTINUE
      DEPR = (LOAN(2,J)-(LOAN(2,J)*LOAN(3,J)))/LOAN(4,J)
      IF(K.EQ.1) DEPR = 0
      DO 4 J1=1,FINALY
      N = N + 1
      OBJYR = J1
      IF(OBJYR.NE.0) GO TO 1
    1 A = LOAN(2,J) * LOAN(5,J) * LOAN(6,J)/LOAN(7,J)
      A1 = 1.0-(1.0+LOAN(6,J)/LOAN(7,J))**(-LOAN(7,J)*LOAN(8,J))
      A = A/A1
C     A IS NOW THE TOTAL PAYMENT PER PERIOD
      B1 = (1.0 + LOAN(6,J)/LOAN(7,J))
      B = 0
      I1 = (OBJYR-1) * LOAN(7,J) + 1
      I2=OBJYR*LOAN(7,J)
      DO 2 I=I1,I2
      C = I/LOAN(7,J)
      D = LOAN(7,J) * (LOAN(8,J) - C + 1.0/LOAN(7,J))
    2 B = A*(1.0 - 1.0/(B1**D)) + B
      INT(K,N) = B
      C = A*LOAN(7,J) - B
      L = N - 1
      IF(L.EQ.0) L = 1
      PRIN(K,N) = C
```

```
      IF(OBJYR.GT.LOAN(8,J)) GO TO 5
      GO TO 3
    5 INT(K,N) = 0
      PRIN(K,N) = 0
    3 CONTINUE
      Q = (LOAN(2,J) - (LOAN(2,J) * LOAN(5,J)))
      R = PRIN(K,N) - DEPR + (LOAN(2,J) - (LOAN(2,J) * LOAN(5,J)))
      S = PRIN(K,N) - DEPR + EQUIT(K,L)
      T = PRIN(K,N) - DEPR + (LOAN(2,J)*LOAN(3,J)) + EQUIT(K,L)
      IF(J1.EQ.1) EQUIT(K,N) = R
      IF(J1.EQ.1) BAL(K,N) = 0
      IF(J1.EQ.1) CAPPUR(K,N) = 0
      IF(J1.GT.1) EQUIT(K,N) = S
      IF(J1.GT.1) BAL(K,N) = 0
      IF(J1.GT.1) CAPPUR(K,N) = 0
      IF(J1.EQ.FINALY) EQUIT(K,N) = T
      IF(J1.EQ.FINALY.AND.(K.EQ.1.OR.K.EQ.2.OR.K.EQ.4.OR.K.EQ.11))
     . EQUIT(K,N) = 0
      IF(J1.EQ.FINALY) BAL(K,N) = LOAN(2,J) * LOAN(5,J)
      IF(J1.EQ.FINALY.AND.(K.EQ.1.OR.K.EQ.2.OR.K.EQ.4.OR.K.EQ.11))
     . BAL(K,N) = 0
      IF(J1.EQ.FINALY) CAPPUR(K,N) = (LOAN(2,J)-(LOAN(2,J)*LOAN(5,J)))
      IF(J1.EQ.FINALY.AND.(K.EQ.1.OR.K.EQ.2.OR.K.EQ.4.OR.K.EQ.11))
     . CAPPUR(K,N) = 0
      IF(N.GT.FINYR) GO TO 6
    4 CONTINUE
      GO TO 10
    9 PRIN(K,N) = 0
      INT(K,N) = 0
      DEPR = 0
      EQUIT(K,N) = (LOAN(2,J) - (LOAN(2,J) * LOAN(5,J)))
      BAL(K,N) = LOAN(2,J) * LOAN(5,J)
      CAPPUR(K,N) = (LOAN(2,J)-(LOAN(2,J) * LOAN(5,J)))
      GO TO 7
   10 CONTINUE
      IF(N.LE.FINYR) GO TO 7
    6 CONTINUE
      RETURN
      END
C*****************************************************************
C
C     DETERMINING TOTAL MONTHLY FINANCING COSTS
C
C*****************************************************************
      SUBROUTINE MONTHS(LOAN, TMPRN, TMINT, TOTAL, ACRES,TOINT,TOPRN)
      REAL TOINT(30), TOPRN(30), TOTAL(40), LOAN(8,11), MTHINT(11,30,12)
     .. MTHPRN(11,30,12), TMINT(30,12),TMPRN(30,12)
      INTEGER Y, OBJYR
      LOAN(2,1) = TOTAL(1)
      LOAN(2,2) = TOTAL(2) + TOTAL(3)
      LOAN(2,3) = TOTAL(4)
      LOAN(2,4) = TOTAL(5) + TOTAL(6)
      LOAN(2,5) = TOTAL(7)
      LOAN(2,6) = TOTAL(8)
```

```
      TOPRN(Y) = 0
      DO 12 M=1,12
      TMINT(Y,M) = 0
      TMPRN(Y,M) = 0
      DO 13 K=5,9
      TMINT(Y,M) = TMINT(Y,M) + MTHINT(K,Y,M)
      TMPRN(Y,M) = TMPRN(Y,M) + MTHPRN(K,Y,M)
   13 CONTINUE
      TMINT(Y,M) = TMINT(Y,M) / ACRES
      TMPRN(Y,M) = TMPRN(Y,M) / ACRES
      TOINT(Y) = TOINT(Y) + TMINT(Y,M)
      TOPRN(Y) = TOPRN(Y) + TMPRN(Y,M)
   12 CONTINUE
   11 CONTINUE
      RETURN
      END
C*****************************************************************
C
C     DETERMINING TOTAL MONTHLY OPERATING COSTS
C
C*****************************************************************
      SUBROUTINE MULT(VAR,VPPRIC,M2,ACRES,MPAOEX,MTHTOP,MTHTOC,
     . MTHPAC,OPTOTL,OPPATL, OPPHTL, CAOPEX,MONTHT)
      REAL MTHTOP(40,12), MTHTOC(40,12), MTHPAC(40,12),
     . OPTOTL(40),OPPATL(40), OPPHTL(40)
      REAL VAR(50), MPAOEX(40,12), VPPRIC(40), MONTHT(12)
C
C
      DO 1 J=1,12
      DO 2 I=1,M2
      MTHTOP(I,J) = MPAOEX(I,J) * ACRES
    2 CONTINUE
    1 CONTINUE
C
C
      DO 3 J=1,12
      DO 4 I=1,M2
      IF(I.NE.18) GO TO 5
      IF(I.EQ.18) GO TO 6
    5 MTHTOC(I,J) = MTHTOP(I,J) * VPPRIC(I)
      GO TO 7
    6 K = MTHTOP(18,J)
      IF(K.LE.1000) GO TO 20
      IF(K.GT.1000) GO TO 21
   20 MTHTOC(18,J) = K * VAR(15)
      GO TO 8
   21 MTHTOC(18,J) = ((K-1000) * VAR(16)) + (1000 * VAR(15))
    8 CONTINUE
    7 CONTINUE
    4 CONTINUE
    3 CONTINUE
C
C
      DO 9 J=1,12
```

```
      DO 10 I=1,M2
      MTHPAC(I,J) = MTHTOC(I,J) / ACRES
   10 CONTINUE
    9 CONTINUE
C
      DO 22 J=1,12
      MONTHT(J) = 0
      DO 23 I=1,M2
      MONTHT(J) = MONTHT(J) + MTHPAC(I,J)
   23 CONTINUE
   22 CONTINUE
C
      DO 11 I=1,M2
      OPTOTL(I) = 0
      DO 12 J=1,12
      OPTOTL(I) = OPTOTL(I) + MTHTOC(I,J)
   12 CONTINUE
   11 CONTINUE
C
C
      DO 13 I=1,M2
      OPPATL(I) = 0
      DO 14 J=1,12
      OPPATL(I) = OPPATL(I) + MTHPAC(I,J)
   14 CONTINUE
   13 CONTINUE
C
C
      DO 15 I=1,M2
      OPPHTL(I) = 0
      DO 16 J=1,12
      OPPHTL(I) = OPPHTL(I) + MPAOEX(I,J)
   16 CONTINUE
   15 CONTINUE
C
C
      CAOPEX = 0
      DO 17 I=1,M2
      CAOPEX = CAOPEX + OPPATL(I)
   17 CONTINUE
      RETURN
      END
C*****************************************************************
C
C     DETERMINING TOTAL ANNUAL FINANCE CHARGES AND OTHER INFO
C
C*****************************************************************
      SUBROUTINE INFO(INT,EQUIT,PRIN,LOAN,ACRES,EQSUM,INTSUM,
     . PRINSM,TEQREQ,REMBAL,TFINPA,TDEPPA,FINYR,BAL,BALSUM,CAPPUR,
     .TCAPP)
      REAL EQSUM(30), INTSUM(30), PRINSM(30), REMBAL(30),BALSUM(30)
     .,TCAPP(30), LOAN(8,11)
      INTEGER PRIN(11,30),INT(11,30),EQUIT(11,30),FINYR,BAL(11,30)
     .,CAPPUR(11,30)
```

```
      LOAN(2,7) = TOTAL(9)
      LOAN(2,8) = TOTAL(10)
      LOAN(2,9) = TOTAL(11) + TOTAL(12)
      LOAN(2,10) = TOTAL(13) + TOTAL(14) + TOTAL(15)
      LOAN(2,11) = TOTAL(16) + TOTAL(17)
      MAX = 0
      DO 10 J=1,11
   10 IF(LOAN(4,J).GT.MAX) MAX = LOAN(4,J)
      FINMTH = MAX * 12
      DO 9 J=5,9
      LIFE = LOAN(4,J)
      K = J
      N = 0
      Y = 0
    7 CONTINUE
      DO 4 J1=1,LIFE
      OBJYR = J1
      Y = Y+1
      B= 0
    1 A = LOAN(2,J) + LOAN(5,J) * LOAN(6,J)/LOAN(7,J)
      A1 = 1.0-(1.0+LOAN(6,J)/LOAN(7,J))**(-LOAN(7,J)*LOAN(8,J))
      A= A/A1
C     A IS NOW THE TOTAL PAYMENT PER PERIOD
      B1 = (1.0 + LOAN(6,J)/LOAN(7,J))
      I1 = (OBJYR-1) * LOAN(7,J) + 1
      I2=OBJYR*LOAN(7,J)
      M = 0
      DO 2 I=I1,I2
      N = N+1
      M = M + 1
      B = 0
      C = 0
      C = I/12.0
      D = LOAN(7,J) * (LOAN(8,J) - C + 1.0/LOAN(7,J))
      B = A * (1.0 - 1.0/(B1**D)) + B
      C = A*LOAN(7,J) - B
      P = A - B
      IF(J1.GT.LOAN(8,J)) GO TO 6
      GO TO 8
    6 MTHINT(K,Y,M) = 0
      MTHPRN(K,Y,M) = 0
      GO TO 14
    8 CONTINUE
      MTHINT(K,Y,M) = B
      MTHPRN(K,Y,M) = P
   14 CONTINUE
      IF(N.EQ.FINMTH) GO TO 3
    2 CONTINUE
    4 CONTINUE
      IF(N.LE.FINMTH) GO TO 7
    3 CONTINUE
    9 CONTINUE
      DO 11 Y=1,MAX
      TOINT(Y) = 0
```

```
C
C
      TDEP=0
      TFIN=0
      DO 13 J=1,11
      TFIN=LOAN(2,J)*LOAN(5,J) + TFIN
      LOAN(2,1) = 0
      TDEP=LOAN(2,J)/LOAN(4,J) + TDEP
   13 CONTINUE
      TFINPA = TFIN/ACRES
      TDEPPA = TDEP/ACRES
C
C
      L = FINYR
      EQSUM(1) = 0
      DO 11 N=1,L
      EQSUM(N) = EQSUM(N) * ACRES
      INTSUM(N) = 0
      PRINSM(N) = 0
      BALSUM(N) = 0
      TCAPP(N) = 0
      DO 12 K=1,11
      EQSUM(N) = EQSUM(N) + EQUIT(K,N)
      INTSUM(N) = INTSUM(N) + INT(K,N)
      PRINSM(N) = PRINSM(N) + PRIN(K,N)
      BALSUM(N) = BALSUM(N) + BAL(K,N)
      TCAPP(N)= TCAPP(N) + CAPPUR(K,N)
   12 CONTINUE
      EQSUM(N) = EQSUM(N) / ACRES
      INTSUM(N) = INTSUM(N) / ACRES
      PRINSM(N) = PRINSM(N) / ACRES
      BALSUM(N) = BALSUM(N) / ACRES
      TCAPP(N) = TCAPP(N) / ACRES
   11 CONTINUE
C
C
      TEQREQ = 0
      DO 15 K=1,11
      TEQREQ = EQUIT(K,1) + TEQREQ
   15 CONTINUE
      TEQREQ = TEQREQ/ACRES
C
C
      N = 1
      REMBAL(N) = BALSUM(N) - PRINSM(N)
      DO 14 N=2,L
      REMBAL(N)= REMBAL(N-1) - PRINSM(N) + BALSUM(N)
   14 CONTINUE
      RETURN
      END
C*****************************************************************
C
C     WRITING OUT VARIABLE COSTS PER TOTAL ACRE
C
```

