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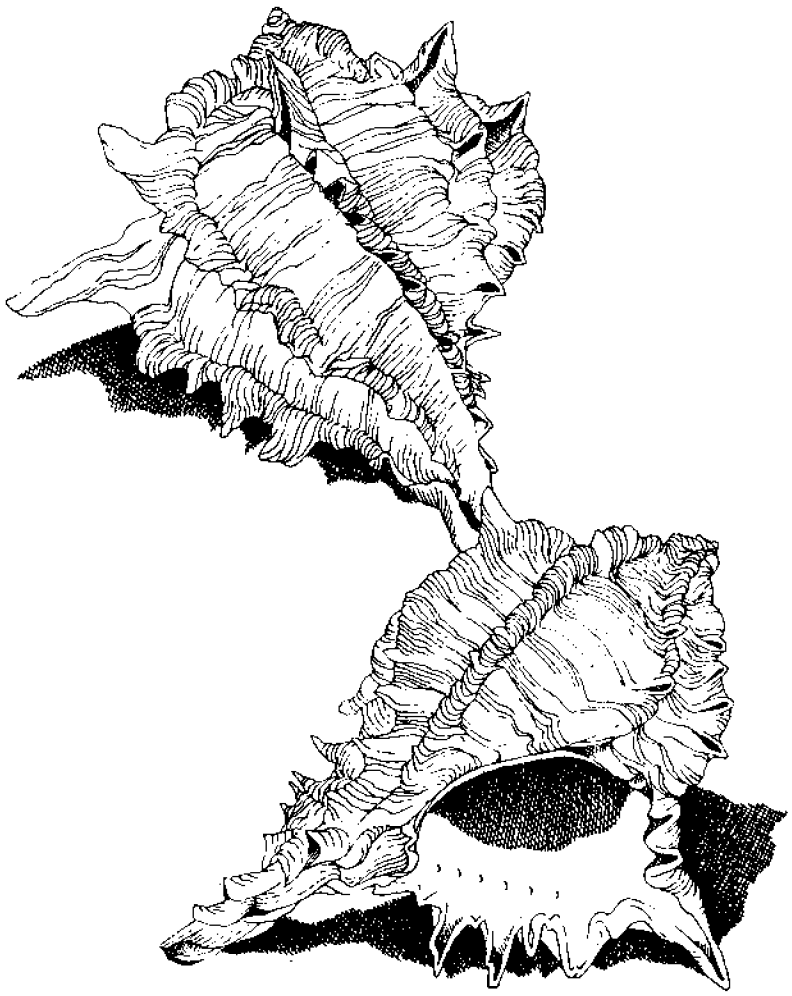

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by

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I. Introduction

This publication examines the projected costs and returns of raising hybrid striped bass in eastern North Carolina. The costs and returns are still projected because, as of August 1988, there had not been a commercial harvest in the state. The first commercial crop probably will be harvested this fall.

This report is based on information derived from three sources: 1) Lee Brothers and his father, Harvey Brothers, who have built the first commercial-scale facility in the state for raising hybrid striped bass for food, 2) UNC Sea Grant personnel at the aquaculture research and demonstration facility near Aurora, N.C., and 3) literature on the economics of catfish farming. In particular, heavy use has been made of the work done at Mississippi State University as presented by Waldrop and Dillard.

The budgets presented in Sections II-IV of this report are for new enterprises, and they assume that all of the inputs to the farm will be purchased new at the start of operation. Thus, the budgets presented in these sections are full-cost budgets.

The budgets assume that all financing for capital construction and operating costs will be from the owner's equity. Therefore, no loan repayment schedules are included. But because opportunity costs of capital are important to the profitability of a new venture, they are included as a separate line item in the budgets.

Partial budgets for an additional enterprise on a pre-existing farm are presented in Section V. This budget assumes land and general farm machinery are already owned, and that the owner/operator will provide the management for the fish production enterprise as a supplemental farm commodity.

The farming operation as it is developed in this report uses two sizes of levee-type ponds to raise fingerlings to marketable size. There are no provisions in any of the budgets for spawning fish and rearing larvae to produce fingerlings. It is assumed that the fingerlings will be purchased.

The timing of the production cycle starts in June with the arrival of the purchased fingerlings. These are cultured in the smaller of the two sizes of ponds on the farm for the remainder of the first growing season. When growth stops during the first winter, the fish are caught, inventoried and moved to the larger ponds for the second season of growth. Finally, they are harvested over the course of the second winter. The total length of the grow-out process is roughly 18 months. After the first year, the next year's crop will be started in the small ponds while this year's crop is growing in the larger ponds.

The authors would like to add a note at the time of publication. The actual weights achieved by the hybrids in the first year of production by the commercial scale farm and by the experiment station have not reached the weights projected in this working paper. The actual weights averaged in the range of 1.3 to 1.5 pounds. We believe that last summer's unusually hot weather, combined with the cooler than usual fall weather, depressed the growth of the fish. It is still believed that the figures of 1.5 to 1.7 pound per fish are reasonable estimates for a normal growing season in North Carolina.

II. Farm size, design and capital requirements

Three sizes of farms are examined in this report. The smallest has three 2.5-acre first-year ponds and three 7.5-acre second-year ponds (all pond sizes include the area used for the levees) for a total of about 30 acres of water on a 40-acre plot of land. The intermediate-sized farm doubles this plan to give six 2.5-acre ponds and six 7.5 acre ponds for a total of 60 acres of water on 80 acres of land. The largest size farm doubles this plan again to give 12 2.5-acre ponds and 12 7.5-acre ponds for a total of 120 acres of water on 160 acres of land.

