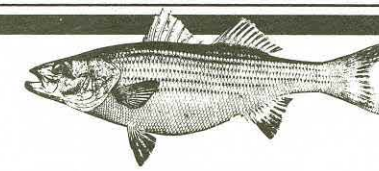
Maryland Sea Grant Extension Program

FINFISH AQUACULTURE
WORKBOOK SERIES



Figuring Production Costs in Finfish Aquaculture

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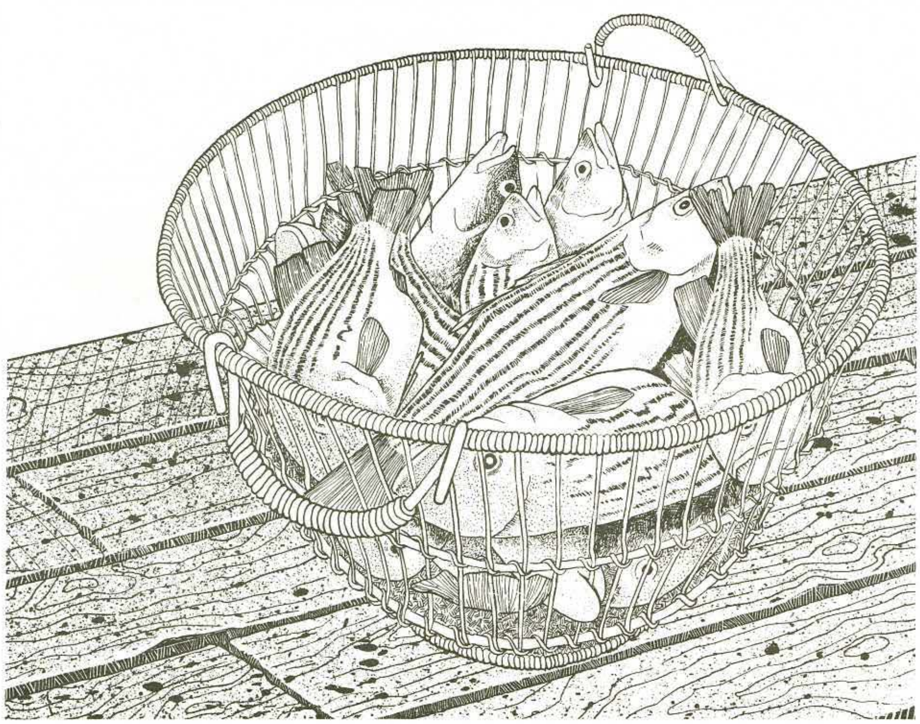

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Introduction

If you are serious about investing in commercial finfish aquaculture, you will need to prepare a detailed business plan — this will provide an accurate cash-flow analysis to help you predict rates of return on your investment. Because preparation of a business plan itself can be costly, you can work up preliminary estimates to determine whether a complete plan is even warranted. The mathematical formulas and tables in this workbook will enable you to do such estimates by accounting for the major production costs that aquaculture operations require, namely, buying, feeding, and maintaining your fish. You can then compare these estimates with reasonable expectations about market prices to determine if you can grow fish for less than you can sell them. If so and your proposed operation appears to be economically viable, you will then want to undertake a comprehensive business plan.

Production costs are typically divided between *variable costs* and *fixed costs.* Variable costs depend on your level of production and include, for example, seed (the number of eggs or fish you begin with) and food (the amount your fish require to bring them to market or harvest size). Fixed costs, on the other hand, must be paid regardless of your level of production and include such outlays as payroll and capital costs, interest and depreciation on the aquaculture facility. Some labor may be a variable cost, but we include all labor under payroll for simplicity.

The following sections show you how to calculate some of the major variable and fixed costs so that you can estimate their contribution to the cost of producing marketable fish.