```
C*********************************************************************
      SUBROUTINE COSTPA(TITLE,MTHPAC,ACRES,TYPE,OPPATL,OPPHTL,M2,
     .MTYPE,VAR)
      CHARACTER*10 TITLE(20)
      INTEGER TYPE
      REAL MTHPAC(40,12), OPPATL(40), OPPHTL(40), VAR(50)
C
      IIII=VAR(13)
      KKKK=VAR(17)
      GO TO (50,51),IIII
   50 CONTINUE
      WRITE(6,1)
      WRITE(6,2)
      WRITE(6,3) ACRES
    1 FORMAT('1',46X,'VARIABLE PHYSICAL (RESOURCE) INPUT COST')
    2 FORMAT(' ',47X,'ON A PER ACRE AND PER MONTH BASIS')
    3 FORMAT(' ',45X,'FOR A',2X,F5.1,2X,'ACRE GROW-OUT OPERATION')
      GO TO (4,5), TYPE
    4 CONTINUE
      WRITE(6,6)
    6 FORMAT(' ',52X,'OF SIMPLE SYSTEM DESIGN')
      GO TO 8
    5 CONTINUE
      WRITE(6,7)
    7 FORMAT(' ',51X,'OF MODULAR SYSTEM DESIGN')
      WRITE(6,1000) MTYPE
 1000 FORMAT(' ',58X,'SYSTEM',1X,I1)
    8 CONTINUE
      WRITE(6,9)
    9 FORMAT(/////)
      WRITE(6,10)
   10 FORMAT(' ',17X,'JAN',7X,'FEB',7X,'MAR',7X,'APR',7X,'MAY',7X,'JUN',
     .7X,'JUL',7X,'AUG',7X,'SEP',7X,'OCT',7X,'NOV',7X,'DEC')
      WRITE(6,11)
   11 FORMAT(' ',17X,'---',10(7X,'---'),7X,'---')
      DO 200 I=1,20
      WRITE(6,12) TITLE(I), (MTHPAC(I,J),J=1,12)
   12 FORMAT('0',A10,12(1X,F9.2))
  200 CONTINUE
   51 CONTINUE
      GO TO (52,53),KKKK
   52 CONTINUE
C
      WRITE(6,13)
      WRITE(6,14)
      WRITE(6,15) ACRES
   13 FORMAT('1',46X,'VARIABLE PHYSICAL (RESOURCE) INPUT COST')
   14 FORMAT(' ',48X,'ON A PER ACRE AND ANNUAL BASIS')
   15 FORMAT(' ',45X,'FOR A',2X,F5.1,2X,'ACRE GROW-OUT OPERATION')
      GO TO (16,17), TYPE
   16 CONTINUE
      WRITE(6,18)
   18 FORMAT(' ',52X,'OF SIMPLE SYSTEM DESIGN')
      GO TO 19
```

```
   17 CONTINUE
      WRITE(6,20)
   20 FORMAT(' ',51X,'OF MODULAR SYSTEM DESIGN')
      WRITE(6,1001) MTYPE
 1001 FORMAT(' ',58X,'SYSTEM',1X,I1)
   19 CONTINUE
      WRITE(6,21)
   21 FORMAT(/////)
      WRITE(6,22)
   22 FORMAT(' ',57X,'ANNUAL INPUT COSTS')
      DO 201 I=1,M2
      WRITE(6,24) TITLE(I), OPPATL(I)
   24 FORMAT('0',48X,A10, 5X,'$',2X,F10.2)
  201 CONTINUE
C
      WRITE(6,25)
   25 FORMAT('1',42X,'UNITS OF VARIABLE PHYSICAL (RESOURCE) INPUT')
      WRITE(6,26)
   26 FORMAT(' ',48X,'ON A PER ACRE AND ANNUAL BASIS')
      WRITE(6,27) ACRES
   27 FORMAT(' ',45X,'FOR A',2X,F5.1,2X,'ACRE GROW-OUT OPERATION')
      GO TO (28,29), TYPE
   28 CONTINUE
      WRITE(6,30)
   30 FORMAT(' ',52X,'OF SIMPLE SYSTEM DESIGN')
      GO TO 31
   29 CONTINUE
      WRITE(6,32)
   32 FORMAT(' ',51X,'OF MODULAR SYSTEM DESIGN')
      WRITE(6,1002) MTYPE
 1002 FORMAT(' ',58X,'SYSTEM',1X,I1)
   31 CONTINUE
      WRITE(6,33)
   33 FORMAT(/////)
      WRITE(6,34)
   34 FORMAT(' ',53X,'ANNUAL PHYSICAL INPUT UNITS')
      DO 202 I=1,M2
      WRITE(6,35) TITLE(I), OPPHTL(I)
   35 FORMAT('0',48X,A10,7X,F10.2)
  202 CONTINUE
   53 CONTINUE
C
      RETURN
      END
C*****************************************************************
C
C     CALCULATING INSURANCE, TAXABLE INCOME, AND INCOME TAXES
C
C*****************************************************************
      SUBROUTINE INSTAX( ACRES, TOTAL, MTHTOC, INSUR, TAX, INCTAX, NHIRE
     .. FINYR, REVENU, CAOPEX, TDEPPA, PAYTAX, SSTAX, TOTINS,
     . INTSUM)
      INTEGER FINYR
      REAL TOTAL(40), MTHTOC(40,12), INSUR(8), TAX(7), INCTAX(30),
```

```
     .INTSUM(30),TAXINC(30),SSTAX(30)
C
C
      BUILDV = TOTAL(5)
      MACHVL = TOTAL(7)+TOTAL(8)+TOTAL(10)+ TOTAL(11)+TOTAL(9)
      PAYROL=0
      DO 1 J=1,12
      PAYROL=PAYROL+MTHTOC(1,J) + MTHTOC(2,J)
     . + MTHTOC(3,J) + MTHTOC(5,J)
    1 CONTINUE
      IF(ACRES.LE.160) A = INSUR(3)
      IF(ACRES.GT.160.AND.ACRES.LE.500) A = INSUR(4)
      IF(ACRES.GT.500) A = INSUR(5)
      BLDINS = BUILDV * INSUR(7) / ACRES
      MACINS = MACHVL * INSUR(2) / ACRES
      METHOD = INSUR(1)
      GO TO (2,3) , METHOD
    2 WRKINS = (A+(PAYROL/100) * INSUR(6))/ACRES
      GO TO 4
    3 WRKINS = PAYROL/100 * INSUR(8) / ACRES
    4 CONTINUE
      TOTINS = WRKINS + BLDINS + MACINS
C
C
      YPAYPP = PAYROL/NHIRE
      IF(PAYROL/NHIRE.LE.TAX(2)) SSTAX2=YPAYPP*TAX(1)*NHIRE / ACRES
      IF(PAYROL/NHIRE.GT.TAX(2)) SSTAX2=TAX(2)*TAX(1)*NHIRE / ACRES
      IF(PAYROL/NHIRE.LE.TAX(3)) UNEMTX=PAYROL*TAX(4)/ACRES
      IF(PAYROL/NHIRE.GT.TAX(3)) UNEMTX=TAX(3)*NHIRE*TAX(4)/ACRES
      PROPTX = (BUILDV + MACHVL + TOTAL(1)) * TAX(5) / 100 * TAX(6) /
     . ACRES
      PAYTAX = PROPTX
C
C
      ALOSS=0.0
      DO 5 N=1,FINYR
      TAXINC(N)=(REVENU-CAOPEX-INTSUM(N)-TDEPPA-UNEMTX-PROPTX-TOTINS
     .-SSTAX2+ALOSS) * ACRES
      IF(TAXINC(N).LE.TAX(2)) SSTAX1=TAXINC(N)*TAX(7)/ ACRES
      IF(TAXINC(N).GT.TAX(2)) SSTAX1=TAX(2)*TAX(7)/ ACRES
      IF(TAXINC(N).LE.0.0) SSTAX1=0.0
      SSTAX(N)=SSTAX1+SSTAX2+UNEMTX
      IF(TAXINC(N).LT.0.0) ALOSS=TAXINC(N)
      IF(TAXINC(N).GE.0.0) ALOSS=0.0
      IF(TAXINC(N).LT.0) GO TO 7
      IF(TAXINC(N).GT.0.AND.TAXINC(N).LE.3200) GO TO 7
      IF(TAXINC(N).GT.3200.AND.TAXINC(N).LE.4200) GO TO 8
      IF(TAXINC(N).GT.4200.AND.TAXINC(N).LE.5200) GO TO 9
      IF(TAXINC(N).GT.5200.AND.TAXINC(N).LE.6200) GO TO 10
      IF(TAXINC(N).GT.6200.AND.TAXINC(N).LE.7200) GO TO 11
      IF(TAXINC(N).GT.7200.AND.TAXINC(N).LE.11200) GO TO 12
      IF(TAXINC(N).GT.11200.AND.TAXINC(N).LE.15200) GO TO 13
      IF(TAXINC(N).GT.15200.AND.TAXINC(N).LE.19200) GO TO 14
      IF(TAXINC(N).GT.19200.AND.TAXINC(N).LE.23200) GO TO 15
```

```
      IF(TAXINC(N).GT.23200.AND.TAXINC(N).LE.27200) GO TO 16
      IF(TAXINC(N).GT.27200.AND.TAXINC(N).LE.31200) GO TO 17
      IF(TAXINC(N).GT.31200.AND.TAXINC(N).LE.35200) GO TO 18
      IF(TAXINC(N).GT.35200.AND.TAXINC(N).LE.39200) GO TO 19
      IF(TAXINC(N).GT.39200.AND.TAXINC(N).LE.43200) GO TO 20
      IF(TAXINC(N).GT.43200.AND.TAXINC(N).LE.47200) GO TO 21
      IF(TAXINC(N).GT.47200.AND.TAXINC(N).LE.55200) GO TO 22
      IF(TAXINC(N).GT.55200.AND.TAXINC(N).LE.67200) GO TO 23
      IF(TAXINC(N).GT.67200.AND.TAXINC(N).LE.79200) GO TO 24
      IF(TAXINC(N).GT.79200.AND.TAXINC(N).LE.91200) GO TO 25
      IF(TAXINC(N).GT.91200.AND.TAXINC(N).LE.103200) GO TO 26
      IF(TAXINC(N).GT.103200.AND.TAXINC(N).LE.123200) GO TO 27
      IF(TAXINC(N).GT.123200.AND.TAXINC(N).LE.143200) GO TO 28
      IF(TAXINC(N).GT.143200.AND.TAXINC(N).LE.163200) GO TO 29
      IF(TAXINC(N).GT.163200.AND.TAXINC(N).LE.183200) GO TO 30
      IF(TAXINC(N).GT.183200.AND.TAXINC(N).LE.203200) GO TO 31
      IF(TAXINC(N).GT.203200) GO TO 32
    7 INCTAX(N)=0.0
      GO TO 33
    8 INCTAX(N)=.14*(TAXINC(N)-3200)
      GO TO 33
    9 INCTAX(N)=140+.15*(TAXINC(N)-4200)
      GO TO 33
   10 INCTAX(N)=290+.16*(TAXINC(N)-5200)
      GO TO 33
   11 INCTAX(N)=450+.17*(TAXINC(N)-6200)
      GO TO 33
   12 INCTAX(N)=620+.19*(TAXINC(N)-7200)
      GO TO 33
   13 INCTAX(N)=1380+.22*(TAXINC(N)-11200)
      GO TO 33
   14 INCTAX(N)=2260+.25*(TAXINC(N)-15200)
      GO TO 33
   15 INCTAX(N)=3260+.28*(TAXINC(N)-19200)
      GO TO 33
   16 INCTAX(N)=4380+.32*(TAXINC(N)-23200)
      GO TO 33
   17 INCTAX(N)=5660+.36*(TAXINC(N)-27200)
      GO TO 33
   18 INCTAX(N)=7100+.39*(TAXINC(N)-31200)
      GO TO 33
   19 INCTAX(N)=8660+.42*(TAXINC(N)-35200)
      GO TO 33
   20 INCTAX(N)=10340+.45*(TAXINC(N)-39200)
      GO TO 33
   21 INCTAX(N)=12140+.48*(TAXINC(N)-43200)
      GO TO 33
   22 INCTAX(N)=14060+.50*(TAXINC(N)-47200)
      GO TO 33
   23 INCTAX(N)=18060+.53*(TAXINC(N)-55200)
      GO TO 33
   24 INCTAX(N)=24420+.55*(TAXINC(N)-67200)
      GO TO 33
   25 INCTAX(N)=31020+.58*(TAXINC(N)-79200)
```