All three farm sizes are laid out on square plots of land that are multiples of a square 40-acre plot. But it should be pointed-out that the farm design will almost always be determined by the peculiarities of the specific site under consideration. Future experiences of commercial growers will help identify optimal pond sizes. Thus, the farm designs which are presented in Figure 1 may not be suitable for any particular situation. Instead, they represent one potential design. The 25 percent of the land not devoted to ponds in each of the designs is intended for buildings, work areas and unusable portions of the plots such as wetlands and creek bottoms. This portion and its location will vary among sites.

The pond size varies from the basic 2.5- and 7.5-acre sizes to explore the effects of larger and smaller pond sizes on the budgets for each of the three farm sizes. Figure 2 presents the farm designs used when the pond sizes are halved to 1.25-acres for the first-year ponds and 3.75-acres for the second-year ponds.

Figure 3 presents the farm designs used when the pond sizes are doubled to 5 acres for the first-year ponds and 15 acres for the second-year ponds. The smallest farm size did not have sufficient water area to allow for the use of such large ponds. It was necessary to use 3.75-acre first-year ponds and 11.25-acre second-year ponds for the large pond version of the smallest farm.

As with Figure 1, the designs of the farms in Figures 2 and 3 are generalizations. The actual farm designs used will be determined by the specific site under consideration. Other site-specific factors influencing the construction costs of the farm are the depth and availability of ground water and the soils and sub-soils on the site.

Water supply is obviously an important consideration in growing the hybrid. Even with access to clean brackish surface water, Sea Grant biologists recommend freshwater wells capable of supplying 30 to 40 gallons per minute per surface acre of pond. Both the experimental farm and the commercial farm are located over the Castle-Hayne aquifer in eastern North Carolina. At these locations, the aquifer is approximately 270 feet deep. A 12-inch outside diameter well would yield up to 2,000 gallons of water per minute. These figures are used throughout this analysis. All wells are assumed to be 12 inches in outside diameter. But again, they are site-specific: much larger or more wells may be necessary to produce this quantity of water somewhere else.

Construction costs for the earth-moving necessary for the erection of the levees are also site specific. These costs will be determined by the topography of the site and by its soil and sub-soils. At both the experimental farm and the commercial farm, the sub-soil has sufficient clay, and the topography is such that the levees can be pushed up without breaking through to a more porous layer of sub-soil. This may not be the case at all sites. If alternative construction techniques must be used, then the construction costs for the levees and pond bottoms could be much higher than those used in this report.

Table 1 lists the requirements and costs for each size farm for the items that don't vary with pond size. Land is priced at $800 per acre. Land represents the second largest design-independent cost for the smallest farm and the largest cost for the two larger farms. Drilling and equipping the wells is the largest design-independent cost for the smallest farm and the second largest cost for the two larger farms. Other items in the equipment budgets are given in Table 1.

Miscellaneous equipment includes a side-mount mower, disk harrow, lime-spreader and front-end

loader. These items are required for all three farm sizes. The smaller farms may find it advantageous to hire the services associated with this equipment, but this alternative is not included in the budgets. Additional tractors, PTO-drive pumps and feeders are included in the equipment list for the larger farms. Feed storage is allocated at one unit per 100-acres.

Table 2 presents the basic construction parameters for the three-by-three combination of pond size and farm size options. The table shows the items in the capital budget that vary with the size of the ponds for each size of farm. The length of levees to be constructed are taken from Figures 1 to 3 as are the length of water pipe needed for each of the designs. The number of valves is specified as one per pond plus two per well. There is one drainage structure per pond, and one aerator per pond plus one emergency aerator per seven ponds.

Table 3 translates the physical requirements given in Table 2 to dollar costs. The investment costs from Table 1 are also included to give the total investment required for each of the nine combinations of pond size and farm size.

The cost of levee construction assumes that 6 cubic yards of earthmoving is required per linear foot of levee built. The levees are 12 feet across the top and 6 feet tall. The slope ofthe sides is 2.5:1. The cost of earthmoving is specified as 80 cents per cubic yard. There is a cost of $1.236 per linear foot of levee for gravel surfacing and ground cover. Thus, the cost of levee construction is $6.036 per linear foot.

Water supply pipes are specified as 8-inch PVC priced at $4 per foot installed. Drainage structures are priced at $1,300 each. Aerators are priced at $500 per acre serviced for the standard model and at $2,500 each for the emergency model. The effect of using a fixed cost per acre will be to overestimate the cost of the large pond designs and to underestimate the cost of the small pond designs.

The electric service is based on the length of water lines specified for each farm design. The cost is estimated as $1,400 for hook-up charges plus $600 per pond for junction boxes plus $1.10 per foot of installed line. The length of installed line is assumed to be equal to the length of water lines required for each of the farm designs. Costs of junction boxes may be reduced by locating them to supply electricity to more than one pond.

The total investment in all of the small pond designs is much higher than in either the medium or the large pond designs. This occurs because the smallest pond size requires a greater duplication of equipment and a more complicated levee layout.

Examining the costs from small to large ponds illustrates (for a given farm size) the premium paid for smaller ponds to provide some risk reduction and perhaps some reduced harvesting costs and increased harvesting convenience.

In the channel catfish industry, studies on the optimum pond size have found lowest production costs when the pond size is 20 acres (Waldrop and Dillard 1985). None of the designs in this report uses such a large pond size. This is because, so far, management techniques have not been developed for the larger ponds in hybrid production. Smaller ponds may reduce the risk of loss from disease. But they are obviously more expensive to construct.

Once the equipment lists and construction costs have been developed, the costs of depreciation and maintenance can be determined. The depreciation charges are made on a straight-line basis with zero salvage values. The maintenance costs are calculated as a constant percentage of the new price of each item. The useful lives and the maintenance percentages are taken from Waldrop and Dillard (1985) with some alterations.

Tables 4 to 6 present these costs for the small, medium and large farms, using the medium-size pond designs.