Variable Costs

Seed Cost

All aquaculture operations begin with seed, whether you purchase fish eggs or, more likely, fry or fingerlings. To determine the contribution of seed to production cost, you will need to know or estimate the (1) purchase price of seed (or, if you have a hatchery, the cost of production), (2) survival rate from seed to market size, and (3) size fish you are going to harvest. Using the following equation, you can then calculate the cost contribution of seed (C_{seed}) to the final production cost of your harvested fish:

(1)

$$C_{seed} = \frac{P_{seed}}{W \times S}$$

where

C_{seed} = Cost contribution for producing a pound of fish

P_{seed} = Purchase price of seed (or cost of production in your hatchery)

W = Expected average weight of harvestable fish

S = Percentage of fish surviving from seed to market size

As an example, let's assume you are purchasing hybrid striped bass fry from a producer and want to estimate the cost per pound of producing a market weight fish (W) of 1.5 pounds. If the purchase price (P) of the fry is $0.25 each and you presume a survival rate (S) of 70%, the cost of seed per pound for rearing a 1.5 pound fish can be calculated as follows:

Example:

$$C_{seed} = \frac{.25}{1.5 \times .70} = \frac{.25}{1.05} = \$0.24$$

Note that the $0.24 does not depend directly on the type of aquaculture technology to grow the fish — cage, open pond, or recirculating systems. Indirectly, it can make a difference: with more intensive recirculating systems, for example, survival rate may be higher than a less intensive open pond system.

Tables 1a-1d have been generated using Equation (1) — they allow you to compare the effect of different combinations of seed prices (P), harvest weights (W) and survival estimates (S). The row headings represent different seed costs, while column headings represent different weights at which fish are harvested. Each table represents a different estimate of

(1a) 100% SURVIVAL

Seed Price Per lb.	Size at Harvest (lbs.) 0.75	1.00	1.25	1.50	1.75	2.00
	Cost per Pound					
$0.05	$0.07	$0.05	$0.04	$0.03	$0.03	$0.03
$0.10	$0.13	$0.10	$0.08	$0.07	$0.06	$0.05
$0.15	$0.20	$0.15	$0.12	$0.10	$0.09	$0.08
$0.20	$0.27	$0.20	$0.16	$0.13	$0.11	$0.10
$0.25	$0.33	$0.25	$0.20	$0.17	$0.14	$0.13
$0.30	$0.40	$0.30	$0.24	$0.20	$0.17	$0.15
$0.35	$0.47	$0.35	$0.28	$0.23	$0.20	$0.18
$0.40	$0.53	$0.40	$0.32	$0.27	$0.23	$0.20
$0.45	$0.60	$0.45	$0.36	$0.30	$0.26	$0.23
$0.50	$0.67	$0.50	$0.40	$0.33	$0.29	$0.25

(1b) 90% SURVIVAL

Seed Price Per lb.	Size at Harvest (lbs.) 0.75	1.00	1.25	1.50	1.75	2.00
	Cost per Pound					
$0.05	$0.07	$0.06	$0.04	$0.04	$0.03	$0.03
$0.10	$0.15	$0.11	$0.09	$0.07	$0.06	$0.06
$0.15	$0.22	$0.17	$0.13	$0.11	$0.10	$0.08
$0.20	$0.30	$0.22	$0.18	$0.15	$0.13	$0.11
$0.25	$0.37	$0.28	$0.22	$0.19	$0.16	$0.14
$0.30	$0.44	$0.33	$0.27	$0.22	$0.19	$0.17
$0.35	$0.52	$0.39	$0.31	$0.26	$0.22	$0.19
$0.40	$0.59	$0.44	$0.36	$0.30	$0.25	$0.22
$0.45	$0.67	$0.50	$0.40	$0.33	$0.29	$0.25
$0.50	$0.74	$0.56	$0.44	$0.37	$0.32	$0.28

Tables 1a-1d. Effect of seed price, survival and size at harvest on cost per pound of production.

survival rate: 100%, 90%, 80%, 70%.

To use the table, assume a survival rate — in our example, 70% (table 1d); then locate the seed cost and market weight you plan to harvest. At a $0.25 cost of fry and market weight of 1.5 pounds, the cost per pound of production will be $0.24.

Feed Cost

Food may be the most expensive cost in raising fish to harvest size. To determine the contribution of feed to production cost per pound of fish, it is necessary to know the (1) per pound cost of feed, (2) market size, or weight you expect to add to the fish from seed to harvest, (3) survival rate, and (4) the feed conversion ratio, a measure of how efficiently food is converted to body weight.

Survival rate, in relation to the amount of food your fish require, is important because you will be feeding fish that may die before they reach harvest size. When this occurs, the overall feed cost per unit of harvestable fish will increase. The pattern that fish mortality takes will be important in determining how feed costs are affected. For example, if all mortality occurs early, before fish are fed, then the survival rate has little impact on the contribution of feed costs to production. If most of the mortality occurs right before the fish are harvested, then mortality will have its greatest impact on the cost contribution of feed to production cost.