```
1512.          GO TO 33
1513.     26   INCTAX(N)=37980+.60*(TAXINC(N)-91200)
1514.          GO TO 33
1515.     27   INCTAX(N)=45180+.62*(TAXINC(N)-103200)
1516.          GO TO 33
1517.     28   INCTAX(N)=57280+.64*(TAXINC(N)-123200)
1518.          GO TO 33
1519.     29   INCTAX(N)=70380+.66*(TAXINC(N)-143200)
1520.          GO TO 33
1521.     30   INCTAX(N)=83580+.68*(TAXINC(N)-163200)
1522.          GO TO 33
1523.     31   INCTAX(N)=97180+.69*(TAXINC(N)-183200)
1524.          GO TO 33
1525.     32   INCTAX(N)=110980+.70*(TAXINC(N)-203200)
1526.     33   CONTINUE
1527.          IF(N.EQ.1) INCTAX(N) = 0
1528.          INCTAX(N)=INCTAX(N)/ACRES
1529.      5   CONTINUE
1530.    C
1531.          RETURN
1532.          END
1533.    C*****************************************************************
1534.    C
1535.    C     WRITING OUT ANNUAL BUDGETS (ITEMIZED AND NON-ITEMIZED SHEETS)
1536.    C
1537.    C*****************************************************************
1538.          SUBROUTINE BUDGET(OPPHTL,VPPRIC,TLBSPA,TDEPPA,INTSUM,
1539.         . OPPATL,TVARC,TOTINS,PAYTAX,SSTAX,TFIXC,TOCOST,NETRET,HEADER,
1540.         . TYPE,ACRES,INPUT,INCTAX,M2,VINCOM,REVENU, YEAR,MTYPE,EQSUM,
1541.         .RATE,TCAPP,PRINSM,CAOPEX,FINYR,VAR)
1542.          CHARACTER*70 HEADER(20)
1543.          REAL OPPHTL(40), VPPRIC(40), INTSUM(30), OPPATL(40),
1544.         . INPUT(15),INCTAX(30),NETRET,SSTAX(30),EQSUM(30),TCAPP(30),
1545.         .PRINSM(30),BLOSS(30),COCAOT(30),CETCAS(30),CAOPEX,VAR(50),NETRT
1546.          INTEGER TYPE, YEAR,FINYR
1547.          IIII=VAR(23)
1548.          IIIII=VAR(24)
1549.          Y = YEAR
1550.          Y = Y + 1
1551.          N=1
1552.          CETCAS(N)=0.0
1553.          BLOSS(N)=0.0
1554.          DO 200 N=2,FINYR
1555.          COCAOT(N)=TCAPP(N)+INCTAX(N)+PRINSM(N)+INTSUM(N)+CAOPEX+PAYTAX+
1556.         .SSTAX(N)+TOTINS
1557.          CETCAS(N)=REVENU-COCAOT(N)
1558.          IF(CETCAS(N).GT.0) CETCAS(N)=0
1559.          IF(CETCAS(N).LE.0) CETCAS(N)=ABS(CETCAS(N))
1560.          BLOSS(N)=CETCAS(N)+BLOSS(N-1)
1561.    200   CONTINUE
1562.    C
1563.          GO TO (102,103), IIII
1564.    102   CONTINUE
1565.          WRITE(6,1) ACRES
```

```
1566.        1    FORMAT('1',29X,'TABLE VI: ANNUAL COSTS AND RETURNS ON A PER ACRE B
1567.            .ASIS FOR A',1X,F5.1,1X,'ACRE')
1568.             GO TO (2,3), TYPE
1569.       2     CONTINUE
1570.             WRITE(6,4) YEAR
1571.        4    FORMAT(' ',39X,'GROW-OUT OPERATION OF SIMPLE SYSTEM DESIGN. ITEMIZ
1572.            .ED SHEET.',1X,'(YEAR',1X,I2,')')
1573.             GC TO 6
1574.        3    CONTINUE
1575.             WRITE(6,5) YEAR
1576.        5    FORMAT(' ',39X,'GROW-OUT OPERATION OF MODULAR SYSTEM DESIGN. ITEMI
1577.            .ZED SHEET.',1X,'(YEAR',1X,I2,')')
1578.             WRITE(6,1000) MTYPE
1579.      1000   FORMAT(' ',39X,'SYSTEM',1X,I1)
1580.        6    CONTINUE
1581.             WRITE(6,8)
1582.        8    FORMAT(' ',24X,84('-'))
1583.             WRITE(6,10)
1584.       10    FORMAT(' ',76X,'PRICE OR',14X,'VALUE OR')
1585.             WRITE(6,76)
1586.       76    FORMAT(' ',66X,'UNIT',6X,'COST/UNIT',3X,'QUANTITY',4X,'COST')
1587.             WRITE(6,11)
1588.       11    FORMAT(' ',66X,'----',6X,'---------',3X,'--------',4X,'----')
1589.             WRITE(6,14)
1590.       14    FORMAT(' ',24X,'1. GROSS RECEIPTS FROM PRODUCTION')
1591.             WRITE(6,15) INPUT(15), TLBSPA, REVENU
1592.       15    FORMAT(' ',29X,'SHRIMP',31X,'LBS.',6X,'$',F8.2,3X,F7.2,3X,'$',F7.2
1593.            .)
1594.             WRITE(6,16)
1595.       16    FORMAT(' ',99X,'-------')
1596.             WRITE(6,17) REVENU
1597.       17    FORMAT(' ',27X,'TOTAL',66X,'$',F7.2)
1598.             WRITE(6,18)
1599.       18    FORMAT('0',24X,'2. VARIABLE COSTS')
1600.             DO 21 I=1,M2
1601.             WRITE(6,20) HEADER(I),VPPRIC(I),OPPHTL(I),OPPATL(I)
1602.       20    FORMAT(' ',A70,7X,F8.2,3X,F8.2,3X,F7.2)
1603.       21    CONTINUE
1604.             WRITE(6,22) SSTAX(Y)
1605.       22    FORMAT(' ',29X,'PAYROLL TAXES', 57X,F7.2)
1606.             WRITE(6,23)
1607.       23    FORMAT(' ',99X,'-------')
1608.      103    CONTINUE
1609.             TVARC = SSTAX(Y)
1610.             DO 26 I=1,M2
1611.             TVARC = TVARC + OPPATL(I)
1612.       26    CONTINUE
1613.             GO TO (104,105),IIII
1614.      104    CONTINUE
1615.             WRITE(6,24) TVARC
1616.       24    FORMAT(' ',27X,'TOTAL VARIABLE COST',52X,'$',F7.2)
1617.      105    CONTINUE
1618.             VINCOM = REVENU - TVARC
1619.             GO TO (106,107), IIII
```

```
106   CONTINUE
      WRITE(6,25) VINCCM
25    FORMAT('0',24X,'3. INCOME ABOVE VARIABLE COSTS',44X,'$',F7.2)
      WRITE(6,27)
27    FORMAT('0',24X,'4. FIXED COSTS')
      WRITE(6,28) TOTINS
28    FORMAT(' ',29X,'INSURANCE',60X,'$',F7.2)
      WRITE(6,29) TDEPPA
29    FORMAT(' ',29X,'DEPRECIATION',58X,F7.2)
107   CONTINUE
      OVERHD = 0
      GO TO (108,109),IIII
108   CONTINUE
      WRITE(6,30) OVERHD
30    FORMAT(' ',29X,'OVERHD  ',62X,F7.2)
      WRITE(6,31) INTSUM(Y)
31    FORMAT(' ',29X,'INTEREST',62X,F7.2)
109   CONTINUE
      TOTTAX=PAYTAX + INCTAX(Y)
      GO TO (110,111), IIII
110   CONTINUE
      WRITE(6,32) PAYTAX
32    FORMAT(' ',29X,'PROPERTY TAXES)',55X,F7.2)
      WRITE(6,33)
33    FORMAT(' ',99X,'--------')
111   CONTINUE
      TFIXC = TOTINS + TDEPPA + OVERHD   + INTSUM(Y) + PAYTAX
      GO TO (112,113),IIII
112   CONTINUE
      WRITE(6,34) TFIXC
34    FORMAT(' ',27X,'TOTAL FIXED COSTS',54X,'$',F7.2)
113   CONTINUE
      TOCOST = TVARC + TFIXC
      GO TO (114,115),IIII
114   CONTINUE
      WRITE(6,35) TOCOST
35    FORMAT('0',24X,'5. TOTAL COSTS OF OPERATION',47X,'$',F7.2)
115   CONTINUE
      NETRET = REVENU - TOCOST
      GO TO (116,117),IIII
116   CONTINUE
      WRITE(6,36) NETRET
36    FORMAT('0',24X,'6. NET RETURNS (TOTAL PROFITS OR LOSS FROM OPERATI
     .ON BEFORE TAX)', 9X,'$',F8.2)
      WRITE(6,81) INCTAX(Y)
81    FORMAT('0',24X,'7. INCOME TAX',60X,'$',F8.2)
      NETRT=NETRET-INCTAX(Y)
      WRITE(6,82) NETRT
82    FORMAT('0',24X,'8. NET RETURNS AFTER TAX',49X,'$',F8.2)
      WRITE(6,37)
37    FORMAT(' ',24X,84('-'))
117   CONTINUE
      EQUITY=(EQSUM(Y)+BLOSS(Y))*RATE
      IF(EQUITY.LT.0) EQUITY=0.0
```

```
      OWNER=NETRET-EQUITY
      IF(NETRET.LT.0) OWNER=NETRET+(0-EQUITY)
      TEQUIT=EQSUM(Y)+BLOSS(Y)
      GO TO (118,119),IIII
  118 CONTINUE
      WRITE(6,89) TEQUIT
   89 FORMAT(' ',27X,'TOTAL EQUITY CAPITAL TO DATE',42X,'$',F8.2)
      WRITE(6,90) EQUITY
   90 FORMAT(' ',27X,'REQUIRED RETURN TO EQUITY CAPITAL',38X,'$',F7.2)
  119 CONTINUE
      TMLABR=OPPATL(4)+OPPATL(6)+OPPATL(7)
      GO TO (120,121),IIII
  120 CONTINUE
      WRITE(6,91) OWNER
   91 FORMAT(' ',27X,'RETURN TO OWNERS LABOR AND MANAGEMENT',33X,'$',F8.
     .2)
  121 CONTINUE
      BRKEVN=TOCOST/TLBSPA
      BRKLBS=TOCOST/INPUT(15)
      GO TO (122,123),IIII
  122 CONTINUE
      WRITE(6,98)BRKEVN
   98 FORMAT(' ',27X,'BREAK-EVEN EX-VESSEL PRICE ON NET RETURNS',
     .29X,'$',F8.2)
      WRITE(6,99) BRKLBS
   99 FORMAT(' ',27X,'BREAK-EVEN POUNDS @ ACTUAL EX-VESSEL PRICE',
     .23X,'LBS.',F10.2)
  123 CONTINUE
C
C
C
      GO TO (124,125),IIIII
  124 CONTINUE
      WRITE(6,38) ACRES
   38 FORMAT('1',29X,'TABLE VII: ANNUAL COSTS RETURNS ON A PER ACRE BASI
     .S FOR A',1X,F5.1,1X,'ACRE')
      GO TO (39,40), TYPE
   39 CONTINUE
      WRITE(6,41)
   41 FORMAT(' ',40X,'GROW-OUT OPERATION OF SIMPLE SYSTEM DESIGN. NON-IT
     .EMIZED SHEET.')
      WRITE(6,72) YEAR
   72 FORMAT(' ',40X,'(YEAR',1X,I2,')')
      GO TO 43
   40 CONTINUE
      WRITE(6,42)
   42 FORMAT(' ',40X,'GROW-OUT OPERATION OF MODULAR SYSTEM DESIGN. NON-I
     .TEMIZED SHEET.')
      WRITE(6,1001) MTYPE
 1001 FORMAT(' ',40X,'SYSTEM',1X,I1)
      WRITE(6,73) YEAR
   73 FORMAT(' ',40X,'(YEAR',1X,I2,')')
   43 CONTINUE
      WRITE(6,44)
```