III. Operating Costs

Standard accounting practices are followed in the division of the operating costs of the firm into fixed costs and variable costs. Fixed costs are those costs that, once the size and design of the farm have been fixed, do not vary with the output level of the farm. Variable costs are those costs that vary directly with the level of production given the size and design of the farm.

We vary from the standard accounting practice because there is an additional line item in each of the Tables 7 to 9 showing the implicit opportunity costs. Opportunity costs are defined as the earnings that the equity investment could make if invested elsewhere. The full cost of production must include some measure of the alternatives available for the capital invested. This is particularly true in this report in which all investment is assumed to be equity based. Thus there are no interest costs on capital or operating loans.

The opportunity costs are calculated at 9.5 percent --- the current prime interest rate. They are charged on the total investment after depreciation, including the current inventory of one-year-old fingerlings plus half of the total operating costs. The inventory of one-year-old fingerlings is included, because it is a part of the current year's invested capital. Half of the operating costs are included to compensate for the fact that the operating expenses are spread out over the current year.

In Section V, we present a partial budget approach to the costs analysis. In the partial budgets, the opportunity costs are not included because the partial budgets are intended to present the changes in an operating farm's financial picture due to the introduction of fish culture. Other, similar changes in the budgets are explained in the discussion in section V. The costs in section V must then be interpreted as partial costs, and any returns to the fish-farming operation must be interpreted as returns to capital, land and the farmer's management.

Fixed Costs

Once the farm is producing, there are costs that do not change with the level of output from a facility of a given size. Included among these costs are the labor to run the farm, a minimum set of utilities, property and payroll taxes, insurance, and maintenance and depreciation charges. All farm sizes are assumed to operate with one manager who receives a salary of $30,000 per year. (We will relax this assumption in Section V).

Hired labor is assumed at the rate of one full-time person (50 40-hour weeks) per 60 acres of water per year at an assumed hourly rate of $6. The overhead on wages is assumed to be 15 percent. In addition, harvesting costs are estimated at 5 cents per pound, which includes temporary labor. The minimum set of utility charges is estimated to be $1,500 per year for all farm sizes. This does not include any costs for pumping water or aerating the ponds. Insurance is estimated at $1,500 per year for all farm sizes. Property tax is calculated at $8 per thousand dollars of improvements and equipment plus $8 per acre of land. The maintenance and depreciation charges have already been discussed.

Variable Costs

The other part of the operating costs are those that vary directly with the level of production on the farm. Fingerlings are assumed to be purchased in quantities sufficient to stock the second year ponds at roughly 3,000 fish per acre given a first-year survival rate of 85 percent. Since the first year ponds are one-third the area of the second year ponds, this requires stocking the first year ponds at 10,600 fish per acre.

The cost of fingerlings has been 20 cents each plus shipping charges for 1.5-inch fish trained to feed. A figure of 21 cents per fish is used.

Feed costs depend upon growth rates, feed conversion rates and survival rates of the fish. As a base

case, a feed conversion rate of 2.5 pounds of feed to one pound of fish has been used. The first year survival rate has been assumed to equal 85 percent, and the second year survival assumed to equal 95 percent. The first year's growth allows the fish to reach a weight of 0.4 pounds. The second year's growth allows the fish to be harvested at an expected weight of 1.7 pounds. The price of feed has been $21 per hundred-weight plus $1,100 per 45,000 pounds shipping or $0.2344 per pound.

Other annual variable costs are estimated as follows. Chemicals are $20 per acre of water. Fuel costs are $210 for pumping, $14 for feeding and $2.50 for mowing per acre of water. Electricity is used to run the aerators at a cost of $77 per acre of water. Harvesting is estimated to cost 5 cents per pound of fish, and the cost of sales is estimated to be 15 cents per pound of fish. These costs are summarized in Tables 7 to 9 for the medium size pond design of the three farm sizes.

IV. Sensitivity to the Assumptions Used

In any exercise in which one tries before the fact to calculate the cost of a new product or technique, it is useful to test the sensitivity of the analysis to the assumptions that have been made. While the figures used in this report are the best estimates available, they are still estimates and, in some cases, best guesses. Sensitivity analysis changes the values or prices used in the analysis and observes the changes in results.

There are three categories of values in this report. The first are construction and equipment requirements. These are derived from the particular farm design chosen. Their effects on costs are examined by changing the basic farm designs. This has been done with the prior exploration of the three pond sizes for each farm size. The results are summarized in Table 10, which presents the total costs by farm size and design. The results of the change in pond size do not include the additional difficulties one may encounter in managing water quality in larger ponds. Water quality will affect the growth rates of the hybrids.

The accounting costs for the small farm range from $1.68 to $1.72 per pound. But the full costs, including the opportunity cost of the investment, ranges from $1.98 to $2.05 per pound for the 30-acre farm. Thus, the opportunity cost of investment adds an additional 30 cents to 33 cents per pound to the accounting costs of producing the fish for the smallest farm. The lowest accounting cost occurs with the large pond design of the 120-acre farm at $1.31 per pound. The opportunity cost adds another 21 cents to this for a full cost of $1.52 per pound.

The second set of values used in this analysis are the prices. The effects of different prices should be examined by looking at those items which are the most important in the budget. In the capital budgets, the cost of the levee construction and the costs of installing and equipping the wells are the two largest items. In the operating budgets, the three costs which stand out are labor, feed, and sales and harvesting costs.

In the first and second columns of Table 11, the prices of feed and fingerlings have been changed from those used in Table 10. The changes are presented only for the medium pond designs. They should be compared to the middle column of Table 10. In the first column of Table 11, the costs have been lowered. The price of fingerlings has been lowered from 21 cents to 16 cents each.