Using the following equation, you can calculate the cost of feed per pound of fish produced. The calculation assumes that mortality is spread evenly over the growing period.

(1C) 80% SURVIVAL

Seed Price Per lb.	Size at Harvest (lbs.) 0.75	1.00	1.25	1.50	1.75	2.00
	Cost per Pound					
$0.05	$0.08	$0.06	$0.05	$0.04	$0.04	$0.30
$0.10	$0.17	$0.13	$0.10	$0.08	$0.07	$0.06
$0.15	$0.25	$0.19	$0.15	$0.12	$0.11	$0.09
$0.20	$0.33	$0.25	$0.20	$0.17	$0.14	$0.13
$0.25	$0.42	$0.31	$0.25	$0.21	$0.18	$0.16
$0.30	$0.50	$0.37	$0.30	$0.25	$0.21	$0.19
$0.35	$0.58	$0.44	$0.35	$0.29	$0.25	$0.22
$0.40	$0.67	$0.50	$0.40	$0.33	$0.29	$0.25
$0.45	$0.75	$0.56	$0.45	$0.37	$0.32	$0.28
$0.50	$0.83	$0.63	$0.50	$0.42	$0.36	$0.31

(1d) 70% SURVIVAL

Seed Price Per lb.	Size at Harvest (lbs.) 0.75	1.00	1.25	1.50	1.75	2.00
	Cost per Pound					
$0.05	$0.10	$0.07	$0.06	$0.05	$0.04	$0.04
$0.10	$0.19	$0.14	$0.11	$0.10	$0.08	$0.07
$0.15	$0.29	$0.21	$0.17	$0.14	$0.12	$0.11
$0.20	$0.38	$0.29	$0.23	$0.19	$0.16	$0.14
$0.25	$0.48	$0.36	$0.29	$0.24	$0.20	$0.18
$0.30	$0.57	$0.43	$0.34	$0.29	$0.24	$0.21
$0.35	$0.67	$0.50	$0.40	$0.33	$0.29	$0.25
$0.40	$0.76	$0.57	$0.46	$0.37	$0.33	$0.29
$0.45	$0.86	$0.64	$0.51	$0.43	$0.37	$0.32
$0.50	$0.95	$0.71	$0.57	$0.48	$0.41	$0.36

(2)

$$C_{feed} = \frac{P \times WA \times FCR}{1 - [0.5 \times (1-S)]}$$

where

C_{feed} = Cost contribution of feed to produce a pound of fish

P = Per pound price of feed

WA = Weight added from purchase seed to harvest size (harvest weight minus seed weight)

FCR = Feed Conversion Ratio

S = Percentage of fish surviving from seed to market size

To continue with our example, assume a feed cost (P) of $0.20 per pound, weight added (WA) of 1.25 pound (1.5 pound harvest size minus the .25 pound starting weight of fingerling), a feed conversion ratio (FCR) of 2.5 to 1 (2.5:1), and the 70% survival rate. Using Equation (2), the contribution of feed to the cost of producing a pound of hybrid striped bass to 1.5 pounds will be calculated as follows:

Example:

$$C_{feed} = \frac{.20 \times 1.25 \times 2.5}{1-[0.5 \times (1-.70)]}$$

$$= \frac{.625}{.85} = \$0.74$$

Tables 2a-2d have been generated using Equation (2) — they allow you to estimate feed cost per pound for producing harvestable fish of varying weights based on different combinations of feed conversion ratios (FCR) and survival. The row headings represent different feed costs, while column headings represent weight added (the difference between harvest weight and the original seed weight). Each table reflects a different feed conversion ratio and survival.

To use the table, estimate a food conversion ratio and survival rate — in our example, FCR = 2.5:1 and S = 70%; at a cost of $0.20 per pound of feed and weight added of 1.25 pounds, the cost contribution of feed per pound is $0.74.

Estimating Variable Costs

The estimate of major variable costs — seed and food — for producing a pound of fish is then the sum of the seed contribution (C_{seed}), $0.24, and feed contribution (C_{feed}), $ $0.74:

(3)

$$C_{variable} = C_{seed} + C_{feed}$$

In our example, the seed cost is $0.74 and the feed cost is $0.24; thus, the variable cost for producing a 1.5 pound fish is $0.98.

Example:

$$C_{variable} = .74 + .24 = \$0.98$$

(2a) 100% SURVIVAL
FCR = 1:1
Weight Added (lbs.)