```
 44   FCRMAT(' ',24X,84('-'))
      WRITE(6,45)
 45   FORMAT('0',99X,'VALUE OR')
      WRITE(6,46)
 46   FORMAT(' ',101X,'COST')
      WRITE(6,47)
 47   FORMAT(' ',99X,'---------')
      WRITE(6,48)
 48   FORMAT('0',24X,'1. GROSS RECEIPTS FROM PRODUCTION')
      WRITE(6,49) REVENU
 49   FORMAT('0',29X,'SHRIMP',63X,'$',F7.2)
      WRITE(6,50)
 50   FORMAT(' ',99X,'-------')
      WRITE(6,51) REVENU
 51   FORMAT(' ',27X,'TOTAL',66X,'$',F7.2)
      WRITE(6,52)
 52   FORMAT('0',24X,'2. VARIABLE COSTS')
      THLABR = OPPATL(1)+OPPATL(2)+OPPATL(3)+
     . OPPATL(5)
      TMLABR = OPPATL(4)+OPPATL(6)+OPPATL(7)
      FUEL=OPPATL(10)+OPPATL(12)+OPPATL(14)+
     . OPPATL(15)
      TMAIN=OPPATL(11)+OPPATL(13)+OPPATL(16)
      UTIL=OPPATL(17)+OPPATL(18)
      TICE=OPPATL(19)
      POSTL=OPPATL(20)
      WRITE(6,53) THLABR
 53   FORMAT('0',29X,'HIRED LABOR',32X,'$',F7.2)
      WRITE(6,54) TMLABR
 54   FORMAT(' ',29X,'MANAGEMENT LABOR',28X,F7.2)
      WRITE(6,55) OPPATL(8)
 55   FORMAT(' ',29X,'FEED',40X,F7.2)
      WRITE(6,56) OPPATL(9)
 56   FORMAT(' ',29X,'FERT',40X,F7.2)
      WRITE(6,57) FUEL
 57   FORMAT(' ',29X,'FUEL',40X,F7.2)
      WRITE(6,58) TMAIN
 58   FORMAT(' ',29X,'MACHINERY MAINTENANCE',23X,F7.2)
      WRITE(6,59) UTIL
 59   FORMAT(' ',29X,'UTILITIES',35X,F7.2)
      WRITE(6,60) TICE
 60   FORMAT(' ',29X,'ICE',41X,F7.2)
      WRITE(6,61) POSTL
 61   FORMAT(' ',29X,'POSTLARVAE',34X,F7.2)
      WRITE(6,62) SSTAX(Y)
 62   FORMAT(' ',29X,'PAYROLL TAXES', 31X, F7.2)
      WRITE(6,63)
 63   FORMAT(' ',73X,'-------')
      WRITE(6,64) TVARC
 64   FORMAT(' ',27X,'TOTAL VARIABLE COST',26X,'$',F7.2)
      WRITE(6,65) VINCOM
 65   FORMAT('0',24X,'3. INCOME ABOVE VARIABLE COSTS',44X,'$',F7.2)
      WRITE(6,66) TFIXC
 66   FORMAT('0',24X,'4. FIXED COSTS',60X,'$',F7.2)
```

```
      WRITE(6,67)
 67   FORMAT(' ', 99X,'--------')
      WRITE(6,68) TOCOST
 68   FORMAT('0',24X,'5. TOTAL COSTS OF OPERATION',47X,'$',F7.2)
      WRITE(6,69) NETRET
 69   FORMAT('0',24X,'6. NET RETURNS (TOTAL PROFIT OR LOSS FROM OPERATIO
     .N BEFORE TAX)',10X,'$',F8.2)
      WRITE(6,201) INCTAX(Y)
 201  FORMAT('0',24X,'7. INCOME TAX',60X,'$',F8.2)
      WRITE(6,202) NETRT
 202  FORMAT('0',24X,'8. NET RETURNS AFTER TAX',49X,'$',F8.2)
      WRITE(6,70)
 70   FORMAT(' ',24X,84('-'))
      TEQUIT=EQSUM(Y)+BLOSS(Y)
      WRITE(6,88) TEQUIT
 88   FORMAT(' ',27X,'TOTAL EQUITY CAPITAL TO DATE',42X,'$',F8.2)
      WRITE(6,93) EQUITY
 93   FORMAT(' ',27X,'REQUIRED RETURN TO EQUITY CAPITAL',38X,'$',F7.2)
      WRITE(6,94) OWNER
 94   FORMAT(' ',27X,'RETURN TO OWNERS LABOR AND MANAGEMENT',33X,'$',
     .F8.2)
      WRITE(6,100) BRKEVN
 100  FORMAT(' ',27X,'BREAK-EVEN EX-VESSEL PRICE ON NET RETURNS',
     .29X,'$',F8.2)
      WRITE(6,101) BRKLBS
 101  FORMAT(' ',27X,'BREAK-EVEN POUNDS @ ACTUAL EX-VESSEL PRICE',
     .23X,'LBS.',F10.2)
      WRITE(6,95)
 95   FORMAT(' ',24X,84('-'))
      WRITE(6,71)
 71   FORMAT('1',1X)
 125  CONTINUE
      RETURN
      END
C*********************************************************************
C
C     DETERMINING INTERNAL RATES OF RETURN ON EQUITY AND TOTAL
C     INVESTMENT
C
C*********************************************************************
      SUBROUTINE INTRAT(FINYR,ROCAOT,TCAPP,INCTAX,PRINSM,INTSUM,CAOPEX,
     .PAYTAX,SSTAX,TOTINS,RETCAS,REVENU,IRR,INVREQ,IRRT)
      INTEGER FINYR
      REAL IRR,ROCAOT(30),TCAPP(30),INCTAX(30),PRINSM(30),INTSUM(30),
     .RETCAS(30), VO1(30), VO2(30),SSTAX(30),INVREQ(30),IRRT
      DO 1 I=1,500,1
      L = FINYR
      N = 1
      R = I-(.99*I)
      VO1(N) = 0 - TCAPP(N)
      DO 2 N=2,L
      ROCAOT(N)=TCAPP(N)+INCTAX(N)+PRINSM(N)+CAOPEX+PAYTAX+SSTAX(N)
     .+TOTINS+INTSUM(N)
      RETCAS(N)=REVENU-ROCAOT(N)
```

```
      A = RETCAS(N)
      NN=N-1
      VO1(N)=A/((1+R)**NN)+VO1(N-1)
2     CONTINUE
      IF(VO1(L).EQ.0) GO TO 3
      IF(I.EQ.1.AND.VO1(L).LT.0) GO TO 14
      IF(I.GT.1.AND.VO1(L).LT.0) GO TO 4
1     CONTINUE
14    IRR=(0-.01)
      GO TO 5
3     IRR=I
      GO TO 5
4     N = 1
      VO2(N)=0-TCAPP(N)
      I=I-1
      R = I-(.99*I)
      DO 6 N=2,L
      ROCAOT(N)=TCAPP(N)+INCTAX(N)+PRINSM(N)+CAOPEX+PAYTAX+SSTAX(N)+
     .TOTINS+INTSUM(N)
      RETCAS(N)=REVENU-ROCAOT(N)
      A = RETCAS(N)
      NN=N-1
      VO2(N)=A/((1+R)**NN)+VO2(N-1)
6     CONTINUE
      B=VO2(L)-VO1(L)
      IRR=I+VO2(L)/B
5     CONTINUE
      DO 7 I=1,500,1
      L=FINYR
      N=1
      R=I-(.99*I)
      VO1(N)=0-INVREQ(N)
      DO 8 N=2,L
      ROCAOT(N)=INVREQ(N)+INCTAX(N)+CAOPEX+PAYTAX+SSTAX(N)+TOTINS
      RETCAS(N)=REVENU-ROCAOT(N)
      A = RETCAS(N)
      NN=N-1
      VO1(N)=A/((1+R)**NN)+VO1(N-1)
8     CONTINUE
      IF(VO1(L).EQ.0) GO TO 9
      IF(I.EQ.1.AND.VO1(L).LT.0) GO TO 15
      IF(I.GT.1.AND.VO1(L).LT.0) GO TO 10
7     CONTINUE
15    IRRT=(0-.01)
      GO TO 11
9     IRRT=I
      GO TO 11
10    N=1
      VO2(N)=0-INVREQ(N)
      I=I-1
      R = I-(.99*I)
      DO 12 N=2,L
      ROCAOT(N)=INVREQ(N)+INCTAX(N)+CAOPEX+PAYTAX+SSTAX(N)+TOTINS
      RETCAS(N)=REVENU-ROCAOT(N)
```

```
      A = RETCAS(N)
      NN=N-1
      VO2(N)=A/((1+R)**NN)+VO2(N-1)
 12   CONTINUE
      B=VO2(L)-VO1(L)
      IRRT=I+VO2(L)/B
 11   CONTINUE
      RETURN
      END
C*****************************************************************
C
C     WRITING OUT ANNUAL CASH FLOW STATEMENT
C
C*****************************************************************
      SUBROUTINE CASHFL(INPUT,INVREQ,TCAPP,REMBAL,TLBSPA,REVENU,CAOPEX,
     . TOTINS,PRINSM,INTSUM,INCTAX,TOCAOT,PAYTAX,SSTAX,NETCAS,
     . CUMCAS,IRR,TAX,FINYR,ACRES,TYPE,OBJYR,BALSUM,MTYPE,IRRT,RETCAS,
     .ROCAOT)
       REAL RETCAS(30), ROCAOT(30)
      REAL INVREQ(30), TOCAOT(30), NETCAS(30), CUMCAS(30)
      REAL TCAPP(30),REMBAL(30),PRINSM(30),INTSUM(30),INPUT(15),
     . INCTAX(30),TAX(7), BALSUM(30),SSTAX(30)
      REAL GLBSPA(30), EVENU(30), AOPEX(30), OTINS(30), STAX(30),
     . AYTAX(30), PRICE(30) ,IRR, IRRT
      INTEGER FINYR, TYPE, OBJYR(30)
      WRITE(6,10) ACRES
 10   FORMAT('1',5X,'TABLE  : ANNUAL CASH FLOW STATEMENT FOR A',1X,F5.1
     .,1X,'ACRE GROW-OUT')
      GO TO (1,2), TYPE
  1   WRITE(6,11)
 11   FORMAT(' ',14X,'OPERATION OF SIMPLE SYSTEM DESIGN.')
      GO TO 12
  2   WRITE(6,13)
 13   FORMAT(' ',14X,'OPERATION OF MODULAR SYSTEM DESIGN')
      WRITE(6,1000) MTYPE
 1000 FORMAT(' ',14X,'SYSTEM',1X,I1)
 12   CONTINUE
      WRITE(6,14)
 14   FORMAT('-',4X,128('-'))
      WRITE(6,15)
 15   FORMAT(' ',12X,'ITEM',20X,'UNIT',45X,'YEAR (END OF)')
      WRITE(6,16)
 16   FORMAT(' ',4X,128('-'))
C
      DO 5 N=1,FINYR
      INVREQ(N) = TCAPP(N) + BALSUM(N)
      GLBSPA(N) = TLBSPA
      PRICE(N) = INPUT(15)
      EVENU(N) = REVENU
      AOPEX(N) = CAOPEX
      OTINS(N) = TOTINS
      STAX(N) = SSTAX(N)
      AYTAX(N) = PAYTAX
      IF(N.EQ.1) GLBSPA(N) = 0
```