The cost of feed has been lowered from 23.44 cents to 20 cents. In the second column the cost of feed has been increased from 23.44 cents to 28 cents per pound. The costs of fingerlings has been raised from 21 cents to 26 cents. These changes are given at the bottom of Table11.

For the small farm, the higher prices increase the full cost from $2 to $2.16 per pound. The full costs increase from $1.69 to $1.85 for the medium-sized farm, and increase from $1.55 to $1.72 for the largest farm. This represents an increase of 11 percent in the full cost for the largest farm.

The third set of values used in this report are the operating parameters of the farm. Among these would be the pumping and aeration fuel and electricity usages. The most important among the operating parameters are the biological responses of the fish. In particular, the growth rates, survival rates and the feed conversion rates would seem vital. The last column of Table 11 changes the values of these three rates. The final size of the fish is decreased from 1.7 pounds to 1.5 pounds. The first-year survival rate is decreased from 85 percent to 70 percent, and the feed conversion rate is increased from 2.5:1 to 2.9:1 pounds of feed to pounds of fish.

The ne result of these changes is to decrease the production of the farms by slightly over 27 percent compared to that assumed in Table 10. There is some compensation in the variable costs due to the feed savings from feeding fewer fish the second year. However, the effect of these changes is much larger than that of the price changes. (Note: These estimates are generated using the same input prices as Table 10). The full cost of the small farm increases to $2.53 per pound, and the cost of the medium farm increases to $2.11 per pound. The full cost of the large farm goes to $1.92.

V. A Partial Budget Summary

This section briefly discusses cost summaries appropriate for situations in which farmers/landowners view hybrid grow-out as an additional enterprise on their existing farms. In these cases we are assuming that land is owned, and much of the general farm machinery is already owned. Therefore it will not be part of the initial investment.

Included in this category are the following items from Tables 1 and 4: trucks, tractors, the side-mounted mower, disk harrow, lime spreader and front-end loader. Investment in other equipment and pond construction included in Tables 1-4 that is specific to fish production is retained in the partial enterprise budget.

Additional changes from the earlier budgets are incorporated in the fixed costs below. These are: 1) no salary is charged for a manager, under the assumption that the existing farm owner/operator will manage the fish enterprise, and 2)maintenance and depreciation of the general farm equipment is charged against fish production, but at a lower rate than in the previous budgets, which assume that fish production is the only enterprise on the farm.

In generating the cost estimates below, we assume that maintenance and depreciation charged to fish culture for the general equipment is: 30 percent (40-acre farm); 50 percent (80-acre farm); and 70 percent (120-acre farm). We assume progressively higher rates as the size of the fish production unit increases. This is because larger fish production units are expected to make up a larger share of the total farm's output and to occupy an increasing share of the owner/operator's time. Fish-specific equipment, of course, is charged entirely to the fish production enterprise.

Other investment costs and operating costs are as shown in the previous budgets for the medium-size ponds. Table 12 presents summary information and costs-per-pound for the hybrid enterprise for only medium-size ponds.

A comparison of these costs per pound to those estimated in Table 10 (middle column) shows differences of 37 cents, 18 cents and 9 cents per pound for the 30-, 60-, and 120-acre enterprises, respectively, using the estimates with no capital costs. Using the estimates with the opportunity cost of capital included produces differences of 46 cents, 25 cents and 14 cents per pound for the 30, 60 and 120 acres, respectively. If the earlier estimates in Table 10 are reasonable, these latter differences in costs may be thought of as the opportunity cost of management and equity in land and general farm equipment. Alternatively stated, net returns obtained by subtracting costs (including opportunity capital costs) shown in Table 12 from revenue represents a return to both management and equity inland and general farm equipment.

VI. Summary

The costs of raising hybrid striped bass in eastern North Carolina have been developed. A broad range of full costs of production has been presented. These have ranged from $1.36 to $2.48 per pound, depending upon farm size, pond size and input price/productivity assumed for the "fish only" enterprises.

For the partial budget, only simulations across farm size are presented. These produced full costs ranging from $1.34 per pound for 120 acres of water to $1.44 per pound for 30 acres, all using the medium-size pond design.

Net revenue computations are not presented. The cost-per-pound estimates presented, which include opportunity costs of capital, approximate break-even prices. Thus the reader can estimate net revenue by subtracting expected full cost per pound from expected price and multiplying by expected poundage produced. Early prices received for experimental hybrids and prices casually mentioned by dealers, appear to be more than sufficient to cover the full production costs.

However, two important unknowns will affect future price received. The first is uncertainty about price response to increasing quantities marketed as new production comes on line. This is really a question about the demand elasticity for the hybrid. And since there is no industry yet, we can't answer this question.

The second unknown is what average size fish will actually be produced by the end of the second grow-out season. If it is smaller than expected, significantly lower prices may be offered, and as we have seen above, higher costs incurred. Price per pound, at least in the striped bass market, has been positively related to size of fish (i.e., the larger the fish, the higher the price per pound). Thus variation in size produced will affect price as well as costs.

Finally, as producers gain experience with the hybrid, one would expect to see improvements in production practices and facilities that may lower costs. One might also expect some early experimentation by growers with production variables such as alternative stocking densities. Such experimentation will provide information that will narrow the range of optimal production per acre. In the meantime, we recommend using these estimates with care and giving much attention to the marketing plan (including expected selling price) before moving dirt.

REFERENCES

Waldrop, John E. and James G. Dillard. 1985. "Economics" in Channel Catfish Culture edited by C. S. Tucker. Elsevier, Amsterdam.