Feed Cost Per lb.	0.75	1.00	1.25	1.50	1.75	2.00
	Cost per Pound					
$0.10	$0.08	$0.10	$0.13	$0.15	$0.18	$0.20
$0.15	$0.11	$0.15	$0.19	$0.23	$0.26	$0.30
$0.20	$0.15	$0.20	$0.25	$0.30	$0.35	$0.40
$0.25	$0.19	$0.25	$0.31	$0.38	$0.44	$0.50
$0.30	$0.23	$0.30	$0.38	$0.45	$0.53	$0.60

(2b) 90% SURVIVAL
FCR = 1.5:1
Weight Added (lbs.)

Feed Cost Per lb.	0.75	1.00	1.25	1.50	1.75	2.00
	Cost per Pound					
$0.10	$0.12	$0.16	$0.20	$0.24	$0.28	$0.32
$0.15	$0.18	$0.24	$0.30	$0.36	$0.41	$0.47
$0.20	$0.24	$0.32	$0.39	$0.47	$0.55	$0.63
$0.25	$0.30	$0.39	$0.49	$0.59	$0.69	$0.79
$0.30	$0.36	$0.47	$0.59	$0.71	$0.83	$0.95

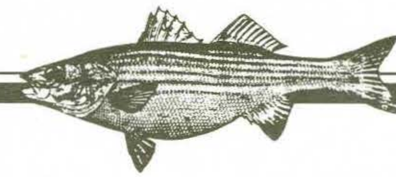
(2c) 80% SURVIVAL
FCR = 2:1
Weight Added (lbs.)

Feed Cost Per lb.	0.75	1.00	1.25	1.50	1.75	2.00
	Cost per Pound					
$0.10	$0.17	$0.22	$0.28	$0.33	$0.39	$0.44
$0.15	$0.25	$0.33	$0.42	$0.50	$0.58	$0.67
$0.20	$0.33	$0.44	$0.56	$0.67	$0.78	$0.89
$0.25	$0.42	$0.56	$0.69	$0.83	$0.97	$1.11
$0.30	$0.50	$0.67	$0.83	$1.00	$1.17	$1.33

(2d) 70% SURVIVAL
FCR = 2.5:1
Weight Added (lbs.)

Feed Cost Per lb.	0.75	1.00	1.25	1.50	1.75	2.00
	Cost per Pound					
$0.10	$0.22	$0.29	$0.37	$0.44	$0.51	$0.59
$0.15	$0.33	$0.44	$0.55	$0.66	$0.77	$0.88
$0.20	$0.44	$0.59	$0.74	$0.88	$1.03	$1.18
$0.25	$0.55	$0.74	$0.92	$1.10	$1.29	$1.47
$0.30	$0.66	$0.88	$01.10	$1.32	$1.54	$1.76

Tables 2a-2d. Effect of feed conversion and feed costs on cost of production.



Fixed Costs

Payroll

Aquaculturists will have to know whether they can afford to hire others, the salaries they can afford to pay others and pay themselves. You can figure how payroll expenses contribute to production costs by dividing the payroll expenses for the fish growing cycle by the expected pounds of production.

(4)

$$C_{payroll} = \frac{S_t}{F}$$

where

$C_{payroll}$ = Cost contribution of payroll to produce a pound of fish

S_t = Total salaries in a year

F = Estimate of total fish production in a year

If, for example, you expect to produce 30,000 pounds of fish and want to pay $20,000 a year in salaries, the cost per pound of fish, $C_{payroll}$, would be $0.67.

Example:

$$C_{payroll} = \frac{\$20,000}{30,000} = \$0.67$$

On the other hand, if you expect to produce 60,000 pounds of fish at the same salary, $C_{payroll}$ would be $0.33. Obviously, high payroll costs have to be spread out over large production to keep this contribution to unit output costs low.

Table 3 provides examples of the contribution of various payroll levels to production costs over different output levels.

Capital Costs

The difficulty in answering just how much capital investment is going to contribute to production costs is in determining what it will cost to put an aquaculture system together. You must determine the source of funds, the expense of obtaining them, and the time over which they must be paid back and depreciated. However, beginning with a rough idea of the total payments over the life of the facility, an approximation can be made of these contributions to output cost per unit.