```
      IF(N.EQ.1)  EVENU(N) = 0
      IF(N.EQ.1)  AOPEX(N) = 0
      IF(N.EQ.1)  OTINS(N) = 0
      IF(N.EQ.1)  STAX(N) = 0
      IF(N.EQ.1)  AYTAX(N) = 0
      TOCAOT(N) = TCAPP(N) + INCTAX(N) + PRINSM(N) + INTSUM(N) +
     . CAOPEX + PAYTAX + SSTAX(N)+ TOTINS
      NETCAS(N) = REVENU - TOCAOT(N)
      IF(N.EQ.1) TOCAOT(N) = TCAPP(N)
      IF(N.EQ.1) NETCAS(N) = EVENU(N) - TCAPP(N)
    5 CONTINUE
      N = 1
      CUMCAS(N) = EVENU(N) - TCAPP(N)
      DO 6 N=2,FINYR
      CUMCAS(N) = NETCAS(N) - TCAPP(N) + CUMCAS(N-1)
    6 CONTINUE
      L = FINYR
      L1 = FINYR
      IF(L1.LE.10) L = FINYR
      IF(L1.GT.10) L = 10
      DO 3 N=1,L
      OBJYR(N) = N-1
    3 CONTINUE
      WRITE(6,17) (OBJYR(N), N=1,L)
   17 FORMAT('0',41X,10(2X,I6))
      WRITE(6,18)
   18 FORMAT('0',6X,'LOAN INFORMATION :')
      WRITE(6,19) (INVREQ(N),N=1,10)
   19 FORMAT('0',5X,'1. INVESTMENT REQUIREMENT       DOL.',4X,10(1X,
     .F7.2))
      WRITE(6,20) (TCAPP(N),N=1,10)
   20 FORMAT(' ',5X,'2. EQUITY REQUIREMENT',10X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,21) (REMBAL(N),N=1,10)
   21 FORMAT(' ',5X,'3. LOAN BALANCE',16X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,22)
   22 FORMAT('0',4X,128('-'))
      WRITE(6,23)
   23 FORMAT(' ',9X,'CASH FLOW')
      WRITE(6,24)
   24 FORMAT(' ',4X,128('-'))
      WRITE(6,25)
   25 FORMAT('0',5X,'4. PRODUCTION:')
      WRITE(6,26) (GLBSPA(N),N=1,10)
   26 FORMAT(' ',10X,'POUNDS',20X,'LBS.',4X,10(1X,F7.2))
      WRITE(6,27) (PRICE(N),N=1,10)
   27 FORMAT(' ',10X,'PRICE/POUND',15X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,28) ( EVENU(N),N=1,10)
   28 FORMAT(' ',8X,'TOTAL SALES',17X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,29) ( EVENU(N),N=1,10)
   29 FORMAT('0',5X,'5. TOTAL CASH INFLOW',11X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,30) ( ACFEX(N),N=1,10)
   30 FORMAT('0',5X,'6. CASH OPERATING EXPENSES      DOL.',4X,10(1X,F7.2)
     .)
      WRITE(6,31)
```

```
 31   FORMAT(' ',5X,'7. LCAN PAYMENTS:')
      WRITE(6,32) (PRINSM(N),N=1,10)
 32   FORMAT(' ',10X,'PRINCIPAL PORTION',9X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,33) (INTSUM(N),N=1,10)
 33   FORMAT(' ',10X,'INTEREST PORTION',10X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,34) ( OTINS(N),N=1,10)
 34   FORMAT(' ',5X,'8. INSURANCE',19X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,35)
 35   FORMAT(' ',5X,'9. TAXES:')
      WRITE(6,36) (INCTAX(N),N=1,10)
 36   FORMAT(' ',10X,'INCOME',20X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,37) ( STAX(N),N=1,10)
 37   FORMAT(' ',10X,'PAYROLL',19X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,38) ( AYTAX(N),N=1,10)
 38   FORMAT(' ',10X,'PROPERTY',18X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,39) (TCAPP(N),N=1,10)
 39   FORMAT(' ',4X,'10. CAPITAL PURCHASES (EQUITY)  DOL.',4X,10(1X,F7.2
     .))
      WRITE(6,40) (TOCAOT(N),N=1,10)
 40   FORMAT('0',4X,'11. TOTAL CASH OUTFLOW',10X,'DOL.',4X,10(1X,F7.2))
      WRITE(6,41)   (NETCAS(N),N=1,10)
 41   FORMAT('0',4X,'12. NET CASH INFLOW',13X,'DOL.',4X,10(F8.2))
      WRITE(6,42) (CUMCAS(N),N=1,10)
 42   FORMAT('0',4X,'13. CUMULATIVE CASH POSITION    DOL.',4X,10(
     .F8.2))
      WRITE(6,43)
 43   FORMAT(' ',4X,128('-'))
      CALL INTRAT(FINYR,ROCAOT,TCAPP,INCTAX,PRINSM,INTSUM,CAOPEX,PAYTAX,
     .SSTAX,TOTINS,RETCAS,REVENU,IRR,INVREQ,IRRT)
      WRITE(6,44) IRR
 44   FORMAT(' ',14X,'RETURNS TO EQUITY CAPITAL =',1X,F6.2,1X,'%')
      WRITE(6,78) IRRT
 78   FORMAT(' ',14X,'RETURNS TO TOTAL INVESTMENT =',1X,F6.2,1X,'%')
      WRITE(6,45)
 45   FORMAT(' ',4X,128('-'))
C
      IF(L1.GT.10) GO TO 100
      GO TO 200
 100  CONTINUE
      WRITE(6,46)
 46   FORMAT('1',5X,'TABLE   : ANNUAL CASH FLOW CONTINUED')
      WRITE(6,47)
 47   FORMAT('-',4X,128('-'))
      WRITE(6,48)
 48   FORMAT(' ',8X,'ITEM',50X,'YEAR (END OF)')
      WRITE(6,49)
 49   FORMAT(' ',4X,128('-'))
      DO 4 N=11,FINYR
      OBJYR(N) = N-1
  4   CONTINUE
      WRITE(6,50) (OBJYR(N), N=11,FINYR)
 50   FORMAT(' ',26X,11(2X,I7))
      WRITE(6,51)
 51   FORMAT('0',5X,'LCAN INFO.')
```

```
      WRITE(6,52) (INVREQ(N),N=11,FINYR)
52    FORMAT('0',5X,'1. INV. REQ.',12X,11(1X,F8.2))
      WRITE(6,53) (TCAPP(N),N=11,FINYR)
53    FORMAT(' ',5X,'2. EQUIT. REQ.',10X,11(1X,F8.2))
      WRITE(6,54) (REMBAL(N), N=11,FINYR)
54    FORMAT(' ',5X,'3. LOAN BAL.',12X,11(1X,F8.2))
      WRITE(6,55)
55    FORMAT('0',4X,128('-'))
      WRITE(6,56)
56    FORMAT(' ',9X,'CASH FLOW')
      WRITE(6,57)
57    FORMAT(' ',4X,128('-'))
      WRITE(6,58)
58    FORMAT('0',5X,'4. PRODUCTION')
      WRITE(6,59) (GLBSPA(N),N=11,FINYR)
59    FORMAT(' ',10X,'PCUNDS',13X,11(1X,F8.2))
      WRITE(6,60) (PRICE(N),N=11,FINYR)
60    FORMAT(' ',10X,'PRICE/LB.',10X,11(1X,F8.2))
      WRITE(6,61) ( EVENU(N),N=11,FINYR)
61    FORMAT(' ',8X,'TOTAL SALES',10X,11(1X,F8.2))
      WRITE(6,62) ( EVENU(N),N=11,FINYR)
62    FORMAT('0',5X,'5. TOTAL CASH INFLOW',4X,11(1X,F8.2))
      WRITE(6,63) ( AOPEX(N),N=11,FINYR)
63    FORMAT('0',5X,'6. CASH OPER. COSTS',5X,11(1X,F8.2))
      WRITE(6,64)
64    FORMAT(' ',5X,'7. LOAN PAYMENT')
      WRITE(6,65) (PRINSM(N),N=11,FINYR)
65    FORMAT(' ',10X,'PRINCIPAL',10X,11(1X,F8.2))
      WRITE(6,66) (INTSUM(N),N=11,FINYR)
66    FORMAT(' ',10X,'INTEREST',11X,11(1X,F8.2))
      WRITE(6,67) ( OTINS(N),N=11,FINYR)
67    FORMAT(' ',5X,'8. INSURANCE',12X,11(1X,F8.2))
      WRITE(6,68)
68    FORMAT(' ',5X,'9. TAXES')
      WRITE(6,69) (INCTAX(N),N=11,FINYR)
69    FORMAT(' ',10X,'INCOME' ,13X,11(1X,F8.2))
      WRITE(6,70) ( STAX(N),N=11,FINYR)
70    FORMAT(' ',10X,'PAYROLL',12X,11(1X,F8.2))
      WRITE(6,71) ( AYTAX(N),N=11,FINYR)
71    FORMAT(' ',10X,'PROPERTY',11X,11(1X,F8.2))
      WRITE(6,72) (TCAPP(N),N=11,FINYR)
72    FORMAT(' ',5X,'10. EQUITY',14X,11(1X,F8.2))
      WRITE(6,73) (TCCAOT(N),N=11,FINYR)
73    FORMAT('0',5X,'11. TOTAL CASH OUTFLOW',3X,11(1X,F8.2))
      WRITE(6,74) (NETCAS(N),N=11,FINYR)
74    FORMAT('0',5X,'12. NET CASH INFLOW',6X,11(1X,F8.2))
      WRITE(6,75) (CUMCAS(N),N=11,FINYR)
75    FORMAT('0',5X,'13. CUML. CASH POSIT.',4X,11(F9.2))
      WRITE(6,76)
76    FORMAT(' ',4X,128('-'))
      WRITE(6,77)
77    FORMAT(' ',4X,128('-'))
200   CONTINUE
      RETURN
```

```
      END
C*****************************************************************
C
C     WRITING MONTHLY CASH FLOW STATEMENT
C
C*****************************************************************
      SUBROUTINE MCSHFL(MBAL,CUMCAS,YEAR,J2,INPUT,MONTHT,TMPRN,TMINT,
     .TOTINS,INCTAX,SSTAX,PAYTAX,BALSUM,REVENU,TLBSPA,REMBAL,INVREQ,
     .TCAPP,MCMCAS,TYPE,ACRES,TOINT,TOPRN,PRINSM,INTSUM,MTYPE)
      REAL TOINT(30), TOPRN(30), PRINSM(30), INTSUM(30),SSTAX(30)
      REAL MBAL(12),MCMCAS(12),MONTHT(12),TMPRN(30,12),TMINT(30,12)
      REAL INPUT(15),INCTAX(30),BALSUM(30),REMBAL(30),TCAPP(30)
      REAL CAPP(12),GLBSPA(12),PRICE(12),EVENU(12),CAOPEX(12),PRIN(12),
     .INT(12),OTINS(12),NCTAX(12),STAX(12),AYTAX(12)
      REAL INVREQ(30), CUMCAS(30), NVREQ(12), TOCAOT(12), NETCAS(12)
      INTEGER TYPE, YEAR
      WRITE(6,10) ACRES
 10   FORMAT('1',5X,'TABLE  : MONTHLY CASH FLOW STATEMENT FOR A',1X,F5.1
     .,1X,'ACRE GROW-OUT')
      GO TO (1,2), TYPE
  1   WRITE(6,11) YEAR
 11   FORMAT(' ',14X,'OPERATION OF SIMPLE SYSTEM DESIGN. (YEAR',1X,I2,
     .')')
      GO TO 12
  2   WRITE(6,13) YEAR
 13   FORMAT(' ',14X,'OPERATION OF MODULAR SYSTEM DESIGN. (YEAR',1X,I2,
     .')')
      WRITE(6,1000) MTYPE
1000  FORMAT(' ',14X,'SYSTEM',1X,I1)
 12   CONTINUE
      WRITE(6,14)
 14   FORMAT('-',4X,128('-'))
      WRITE(6,15)
 15   FORMAT(' ',12X,'ITEM',19X,'UNIT',31X,'MONTH (END OF)')
      WRITE(6,16)
 16   FORMAT(' ',4X,128('-'))
      WRITE(6,5)
  5   FORMAT(' ',48X,'BEG',7X,'JAN',7X,'FEB',7X,'MAR',7X,'APR',7X,'MAY',
     .7X,'JUN',7X,'JUL',7X,'AUG')
C
C
      Y = YEAR
      N = Y
      DO 3 M=1,12
      J = M
      NVREQ(M) = 0
      IF(M.EQ.12) NVREQ(M) = INVREQ(N+1)
      CAPP(M) = 0
      IF(M.EQ.12) CAPP(M) = TCAPP(N+1)
      GLBSPA(M) = 0
      IF(M.EQ.J2) GLBSPA(M) = TLBSPA
      PRICE(M) = INPUT(15)
      EVENU(M)= 0
      IF(M.EQ.J2) EVENU(M) = REVENU
```