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Table 1

Requirements and Costs Independent of Pond Size

30-acres of water on 40-acres of land

Land	40	acres	$ 800	$ 32,000
Wells	1		40,000	40,000
Buildings	1		12,000	12,000
Feed storage	1		11,000	11,000
Nets			4,000	4,000
Test Equipment			1,800	1,800
Trucks	1		12,000	12,000
Tractors	1		15,000	15,000
Feeders	1		2,500	2,500
Misc. Equipment			19,000	19,000
PTO-drive pumps	1		3,600	3,600
Total				$ 152,900

60-acres of water on 80-acres of land

Land	80	acres	$ 800	$ 64,000
Wells	1		40,000	40,000
Buildings	1		12,000	12,000
Feed storage	1		11,000	11,000
Nets			4,000	4,000
Test Equipment			1,800	1,800
Trucks	1		12,000	12,000
Tractors	2		15,000	30,000
Feeders	2		2,500	5,000
Misc. Equipment			19,000	19,000
PTO-drive pumps	2		3,600	7,200
Total				$ 206,000

120-acres of water on 160-acres of land

Land	160	acres	$ 800	$ 128,000
Wells	2		40,000	80,000
Buildings	1		12,000	12,000
Feed storage	2		11,000	22,000
Nets			4,000	4,000
Test Equipment			1,800	1,800
Trucks	1		12,000	12,000
Tractors	3		15,000	45,000
Feeders	3		2,500	7,500
Misc. Equipment			19,000	19,000
PTO-drive pumps	3		3,600	10,800
Total				$ 342,100

Table 2

Varying Construction and Equipment Requirements

30-Acre Farm

	Small Ponds	Medium Ponds	Large Ponds
No. of ponds	12	6	4
Ft. of Levees	10,560	7,920	6,930
Cu. Yds. Earthmoving	63,360	47,520	41,580
Ft. Water Pipes	1,750	1,100	760
No. of Valves	14	8	6
No. Drainage Struct	12	6	4
No. of Aerators	14	7	5

60-Acre Farm

	Small Ponds	Medium Ponds	Large Ponds
No. of ponds	24	12	6
Ft. of Levees	21,050	14,520	11,550
Cu. Yds. Earthmoving	126,300	87,120	69,300
Ft. Water Pipes	4,920	2,100	2,150
No. of Valves	28	16	8
No. Drainage Struct	24	12	6
No. of Aerators	28	14	7

120-Acre Farm

	Small Ponds	Medium Ponds	Large Ponds
No. of ponds	48	24	12
Ft. of Levees	40,120	28,640	17,160
Cu. Yds. Earthmoving	240,720	171,840	102,960
Ft. Water Pipes	8,100	4,350	3,350
No. of Valves	52	30	18
No. Drainage Struct	48	24	18
No. of Aerators	55	28	14

Table 3

Total Costs of Construction and Equipment Requirements

30-Acre Farm	Small Ponds	Medium Ponds	Large Ponds
Levees	$ 63,741	$ 47,806	$ 41,830
Water Pipes	7,000	4,400	3,040
Valves	3,500	2,000	1,500
Drainage Struct	15,600	7,800	5,200
Aerators	20,000	17,500	17,500
Elect. Service	10,525	6,210	4,636
Sub-total	$ 120,366	$ 87,716	$ 73,706
From Table 1	152,900	152,900	152,900
Total	$ 273,266	$ 238,616	$ 226,606

60-Acre Farm	Small Ponds	Medium Ponds	Large Ponds
Levees	$ 127,060	$ 87,644	$ 69,717
Water Pipes	19,680	8,400	8,600
Valves	7,000	4,000	2,500
Drainage Struct	31,200	15,600	7,800
Aerators	40,000	35,000	32,500
Elect. Service	21,212	10,910	7,365
Sub-total	$ 245,652	$ 161,054	$ 127,982
From Table 1	206,000	206,000	206,000
Total	$ 451,652	$ 367,054	$ 333,982

120-Acre Farm	Small Ponds	Medium Ponds	Large Ponds
Levees	$ 242,169	$ 172,874	$ 127,483
Water Pipes	32,400	17,400	13,400
Valves	13,500	7,500	4,500
Drainage Struct.	62,400	31,200	15,600
Aerators	77,500	70,000	67,500
Elect. Service	39,110	20,585	12,285
Sub-total	$ 466,579	$ 319,059	$ 237,768
From Table 1	342,100	342,100	342,100
Total	$ 808,679	$ 661,159	$ 579,868

Table 4

30-Acre Farm - Medium Ponds

Depreciation and Maintenance Tables

Item	Life in years	Depreciation charges	Maintenance rate per year (percent)	Maintenance cost per year
Levees	20	2780.30	3.0	1668.18
Utilities				
electric service	10	621.00	5.0	310.50
wells	20	1250.00	3.0	750.00
well pumps	10	1500.00	5.0	750.00
pipes and valves	20	220.00	3.0	132.00
Buildings				
sheds and offices	20	600.00	5.0	600.00
feed storage	10	1100.00	5.0	550.00
Fish Handling Equip.				
aerators 1st	12	312.50	4.2	156.25
aerators 2nd	12	937.50	4.2	468.75
emergency aerator	12	208.33	4.2	104.17
nets	5	800.00	20.0	800.00
test equipment	5	360.00	20.0	360.00
Farm Equipment				
trucks	5	2400.00	9.0	1080.00
tractors	12	1250.00	5.0	750.00
feeders	10	250.00	3.0	75.00
side-mount mower	10	400.00	3.3	133.33
disk harrow	10	800.00	3.0	240.00
lime spreader	10	300.00	3.0	90.00
front-end loader	10	400.00	5.0	200.00
pto drive pump	10	360.00	5.0	180.00
Total per year		16,849.63		9,398.18
Total per surface acre		561.65		313.72