For example, suppose you determine that it will cost $200,000, including interest payments for a given facility with an expected life of 15 years: the average annual expense is $200,000 divided by 15 years, or $13,333. The contribution to cost per pound of production is the average annual expense divided by the annual production amount:

(5)

$$C_{capital} = \frac{E}{A}$$

where

$C_{capital}$ = Capital cost per pound of production

E = Average annual expense of facility

A = Planned annual production

If $13,333 is the average annual expense of the facility and the planned annual production is 30,000 pounds, the cost contribution of capital expenses for producing a pound of fish will be calculated as follows:

Example:

$$C_{capital} = \frac{\$13,333}{30,333} = \$0.44$$

Table 4 enables you to do rough estimates of the contribution of capital costs per pound of fish based on the expected construction costs and the annual finfish production in pounds.

Estimating Fixed Costs

The estimate of major fixed costs — payroll and capital — for producing a pound of fish is then the sum of the payroll contribution ($C_{payroll}$) and capital contribution ($C_{capital}$):

(6)

$$C_{fixed} = C_{payroll} + C_{capital}$$

In our example, the payroll cost is $0.33 and the capital cost is $0.44; thus, the fixed cost for producing a 1.5 pound fish is $0.77.

Estimate of Total Costs

The total *estimated* cost for producing a pound of fish is the sum of the variable and fixed costs:

(7)

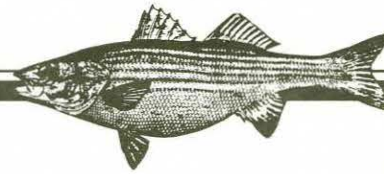
$$C_{total} = C_{variable} + C_{fixed}$$

For our example, the total cost for producing a 1.5 pound fish is $1.75.

Example:

$$C_{total} = \$0.98 + \$0.77 = \$1.75$$

Remember, this estimate of $1.75 for producing a 1.5 pound harvestable fish does not include additional costs such as energy, chemicals and maintenance. Estimates should be made of these expenses as well, and then added to the cost of seed, food, payroll, and capital costs to determine a per unit



cost of production. This estimate can then be compared with the expected price for the product.

In addition, be sure you understand the terms of that price. For example, you must know whether the price for a delivered product is based on its being headed, gutted and shipped in 50-pound boxes on ice. You will have to adjust your price or cost estimates to account for these additional costs.

If the expected price does exceed your production costs and delivery, then it is possible that your proposed aquaculture operation may be profitable. In that case, before investing any money you should then proceed with a full-scale business plan. The business plan will provide the detailed cost estimate and cash flow analysis you will need in order to calculate just what the return on your investment is likely to be.

	Pounds of Production (Thousands)						
	3	7.5	15	30	60	240	500
Payroll Charges	Cost per pound						
$10,000	$3.33	$1.33	$0.67	$0.33	$0.17	$0.04	$0.02
$20,000	$6.67	$2.67	$1.33	$0.67	$0.33	$0.08	$0.04
$30,000	$10.00	$4.00	$2.00	$1.00	$0.50	$0.13	$0.06
$40,000	$13.33	$5.33	$2.67	$1.33	$0.67	$0.17	$0.08
$50,000	$16.67	$6.67	$3.33	$1.67	$0.83	$0.21	$0.10
$60,000	$20.00	$8.00	$4.00	$2.00	$1.00	$0.25	$0.12
$70,000	$23.33	$9.33	$4.67	$2.33	$1.17	$0.29	$0.14
$80,000	$26.67	$10.67	$5.33	$2.67	$1.33	$0.33	$0.16
$100,000	$33.33	$13.33	$6.67	$3.33	$1.67	$0.42	$0.20
$150,000	$50.00	$20.00	$10.00	$5.00	$2.50	$0.63	$0.30

Table 3. Effect of spreading payroll costs (management & labor) over production.

	Pounds of Production (Thousands)						
	3	7.5	15	30	60	240	500
Capital & Construction Costs	Cost per pound						
$50,000	$1.11	$0.44	$0.22	$0.11	$0.06	$0.01	$0.01
$100,000	$2.22	$0.89	$0.44	$0.22	$0.11	$0.03	$0.01
$150,000	$3.33	$1.33	$0.67	$0.33	$0.17	$0.04	$0.02
$200,000	$4.44	$1.78	$0.89	$0.44	$0.22	$0.06	$0.03
$250,000	$5.56	$2.22	$1.11	$0.56	$0.28	$0.07	$0.03
$1,000,000	$22.22	$8.89	$4.44	$2.22	$1.11	$0.28	$0.13

Table 4. Effect of spreading construction and capital costs over production. (Amortized over 15 years)

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