```
      CAOPEX(M) = MONTHT(J)
      PRIN(M) = TMPRN(Y,M)
      INT(M) = TMINT(Y,M)
      IF(M.EQ.12) PRIN(M)=          PRINSM(N+1)-(TOPRN(Y)-TMPRN(Y,M))
      IF(M.EQ.12) INT(M)=          INTSUM(N+1)-(TOINT(Y)-TMINT(  1))
      OTINS(M) = 0
      IF(M.EQ.12) OTINS(M) = TOTINS
      NCTAX(M) = 0
      IF(M.EQ.4 ) NCTAX(M) = INCTAX(N+1)
      STAX(M) = 0
      IF(M.EQ.12) STAX(M) = SSTAX(N+1)
      AYTAX(M) = 0
      IF(M.EQ.4 ) AYTAX(M) = PAYTAX
      TOCAOT(M) = CAPP(M) + NCTAX(M) + PRIN(M) + INT(M) + CAOPEX(M) +
     . STAX(M) + AYTAX(M) + OTINS(M)
      NETCAS(M) = EVENU(M) - TOCAOT(M)
      IF(M.EQ.1) GO TO 4
      GO TO 7
    4 MCMCAS(M) = NETCAS(M) - CAPP(M) + CUMCAS(N)
      GO TO 8
    7 MCMCAS(M) = NETCAS(M) - CAPP(M) + MCMCAS(M-1)
    8 CONTINUE
    3 CONTINUE
      M = 1
      MBAL(M) = REMBAL(N  ) - TMPRN(Y,M)
      DO 9 M=2,12
      MBAL(M) = MBAL(M-1) - PRIN(M) + (NVREQ(M)-CAPP(M))
    9 CONTINUE
      WRITE(6,18)
   18 FORMAT('0',6X,'LCAN INFORMATION :')
      WRITE(6,19) INVREQ(N), (NVREQ(M),M=1,8)
   19 FORMAT('0',5X,'1. INVESTMENT REQUIREMENT       DOL.',3X,F9.2,8(1X,
     .F9.2))
      WRITE(6,20) TCAPP(N), (CAPP(M),M=1,8)
   20 FORMAT(' ',5X,'2. EQUITY REQUIREMENT',10X,'DOL.',3X,F9.2,8(1X,F9.2
     .))
      WRITE(6,21) REMBAL(N), (MBAL(M),M=1,8)
   21 FORMAT(' ',5X,'3. LOAN BALANCE',16X,'DOL.',3X,F9.2,8(1X,F9.2))
      WRITE(6,22)
   22 FORMAT('0',4X,128('-'))
      WRITE(6,23)
   23 FORMAT(' ',9X,'CASH FLOW')
      WRITE(6,24)
   24 FORMAT(' ',4X,128('-'))
      WRITE(6,25)
   25 FORMAT('0',5X,'4. PRODUCTION:')
      WRITE(6,26) (GLBSPA(M),M=1,8)
   26 FORMAT(' ',10X,'POUNDS',20X,'LBS.',12X,8(1X,F9.2))
      WRITE(6,27) (PRICE(7),M=1,8)
   27 FORMAT(' ',10X,'PRICE/POUND',15X,'DOL.',12X,8(1X,F9.2))
      WRITE(6,28) (EVENU(M),M=1,8)
   28 FORMAT(' ',8X,'TOTAL SALES',17X,'DOL.',12X,8(1X,F9.2))
      WRITE(6,29) (EVENU(M),M=1,8)
   29 FORMAT('0',5X,'5. TOTAL CASH INFLOW',11X,'DOL.',12X,8(1X,F9.2))
```

```
      WRITE(6,30) (CAOPEX(M),M=1,8)
30    FORMAT('0',5X,'6. CASH OPERATING EXPENSES      DOL.',12X,8(1X,F9.2)
     .)
      WRITE(6,31)
31    FORMAT(' ',5X,'7. LOAN PAYMENTS:')
      WRITE(6,32) (PRIN(M),M=1,8)
32    FORMAT(' ',10X,'PRINCIPAL PORTION',9X,'DOL.',12X,8(1X,F9.2))
      WRITE(6,33) (INT(M),M=1,8)
33    FORMAT(' ',10X,'INTEREST PORTION',10X,'DOL.',12X,8(1X,F9.2))
      WRITE(6,34) (OTINS(M),M=1,8)
34    FORMAT(' ',5X,'8. INSURANCE',19X,'DOL.',12X,8(1X,F9.2))
      WRITE(6,35)
35    FORMAT(' ',5X,'9. TAXES:')
      WRITE(6,36) (NCTAX(M),M=1,8)
36    FORMAT(' ',10X,'INCOME',20X,'DOL.',12X,8(1X,F9.2))
      WRITE(6,37) (STAX(M),M=1,8)
37    FORMAT(' ',10X,'PAYROLL',19X,'DOL.',12X,8(1X,F9.2))
      WRITE(6,38) (AYTAX(M),M=1,8)
38    FORMAT(' ',10X,'PROPERTY',18X,'DOL.',12X,8(1X,F9.2))
      WRITE(6,39) TCAPP(N), (CAPP(M),M=1,8)
39    FORMAT(' ',4X,'10. CAPITAL PURCHASES (EQUITY)  DOL.',3X,F9.2,8(1X,
     .F9.2))
      WRITE(6,40) (TOCACT(M),M=1,8)
40    FORMAT('0',4X,'11. TOTAL CASH OUTFLOW',10X,'DOL.',12X,8(1X,F9.2))
      WRITE(6,41) (NETCAS(M),M=1,8)
41    FORMAT('0',4X,'12. NET CASH INFLOW',13X,'DOL.',12X,8(1X,F9.2))
      WRITE(6,42) CUMCAS(N), (MCMCAS(M),M=1,8)
42    FORMAT('0',4X,'13. CUMULATIVE CASH POSITION    DOL.',2X,1X,F9.2,
     .8(1X,F9.2))
      WRITE(6,43)
43    FORMAT(' ',4X,128('-'))
      WRITE(6,45)
45    FORMAT(' ',4X,128('-'))
      WRITE(6,46)
46    FORMAT('1',5X,'TABLE  : MONTHLY CASH FLOW CONTINUED')
      WRITE(6,47)
47    FORMAT('-',4X,128('-'))
      WRITE(6,48)
48    FORMAT(' ',8X,'ITEM',34X,'MONTH (END OF)')
      WRITE(6,49)
49    FORMAT(' ',4X,128('-'))
      WRITE(6,6)
6     FORMAT(' ',37X,'SEP',7X,'OCT',7X,'NOV',7X,'DEC')
      WRITE(6,51)
51    FORMAT('0',5X,'LOAN INFO.')
      WRITE(6,52) (NVREQ(M),M=9,12)
52    FORMAT('0',5X,'1. INV. REQ.',14X,4(1X,F9.2))
      WRITE(6,53) (CAPP(M),M=9,12)
53    FORMAT(' ',5X,'2. EQUIT. REQ.',12X,4(1X,F9.2))
      WRITE(6,54) (MBAL(M),M=9,12)
54    FORMAT(' ',5X,'3. LOAN BAL.',14X,4(1X,F9.2))
      WRITE(6,55)
55    FORMAT('0',4X,128('-'))
      WRITE(6,56)
```

```
2268.      56   FORMAT(' ',9X,'CASH FLOW')
2269.           WRITE(6,57)
2270.      57   FORMAT(' ',4X,128('-'))
2271.           WRITE(6,58)
2272.      58   FORMAT('0',5X,'4. PRODUCTION')
2273.           WRITE(6,59) (GLBSPA(M),M=9,12)
2274.      59   FORMAT(' ',10X,'POUNDS',15X,4(1X,F9.2))
2275.           WRITE(6,60) (PRICE(M),M=9,12)
2276.      60   FORMAT(' ',10X,'PRICE/LB.',12X,4(1X,F9.2))
2277.           WRITE(6,61) (EVENU(M),M=9,12)
2278.      61   FORMAT(' ',8X,'TOTAL SALES',12X,4(1X,F9.2))
2279.           WRITE(6,62) (EVENU(M),M=9,12)
2280.      62   FORMAT('0',5X,'5. TOTAL CASH INFLOW',6X,4(1X,F9.2))
2281.           WRITE(6,63) (CAOPEX(M),M=9,12)
2282.      63   FORMAT('0',5X,'6. CASH OPER. COSTS',7X,4(1X,F9.2))
2283.           WRITE(6,64)
2284.      64   FORMAT(' ',5X,'7. LOAN PAYMENT')
2285.           WRITE(6,65) (PRIN(M),M=9,12)
2286.      65   FORMAT(' ',10X,'PRINCIPAL',12X,4(1X,F9.2))
2287.           WRITE(6,66) (INT(M),M=9,12)
2288.      66   FORMAT(' ',10X,'INTEREST',13X,4(1X,F9.2))
2289.           WRITE(6,67) (OTINS(M),M=9,12)
2290.      67   FORMAT(' ',5X,'8. INSURANCE',14X,4(1X,F9.2))
2291.           WRITE(6,68)
2292.      68   FORMAT(' ',5X,'9. TAXES')
2293.           WRITE(6,69) (NCTAX(M),M=9,12)
2294.      69   FORMAT(' ',10X,'INCOME' ,15X,4(1X,F9.2))
2295.           WRITE(6,70) (STAX(M),M=9,12)
2296.      70   FORMAT(' ',10X,'PAYROLL',14X,4(1X,F9.2))
2297.           WRITE(6,71) (AYTAX(M),M=9,12)
2298.      71   FORMAT(' ',10X,'PROPERTY',13X,4(1X,F9.2))
2299.           WRITE(6,72) (CAPP(M),M=9,12)
2300.      72   FORMAT(' ',5X,'10. EQUITY',16X,4(1X,F9.2))
2301.           WRITE(6,73) (TOCAOT(M),M=9,12)
2302.      73   FORMAT('0',5X,'11. TOTAL CASH OUTFLOW',4X,4(1X,F9.2))
2303.           WRITE(6,74) (NETCAS(M),M=9,12)
2304.      74   FORMAT('0',5X,'12. NET CASH INFLOW',7X,4(1X,F9.2))
2305.           WRITE(6,75) (MCMCAS(M),M=9,12)
2306.      75   FORMAT('0',5X,'13. CUML. CASH POSIT.',5X,4(1X,F9.2))
2307.           WRITE(6,76)
2308.      76   FORMAT(' ',4X,128('-'))
2309.           WRITE(6,77)
2310.      77   FORMAT(' ',4X,128('-'))
2311.           WRITE(6,78)
2312.      78   FORMAT('1',//)
2313.           RETURN
2314.           END
2315.      C
2316.      //$DATA
2317.                                   FEEDING LABOR (HIRED)                    HRS.
2318.                                   OPERATING HIRED LABOR                    HRS.
2319.                                   MAINTENANCE LABOR (HIRED)                HRS.
2320.                                   MAINTENANCE LABOR (MANAGEMENT)           HRS.
2321.                                   HARVEST LABOR (HIRED)                    HRS.
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                                        HARVEST LABOR (MANAGEMENT)          HRS.
                                        OPERATING MANAGEMENT LABOR          HRS.
                                        FEED                                LBS.
                                        FERTILIZER                          LBS.
                                        TRUCK FUEL                          GAL.
                                        TRUCK MAINTENANCE (LUBE)
                                        TRACTOR FUEL                        GAL.
                                        TRACTOR MAINTENANCE (LUBE)
                                        PUMPING FUEL (WATER EXCHANGE)       GAL.
                                        PUMPING FUEL (INITIAL FILL-UP)      GAL.
                                        PUMP MAINTENANCE (LUBE)
                                        UTILITIES: ELECTRICITY              KWH.
                                                   WATER                    GAL.
                                        ICE                                 LBS.
                                        POSTLARVAE
        FEDL1
        THIREL
        MAINL1
        MAINL2
        HARL1
        HARL2
        TMANAGL
        FEED
        FERT
        TKFUEL
        TKMAIN
        TCFUEL
        TCMAIN
        PFUEL1
        PFUEL2
        PMAIN
        ELEC
        WATER
        ICE
        PLARV
    LAND
    ROADED LEVEE (CUBIC YARDS)
    NON-ROADED LEVEE (CUBIC YARDS)
    ROAD MATERIAL (CUBIC YARDS)
    OFFICE / LAB BUILDING (SQ FT)
    OFFICE / LAB FOUNDATION (C FT)
    TRUCK
    TRACTOR AND ACCESSORIES
    TRAILOR
    FEED BLOWER
    PUMP (EXTENDED SHAFT)
    PUMP (HYDRAFLO)
    PUMP SHED
    RESERVOIR AND FILTER APPARATUS
    WALKWAYS
    DRAIN VALVE
    PVC PIPE (LINEAR FEET)
    CONCRETE PIPE (LINEAR FEET)
```