Table 5

60-Acre Farm - Medium Ponds

Depreciation and Maintenance Tables

Item	Life in years	Depreciation charges	Maintenance rates per year (percent)	Maintenance cost per year
Levees	20	5162.22	3.0	3097.33
Utilities				
electric service	10	1091.00	5.0	545.50
wells	20	1250.00	3.0	750.00
well pumps	10	1500.00	5.0	750.00
pipes and valves	20	420.00	3.0	252.00
Buildings				
sheds and offices	20	600.00	5.0	600.00
feed storage	10	1100.00	5.0	550.00
Fish Handling Equipment				
aerators 1st	12	625.00	4.2	312.50
aerators 2nd	12	1875.00	4.2	937.50
emergency aerator	12	416.67	4.2	208.33
nets	5	800.00	20.0	800.00
test equipment	5	360.00	20.0	360.00
Farm Equipment				
trucks	5	2400.00	9.0	1080.00
tractors	12	1250.00	5.0	1500.00
feeders	10	500.00	3.0	150.00
side-mount mower	10	400.00	3.3	133.33
disk harrow	10	800.00	3.0	240.00
lime spreader	10	300.00	3.0	90.00
front-end loader	10	400.00	5.0	200.00
pto drive pump	10	720.00	5.0	360.00
Total per year		23,219.88		12,916.50
Total per surface acre		387.00		215.27

Table 6

120-Acre Farm - Medium Ponds

Depreciation and Maintenance Tables

Item	Life in years	Depreciation charges	Maintenance rates per year (percent)	Maintenance cost per year
Levees	20	10203.71	3.0	6122.23
Utilities				
electric service	10	2058.50	5.0	1029.25
wells	20	2500.00	3.0	1500.00
well pumps	10	3000.00	5.0	1500.00
pipes and valves	20	870.00	3.0	522.00
Buildings				
sheds and offices	20	600.00	5.0	600.00
feed storage	10	2200.00	5.0	1100.00
Fish Handling Equipment				
aerators 1st	12	1250.00	4.2	625.00
aerators 2nd	12	3750.00	4.2	1875.00
emergency aerator	12	833.33	4.2	416.67
nets	5	800.00	20.0	800.00
test equipment	5	360.00	20.0	360.00
Farm Equipment				
trucks	5	2400.00	9.0	1080.00
tractors	12	3750.00	5.0	2250.00
feeders	10	750.00	3.0	225.00
side-mount mower	10	400.00	3.3	133.33
disk harrow	10	800.00	3.0	240.00
lime spreader	10	300.00	3.0	90.00
front-end loader	10	400.00	5.0	200.00
pto drive pump	10	1080.00	5.0	540.00
Total per year		38,305.54		21,208.48
Total per surface acre		319.21		176.74

Table 7

Fixed and Variable Costs - 30-Acre, Medium Ponds
(third year of operation)

Fixed Costs			
Salaries		30,000.00	
Hourly wages (1/2 person per 30 acres)		6,000.00	
Utilities		1,500.00	
Property and payroll taxes		6,546.46	
Insurance		1,500.00	
Maintenance		9,398.18	
Depreciation		16,849.63	
Interest on Capital Loans		0.00	
Total fixed costs			$71,794.28
Variable Costs		Fingerlings	Growout
Fingerlings		16,695.00	
Feed		15,842.58	48,913.98
Chemicals	20.00 dollars per acre	150.00	450.00
Fuel			
Pumping	210.00 dollars per acre	1,575.00	4,725.00
Feeding	14.00 dollars per acre	105.00	315.00
Mowing	2.50 dollars per acre	18.75	56.25
Electricity			
Pumping	0.00 dollars per acre	0.00	0.00
Aeration	77.00 dollars per acre	577.50	1,732.50
Harvesting	0.05 dollars per pound		5,456.68
Sales costs	0.15 dollars per pound		16,370.04
Variable Costs		$34,963.83	$78,019.45
Total Variable Costs			$112,983.28
Total Costs			$184,777.56
Total Costs per Acre			$6,159.25
Total Costs per Pound of Fish			$1.69
Total Costs Including Opportunity on		$347,104.00	$2.00

Table 8

Fixed and Variable Costs - 60-Acre, Medium Ponds
(third year of operation)

Fixed Costs			
Salaries		30,000.00	
Hourly wages (1/2 person per 30 acres)		12,000.00	
Utilities		1,500.00	
Property and payroll taxes		8,152.22	
Insurance		1,500.00	
Maintenance		12,916.50	
Depreciation		23,219.88	
Interest on Capital Loans		0.00	
Total fixed costs			$89,288.60
Variable Costs		Fingerlings	Grow-out
Fingerlings		33,390.00	
Feed		31,685.17	97,827.95
Chemicals	20.00 dollars per acre	300.00	900.00
Fuel			
Pumping	210.00 dollars per acre	3,150.00	9,450.00
Feeding	14.00 dollars per acre	210.00	630.00
Mowing	2.50 dollars per acre	37.50	112.50
Electricity			
Pumping	0.00 dollars per acre	0.00	0.00
Aeration	77.00 dollars per acre	1,155.00	3,465.00
Harvesting	0.05 dollars per pound		10,913.36
Sales costs	0.15 dollars per pound		32,740.09
Variable Costs		$69,927.57	$156,038.90
Total Variable Costs			$225,966.57
Total Costs			$315,255.17
Total Costs per Acre			$5,254.25
Total Costs per Pound of Fish		$563,789.00	$1.69

Table 9

Fixed and Variable Costs - 120-Acre, Medium Ponds
(third year of operation)