```
2376.      125
2377.      308
2378.      30
2379.      31 28 31 30 31 30 31 31 30 31 30 31
2380.
2381.      0.0
2382.      0.0
2383.      .16
2384.      0.0
2385.      0.0
2386.      67.5
2387.      45.0
2388.      22.5
2389.      10.0
2390.      8.0
2391.      0.0
2392.      0.0
2393.      3000.0
2394.      30.0
2395.      0.0
2396.
2397.      18
2398.      20
2399.      33
2400.
2401.      500.00 .55 .55 4.00 15.00 .55 4000.00 7500.00 2330.00 5000.00 8100.00
2402.      0.0 100.0 500.0 50.0 500.0 1.97 0.0
2403.
2404.      3.00
2405.      3.00
2406.      3.00
2407.      8.00
2408.      3.90
2409.      8.00
2410.      8.00
2411.      .15
2412.      .13
2413.      .51
2414.      .51
2415.      .41
2416.      .41
2417.      .41
2418.      .41
2419.      .41
2420.      .04
2421.      0.0
2422.      .03
2423.      .0025
2424.
2425.      30.0
2426.      43560.0
2427.      1.9
2428.      2.5
2429.      300.0
```

```
2430.      102.0
2431.      .75
2432.      .30
2433.      138000.00
2434.      10.0
2435.      1.0
2436.      40000.0
2437.      1.0
2438.      0.0
2439.      .0216
2440.      .0063
2441.      1.0
2442.      14.0
2443.      15.0
2444.      43.0
2445.      9.0
2446.      5.0
2447.      1.0
2448.      1.0
2449.      1.0
2450.      6.0
2451.      1.0
2452.      1.0
2453.      42.0
2454.      .05
2455.      .10
2456.      100.0
2457.      1.0
2458.
2459.      0.0
2460.      0.0
2461.      0.0
2462.      10.0   .90   .10   1.0   10.0
2463.      0.0
2464.      0.0
2465.      .40
2466.      10.0   .90   .10   1.0   10.0
2467.      0.0
2468.      0.0
2469.      .40
2470.      10.0   .90   .10   1.0   10.0
2471.      0.0
2472.      0.0
2473.      .50
2474.      10.0   .90   .10   1.0   10.0
2475.      0.0
2476.      0.0
2477.      0.0
2478.      7.0    .80   .12   12.0   5.0
2479.      0.0
2480.      0.0
2481.      0.0
2482.      7.0    .80   .12   12.0   5.0
2483.      0.0
```

```
0.0
0.0
10.0   .80   .12   12.0   5.0
0.0
0.0
0.0
10.0   .80   .12   12.0   5.0
0.0
0.0
0.0
10.0   .80   .12   12.0   5.0
0.0
0.0
0.0
10.0   .90   .10   1.0   10.0
0.0
0.0
.30
10.0   .90   .10   1.0   10.0
1.0
.0076
68.0
102.0
149.0
1.75
.045
8.17
.0605
17700.0
6000.0
.008
.20
2.44
.081
1.0
6