Fixed Costs			
Salaries		30,000.00	
Hourly wages (1/2 person per 30 acres)		24,000.00	
Utilities		1,500.00	
Property and payroll taxes		11,512.64	
Insurance		1,500.00	
Maintenance		21,208.48	
Depreciation		38,305.54	
Interest on Capital Loans		0.00	
Total fixed costs			$128,026.66
Variable Costs		Fingerlings	Growout
Fingerlings		66,780.00	
Feed		63,370.33	195,655.90
Chemicals	20.00 dollars per acre	600.00	1,800.00
Fuel			
Pumping	210.00 dollars per acre	6,300.00	18,900.00
Feeding	14.00 dollars per acre	420.00	1,260.00
Mowing	2.50 dollars per acre	75.00	225.00
Electricity			
Pumping	0.00 dollars per acre	0.00	0.00
Aeration	77.00 dollars per acre	2,310.00	6,930.00
Harvesting	0.05 dollars per pound		21,826.73
Sales costs	0.15 dollars per pound		65,480.17
Variable Costs		$139,855.33	$312,077.80
Total Variable Costs			$451,933.14
Total Costs			$579,959.80
Total Costs per Acre			$4,833.00
Total Cost Per Pound of Fish			$1.33
Total Costs Including Opportunity on		$1,030,515.00	$1.55

Table 10

Costs Summary by Farm Size and Design

	Small Ponds	Medium Ponds	Large Ponds
30-Acre Farm (production of 109,133 pounds)			
Fixed Costs	$ 74,999	$ 71,794	$ 70,715
Variable Costs	112,983	112,983	112,983
Total Costs	$187,982	$184,777	$183,698
Costs per Pound	1.72	1.69	1.68
Including Opportunity Costs	2.05	2.00	1.98
60-Acre Farm (production of 218,267 pounds)			
Fixed Costs	$ 97,101	$ 89,289	$ 86,270
Variable Costs	225,966	225,966	225,966
Total Costs	$323,067	$315,255	$312,236
Costs per Pound	1.48	1.44	1.43
Including Opportunity Costs	1.76	1.69	1.66
120-Acre Farm (production of 436,534 pounds)			
Fixed Costs	$141,572	$128,027	$120,632
Variable Costs	451,933	451,933	451,933
Total Costs	$593,505	$579,960	$572,565
Costs per Pound	1.36	1.33	1.31
Including Opportunity Costs	1.61	1.55	1.52

Table 11

Cost Sensitivity to Biological Parameters and Prices
(medium sized ponds)

	Lower Costs	Higher Costs	Lower Productivity
30-Acre Farm			
Production	109,133	109,133	79,301
Costs per Pound	1.57	1.84	2.13
Including Opportunity Costs	1.86	2.16	2.53
60-Acre Farm			
Production	218,267	218,267	158,602
Costs per Pound	1.32	1.60	1.79
Including Opportunity Costs	1.55	1.85	2.11
120-Acre Farm			
Production	436,534	436,534	317,205
Costs per Pound	1.20	1.48	1.63
Including Opportunity Costs	1.42	1.72	1.92
Values Used in Analysis			
Fingerling Price	0.16	0.26	0.21
Feed Price	0.20	0.28	0.23
Feed Conversion	2.5:1	2.5:1	2.9:1
First Year Survival	85%	85%	70%
Final Weight	1.7	1.7	1.5

Table 12

A Partial Budget Summary for Hybrid Production

	Enterprise Size (Water Acres)		
	30 acres	60 acres	120 acres
Total Investment	$166,616	$305,554	$532,659
Investment per Water/acre	5,554	5,093	4,439
Annual Costs:			
Fixed	31,539	55,622	95,517
Variable	102,622	205,244	410,489
Annual Production (lbs.)	109,134	218,267	436,535
Costs per Pound:			
No cost of capital	1.23	1.20	1.16
With cost of capital	1.44	1.39	1.34

Figure 1: The three medium-pond designs. The first-year ponds are 2.5 acres each, including levees, and the second-year ponds are 7.5 acres each, including levees.