8541.00   11596.00   13131.00   17424.00   22153.00   23892.00   29776.00   31889.00
45867.00   9845.00   12305.00   16345.00   20481.00   26190.00   28375.00   50355.00
2.0
.02
1.5
.001
.3
2.0
3
15 18 21 24 27 30 33 36 39 42 45 48 51
 12.0   16.0   21.0   24.0   27.0   32.0   36.0   39.0   42.0   45.0   48.0   51.0   54.0
4.82 4.62 4.23 3.65 3.21 2.67 2.00 1.44 1.14   .68
4.64 4.41 4.11 3.45 2.83 2.18 1.84 1.65 1.19 1.01
4.17 3.96 3.48 2.78 2.46 2.17 2.07 1.93 1.52 1.22
4.28 3.83 3.25 2.85 2.62 2.23 1.95 1.75 1.54 1.03
4.45 3.57 3.19 2.92 2.57 2.17 1.94 1.71 1.26 1.03
4.61 3.83 3.43 3.25 2.89 2.33 2.02 1.72 1.34   .79
.1025
/*END
```

Table A1: Example of Output Representing List of Initial (First Year) Capital Expenditures.

UNITS OF FIXED PHYSICAL (RESOURCE) INPUT
FOR A 118.0 ACRE GROW-OUT OPERATION
OF SIMPLE SYSTEM DESIGN

	UNITS/ACRE	PRICE/UNIT	TOTAL/ACRE	TOTAL FOR OPERATION
LAND	1.000	500.00	500.00	59000.00
ROADED LEVEE (CUBIC YARDS)	2790.152	0.55	1534.58	181080.80
NON-ROADED LEVEE (CUBIC YARDS)	227.153	0.55	124.93	14742.20
ROAD MATERIAL (CUBIC YARDS)	25.111	4.00	100.45	11852.57
OFFICE / LAB BUILDING (SQ FT)	13.559	15.00	203.39	24000.00
OFFICE / LAB FOUNDATION (C FT)	1.507	0.55	0.83	97.78
TRUCK	0.017	4000.00	67.80	8000.00
TRACTOR AND ACCESSORIES	0.008	7500.00	63.56	7500.00
TRAILER	0.008	2330.00	19.75	2330.00
FEED BLOWER	0.008	5000.00	42.37	5000.00
PUMP (EXTENDED SHAFT)	0.017	17424.00	295.32	34847.97
PUMP (HYDRAFLO)	0.000	0.00	0.00	0.00
PUMP SHED	0.017	100.00	1.69	200.00
RESERVOIR AND FILTER APPARATUS	0.008	500.00	4.24	500.00
WALKWAYS	0.508	50.00	25.42	3000.00
DRAIN VALVE	0.508	500.00	254.24	30000.00
PVC PIPE (LINEAR FEET)	14.746	1.97	29.05	3427.80
CONCRETE PIPE (LINEAR FEET)	26.949	12.00	323.39	38159.98
		GRAND TOTALS	3591.01	423738.40

Table A2. Example of Output Matrix Representing Monthly Operating Costs in Terms of Physical Units of Input.

UNITS OF VARIABLE PHYSICAL (RESOURCE) INPUT
ON A PER ACRE AND PER MONTH BASIS
FOR A 118.0 ACRE GROW-OUT OPERATION
OF SIMPLE SYSTEM DESIGN

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FEDL1	0.00	0.00	0.00	0.00	0.00	0.69	0.90	0.98	1.02	1.13	0.15	0.00
THIREL	0.00	0.00	0.00	0.00	3.16	2.47	2.26	2.18	2.14	2.03	2.53	0.00
MAINL1	0.00	0.00	1.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAINL2	0.00	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HARL1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HARL2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00
THANAGL	1.58	1.58	0.90	1.58	1.58	1.58	1.58	1.58	1.58	1.58	0.47	0.00
FEED	0.00	0.00	0.00	0.00	0.00	320.16	471.48	492.46	543.63	742.03	1.10	1.58
FERT	0.00	0.00	0.00	28.60	14.30	0.00	0.00	0.00	0.00	0.00	111.14	0.00
TKFUEL	0.09	0.08	0.09	0.09	0.15	0.18	0.18	0.18	0.18	0.18	0.00	0.00
TKMAIN	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.09
TCFUEL	0.15	0.13	0.15	0.14	0.25	0.29	0.29	0.29	0.29	0.29	0.00	0.01
TCMAIN	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.15
PFUEL1	0.00	0.00	0.00	0.00	0.00	0.00	2.79	6.65	10.73	13.30	0.01	0.02
PFUEL2	0.00	0.00	0.00	2.15	0.00	0.00	0.00	0.00	0.00	0.00	1.72	0.00
PMAIN	0.00	0.00	0.00	0.32	0.00	0.00	0.42	1.00	1.61	1.99	0.00	0.00
ELEC	12.71	12.71	12.71	12.71	25.42	25.42	25.42	25.42	25.42	25.42	0.26	0.00
WATER	16.64	15.03	16.64	16.10	41.86	48.31	49.92	49.92	48.31	49.92	25.42	12.71
ICE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.44	16.64
PLARV	0.00	0.00	0.00	0.00	25423.73	0.00	0.00	0.00	0.00	0.00	294.98	0.00
											0.00	0.00

Table A3. Example of Output Matrix Representing Monthly Operating Costs in Terms of Dollars.

VARIABLE PHYSICAL (RESOURCE) INPUT COST
ON A PER ACRE AND PER MONTH BASIS
FOR A 118.0 ACRE GROW-OUT OPERATION
OF SIMPLE SYSTEM DESIGN

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FEDL1	0.00	0.00	0.00	0.00	0.00	2.07	2.69	2.93	3.06	3.40	0.46	0.00
THIREL	0.00	0.00	0.00	0.00	9.48	7.41	6.79	6.55	6.42	6.08	7.60	0.00
MAINL1	0.00	0.00	4.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAINL2	0.00	0.00	5.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HARL1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00
HARL2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.80	0.00
TMANAGL	12.61	12.61	7.19	12.61	12.61	12.61	12.61	12.61	12.61	12.61	8.81	12.61
FEED	0.00	0.00	0.00	0.00	0.00	48.02	70.72	73.87	81.54	111.30	16.67	0.00
FERT	0.00	0.00	0.00	3.72	1.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TKFUEL	0.05	0.04	0.05	0.05	0.08	0.09	0.09	0.09	0.09	0.09	0.01	0.05
TKMAIN	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01
TCFUEL	0.06	0.05	0.06	0.06	0.10	0.12	0.12	0.12	0.12	0.12	0.02	0.06
TCMAIN	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.01
PFUEL1	0.00	0.00	0.00	0.00	0.00	0.00	1.14	2.73	4.40	5.45	0.70	0.00
PFUEL2	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PMAIN	0.00	0.00	0.00	0.13	0.00	0.00	0.17	0.41	0.66	0.82	0.11	0.00
ELEC	0.51	0.51	0.51	0.51	1.02	1.02	1.02	1.02	1.02	1.02	1.02	0.51
WATER	0.23	0.22	0.23	0.23	0.39	0.43	0.44	0.44	0.43	0.44	0.14	0.23
ICE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.85	0.00
PLARV	0.00	0.00	0.00	0.00	63.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A4. Example of Output Representing Annual Operating Expense Summary in Terms of Dollars.

VARIABLE PHYSICAL (RESOURCE) INPUT COST
ON A PER ACRE AND ANNUAL BASIS
FOR A 118.0 ACRE GROW-OUT OPERATION
OF SIMPLE SYSTEM DESIGN

ANNUAL INPUT COSTS		
FEDL1	$	14.61
THIREL	$	50.35
MAINL1	$	4.07
MAINL2	$	5.42
HARL1	$	3.70
HARL2	$	3.80
TMANAGL	$	142.10
FEED	$	402.14
FERT	$	5.58
TKFUEL	$	0.78
TKMAIN	$	0.12
TCFUEL	$	1.01
TCMAIN	$	0.15
PFUEL1	$	14.42
PFUEL2	$	0.88
PMAIN	$	2.30
ELEC	$	9.66
WATER	$	3.89
ICE	$	8.85
PLARV	$	63.56

Table A5. Example of Output Representing Annual Operating Expense Summary in Terms of Physical Inputs.

UNITS OF VARIABLE PHYSICAL (RESOURCE) INPUT
ON A PER ACRE AND ANNUAL BASIS
FOR A 118.0 ACRE GROW-OUT OPERATION
OF SIMPLE SYSTEM DESIGN

	ANNUAL PHYSICAL INPUT UNITS
FEDL1	4.87
THIREL	16.78
MAINL1	1.36
MAINL2	0.68
HARL1	0.95
HARL2	0.47
TMANAGL	17.76
FEED	2680.91
FERT	42.90
TKFUEL	1.54
TKMAIN	0.23
TCFUEL	2.46
TCMAIN	0.37
PFUEL1	35.18
PFUEL2	2.15
PMAIN	5.60
ELEC	241.53
WATER	375.71
ICE	294.98
PLARV	25423.73

Table A6: Example of Output Representing Detailed Annual Budget for a Given Object Year.

TABLE VI: ANNUAL COSTS AND RETURNS ON A PER ACRE BASIS FOR A 118.0 ACRE GROW-OUT OPERATION OF SIMPLE SYSTEM DESIGN. ITEMIZED SHEET. (YEAR 6)

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST
1. GROSS RECEIPTS FROM PRODUCTION				
SHRIMP	LBS.	$ 3.25	589.96	$1917.36
TOTAL				$1917.36
2. VARIABLE COSTS				
FEEDING LABOR (HIRED)	HRS.	3.00	4.87	14.61
OPERATING HIRED LABOR	HRS.	3.00	16.78	50.35
MAINTENANCE LABOR (HIRED)	HRS.	3.00	1.36	4.07
MAINTENANCE LABOR (MANAGEMENT)	HRS.	8.00	0.68	5.42
HARVEST LABOR (HIRED)	HRS.	3.90	0.95	3.70
HARVEST LABOR (MANAGEMENT)	HRS.	8.00	0.47	3.80
OPERATING MANAGEMENT LABOR	HRS.	8.00	17.76	142.10
FEED	LBS.	0.15	2680.91	402.14
FERTILIZER	LBS.	0.13	42.90	5.58
TRUCK FUEL	GAL.	0.51	1.54	0.78
TRUCK MAINTENANCE (LUBE)		0.51	0.23	0.12
TRACTOR FUEL	GAL.	0.41	2.46	1.01
TRACTOR MAINTENANCE (LUBE)		0.41	0.37	0.15
PUMPING FUEL (WATER EXCHANGE)	GAL.	0.41	35.18	14.42
PUMPING FUEL (INITIAL FILL-UP)	GAL.	0.41	2.15	0.88
PUMP MAINTENANCE (LUBE)		0.41	5.60	2.30
UTILITIES: ELECTRICITY	KWH.	0.04	241.53	9.66
WATER	GAL.	0.00	375.71	3.89
ICE	LBS.	0.03	294.98	8.85
POSTLARVAE		0.00	25423.73	63.56
PAYROLL TAXES				17.13
TOTAL VARIABLE COST				$ 754.51
3. INCOME ABOVE VARIABLE COSTS				$1162.85
4. FIXED COSTS				
INSURANCE				$ 14.00
DEPRECIATION				282.39
OVERHD				-0.00
INTEREST				172.14
PROPERTY TAXES)				5.82
TOTAL FIXED COSTS				$ 474.35
5. TOTAL COSTS OF OPERATION				$1228.86
6. NET RETURNS (TOTAL PROFITS OR LOSS FROM OPERATION BEFORE TAX)				$ 688.50
7. INCOME TAX				$ 279.97
8. NET RETURNS AFTER TAX				$ 408.53
TOTAL EQUITY CAPITAL TO DATE				$ 810.21
REQUIRED RETURN TO EQUITY CAPITAL				$ 83.05
RETURN TO OWNERS LABOR AND MANAGEMENT				$ 605.46
BREAK-EVEN EX-VESSEL PRICE ON NET RETURNS				$ 2.08
BREAK-EVEN POUNDS @ ACTUAL EX-VESSEL PRICE			LBS.	378.11

Table A7: Example of Output Representing General Annual Budget for a Given Object Year.

TABLE VII: ANNUAL COSTS RETURNS ON A PER ACRE BASIS FOR A 118.0 ACRE GROW-OUT OPERATION OF SIMPLE SYSTEM DESIGN. NON-ITEMIZED SHEET. (YEAR 6)

		VALUE OR COST
1. GROSS RECEIPTS FROM PRODUCTION		
SHRIMP		$1917.36
TOTAL		$1917.36
2. VARIABLE COSTS		
HIRED LABOR	$ 72.73	
MANAGEMENT LABOR	151.32	
FEED	402.14	
FERT	5.58	
FUEL	17.09	
MACHINERY MAINTENANCE	2.56	
UTILITIES	13.55	
ICE	8.85	
POSTLARVAE	63.56	
PAYROLL TAXES	17.13	
TOTAL VARIABLE COST	$ 754.51	
3. INCOME ABOVE VARIABLE COSTS		$1162.85
4. FIXED COSTS		$ 474.35
5. TOTAL COSTS OF OPERATION		$1228.86
6. NET RETURNS (TOTAL PROFIT OR LOSS FROM OPERATION BEFORE TAX)		$ 688.50
7. INCOME TAX		$ 279.97
8. NET RETURNS AFTER TAX		$ 408.53
TOTAL EQUITY CAPITAL TO DATE		$ 810.21
REQUIRED RETURN TO EQUITY CAPITAL		$ 83.05
RETURN TO OWNERS LABOR AND MANAGEMENT		$ 605.46
BREAK-EVEN EX-VESSEL PRICE ON NET RETURNS		$ 2.08
BREAK-EVEN POUNDS @ ACTUAL EX-VESSEL PRICE	LBS.	378.11

Table A8. Example of Output Representing Annual Cash Flow Statement.

TABLE : ANNUAL CASH FLOW STATEMENT FOR A 118.0 ACRE GROW-OUT OPERATION OF SIMPLE SYSTEM DESIGN.

ITEM	UNIT	YEAR (END OF)									
		0	1	2	3	4	5	6	7	8	9
LOAN INFORMATION :											
1. INVESTMENT REQUIREMENT	DOL.	3590.89	0.00	0.00	0.00	0.00	0.00	0.00	131.34	0.00	0.00
2. EQUITY REQUIREMENT	DOL.	408.11	0.00	0.00	0.00	0.00	0.00	0.00	26.27	0.00	0.00
3. LOAN BALANCE	DOL.	3182.78	2946.80	2685.60	2396.42	2076.23	1721.68	1439.73	1234.64	877.17	483.50
CASH FLOW											
4. PRODUCTION:											
POUNDS	LBS.	0.00	589.96	589.96	589.96	589.96	589.96	589.96	589.96	589.96	589.96
PRICE/POUND	DOL.	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
TOTAL SALES	DOL.	0.00	1917.36	1917.36	1917.36	1917.36	1917.36	1917.36	1917.36	1917.36	1917.36
5. TOTAL CASH INFLOW	DOL.	0.00	1917.36	1917.36	1917.36	1917.36	1917.36	1917.36	1917.36	1917.36	1917.36
6. CASH OPERATING EXPENSES	DOL.	0.00	737.38	737.38	737.38	737.38	737.38	737.38	737.38	737.38	737.38
7. LOAN PAYMENTS:											
PRINCIPAL PORTION	DOL.	0.00	235.97	261.20	289.19	320.19	354.55	281.95	310.15	357.47	393.67
INTEREST PORTION	DOL.	0.00	322.80	297.57	269.61	238.60	204.25	172.14	143.92	124.63	88.44
8. INSURANCE	DOL.	0.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
9. TAXES:											
INCOME	DOL.	0.00	196.61	210.10	225.48	242.53	261.43	279.97	296.33	307.53	328.74
PAYROLL	DOL.	0.00	17.13	17.13	17.13	17.13	17.13	17.13	17.13	17.13	17.13
PROPERTY	DOL.	0.00	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.82
10. CAPITAL PURCHASES (EQUITY)	DOL.	408.11	0.00	0.00	0.00	0.00	0.00	0.00	26.27	0.00	0.00
11. TOTAL CASH OUTFLOW	DOL.	408.11	1529.72	1543.20	1558.60	1575.65	1594.55	1508.39	1551.01	1563.96	1585.19
12. NET CASH INFLOW	DOL.	-408.11	387.65	374.16	358.76	341.71	322.81	408.97	366.35	353.40	332.18
13. CUMULATIVE CASH POSITION	DOL.	-408.11	-20.46	353.70	712.45	1054.16	1376.97	1785.95	2126.02	2479.43	2811.60

RETURNS TO EQUITY CAPITAL = 91.68 %
RETURNS TO TOTAL INVESTMENT = 20.12 %

Table A8 (continued). Example of Output Representing Annual Cash Flow Statement.

TABLE : ANNUAL CASH FLOW CONTINUED

ITEM	YEAR (END OF)
	10
LOAN INFO.	
1. INV. REQ.	743.42
2. EQUIT. REQ.	110.24
3. LOAN BAL.	683.14
CASH FLOW	
4. PRODUCTION	
POUNDS	589.96
PRICE/LB.	3.25
TOTAL SALES	1917.36
5. TOTAL CASH INFLOW	1917.36
6. CASH OPER. COSTS	737.38
7. LOAN PAYMENT	
PRINCIPAL	433.54
INTEREST	48.58
8. INSURANCE	14.00
9. TAXES	
INCOME	352.66
PAYROLL	17.13
PROPERTY	5.82
10. EQUITY	110.24
11. TOTAL CASH OUTFLOW	1719.35
12. NET CASH INFLOW	198.01
13. CUML. CASH POSIT.	2899.38

Table A9:. Example of Output Representing Monthly Cash Flow Statement for a Given Year in the Planning Horizon.

TABLE : MONTHLY CASH FLOW STATEMENT FOR A 118.0 ACRE GROW-OUT OPERATION OF SIMPLE SYSTEM DESIGN. (YEAR 6)

ITEM	UNIT	MONTH (END OF)								
		BEG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
LOAN INFORMATION :										
1. INVESTMENT REQUIREMENT	DOL.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. EQUITY REQUIREMENT	DOL.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. LOAN BALANCE	DOL.	1721.68	1721.68	1721.68	1721.68	1721.68	1721.68	1721.68	1721.68	1721.68
CASH FLOW										
4. PRODUCTION:										
POUNDS	LBS.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PRICE/POUND	DOL.		3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
TOTAL SALES	DOL.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. TOTAL CASH INFLOW	DOL.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. CASH OPERATING EXPENSES	DOL.		13.48	13.45	17.54	18.20	89.13	71.81	95.84	100.81
7. LOAN PAYMENTS:										
PRINCIPAL PORTION	DOL.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INTEREST PORTION	DOL.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8. INSURANCE	DOL.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9. TAXES:										
INCOME	DOL.		0.00	0.00	0.00	279.97	0.00	0.00	0.00	0.00
PAYROLL	DOL.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PROPERTY	DOL.		0.00	0.00	0.00	5.82	0.00	0.00	0.00	0.00
10. CAPITAL PURCHASES (EQUITY)	DOL.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11. TOTAL CASH OUTFLOW	DOL.		13.48	13.45	17.54	303.99	89.13	71.81	95.84	100.81
12. NET CASH INFLOW	DOL.		-13.48	-13.45	-17.54	-303.99	-89.13	-71.81	-95.84	-100.81
13. CUMULATIVE CASH POSITION	DOL.	1376.97	1363.50	1350.04	1332.50	1028.51	939.38	867.57	771.73	670.93

Table A9 (continued). Example of Output Representing Monthly Cash Flow Statement for a Given Year in the Planning Horizon.

TABLE : MONTHLY CASH FLOW CONTINUED

ITEM	MONTH (END OF)			
	SEP	OCT	NOV	DEC
LOAN INFO.				
1. INV. REQ.	0.00	0.00	0.00	0.00
2. EQUIT. REQ.	0.00	0.00	0.00	0.00
3. LOAN BAL.	1721.68	1721.68	1721.68	1439.73
CASH FLOW				
4. PRODUCTION				
POUNDS	0.00	0.00	589.96	0.00
PRICE/LB.	3.25	3.25	3.25	3.25
TOTAL SALES	0.00	0.00	1917.36	0.00
5. TOTAL CASH INFLOW	0.00	0.00	1917.36	0.00
6. CASH OPER. COSTS	110.38	141.38	51.89	13.48
7. LOAN PAYMENT				
PRINCIPAL	0.00	0.00	0.00	281.95
INTEREST	0.00	0.00	0.00	172.14
8. INSURANCE	0.00	0.00	0.00	14.00
9. TAXES				
INCOME	0.00	0.00	0.00	0.00
PAYROLL	0.00	0.00	0.00	17.13
PROPERTY	0.00	0.00	0.00	0.00
10. EQUITY	0.00	0.00	0.00	0.00
11. TOTAL CASH OUTFLOW	110.38	141.38	51.89	498.69
12. NET CASH INFLOW	-110.38	-141.38	1865.47	-498.69
13. CUML. CASH POSIT.	560.54	419.16	2284.64	1785.94