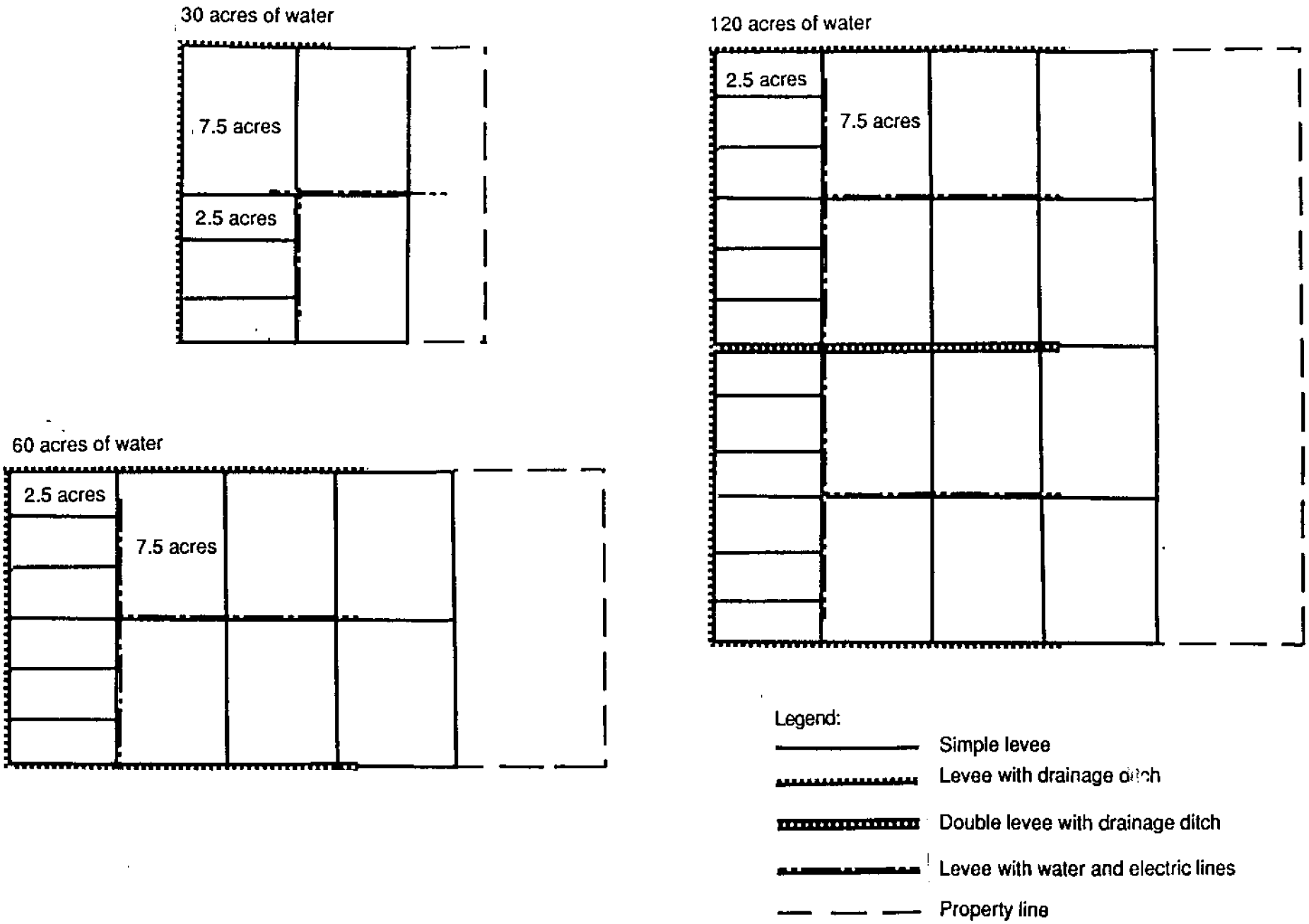

Figure 2: The three small-pond designs. The first-year ponds are 1.25 acres each, and the second-year ponds are 3.75 acres each.

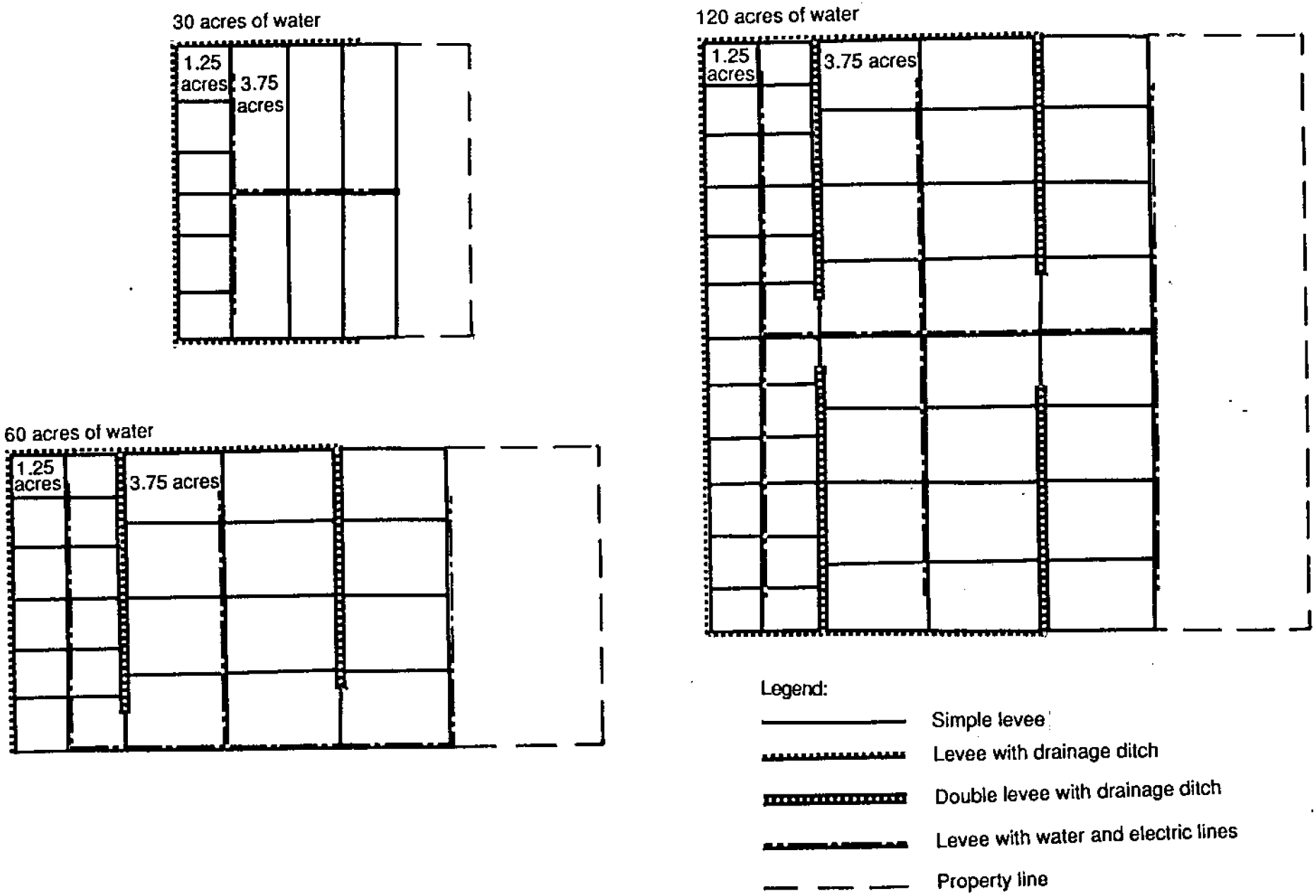

Figure 3: The three large-pond designs. The small farm has 3.75-acre first-year ponds and 11.25-acre second-year ponds. The two larger ponds have 5-acre first-year ponds and 15-acres second-year ponds.