VIII. MARKET FOR HARD CLAMS

Clams are generally marketed piece-rate, i.e., by count container, or individual clam, particularly for the premium-size category of littlenecks. The three market categories generally recognized are littlenecks, cherrystones and chowders. As pointed out below, littlenecks are the smallest-size category and command the highest prices. This clam is generally 1 3/4 - 2 1/2 inches (Brown and Folsom, 1983) measured by its largest shell dimension, though some states allow harvest based on different shell measurements. As the smallest size clam is the most valuable, the grower is only concerned with achieving minimum size clams to market as littlenecks, and not with larger size, less valuable clams.

Minimum sizes for harvesting are in Table 9. Note some differences in minimum-allowed harvest sizes from private (leased) beds compared to public beds (e.g., Florida). Discussion is underway in several states to exempt harvests off private, or culture, beds from minimum harvest size regulations. Obviously, it is in no grower's interest to harvest a size too small to market.

One of the problems in analyzing markets and recent clam harvests is that landings data report values in pounds of meat. These values result from harvest of all size clams and represent an average value for all three market categories. Thus, average landing values (for cultured and wild harvest) are less appropriate to the clam grower who markets only littlenecks. Because these data are all that exist, however, they are discussed below.

Products and Market Structure

Many clam products are distributed locally to restaurants and retail markets. The predominant product form for littlenecks is live (in shell). Chowders are largely marketed as shucked meat. Cherrystones are marketed both live (in shell) and as meats. As noted by Vondruska (1988), hard clams "... have the lowest percentage of landings converted into fresh and frozen shucked meats, 4-28 percent in 1975-84, because hard clams are marketed largely in the shell."

Brown and Folsom (1983) reported that from 1979-83, Fulton Market in New York marketed about 10 percent of total U.S. hard clam landings. Allowing for some sales through other wholesale markets, the bulk of hard clam landings are still marketed through distributors. A survey by Adams and Busby (1986) found that 76 percent of Florida's east coast 1985 hard clam harvest was distributed through wholesaler/distributors. Similar distribution probably occurs in the other large clam-producing state, North Carolina.

Potential investors should talk with clam and seafood dealers and distributors in their area. Culturists should also talk to producers about their marketing programs and production practices. Other producers can give valuable information about markets and services of local distributors.

Table 9. Minimum hard clam legal harvesting size for five South Atlantic states

<table>
<thead>
<tr>
<th>State</th>
<th>Wild Harvest</th>
<th>Culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>North Carolina</td>
<td>1&quot;</td>
<td>None</td>
</tr>
<tr>
<td>South Carolina</td>
<td>1&quot;</td>
<td>None</td>
</tr>
<tr>
<td>Georgia</td>
<td>1&quot;</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Florida</td>
<td>1&quot;</td>
<td>1&quot; within state</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7/8&quot; out of state</td>
</tr>
</tbody>
</table>

1 Effective early 1990. Discussions underway in several states for changes. For most recent size regulations, check with state's regulatory agency.
Potential investors considering marketing their own harvests should explore early local markets such as retail establishments and restaurants. Do not overlook the costs of marketing and distribution if you decide to "do it yourself." These costs can be significant, particularly when individual customers purchase relatively small quantities.

Between 1979 and 1986, U.S. hard clam landings have fluctuated between about 12 million pounds (meat weight) and 18 million pounds (Fig. 10). Landings have declined to a range of 11-12 million pounds in the 1986-88 period. Landings appear to have become more variable from the mid-1970s to the present, compared with those in 1960 through the mid-1970s (see Table 10). During this earlier period, landings were relatively stable at 14-16 million pounds per year. Also note in Table 10 that landings of both ocean quahogs and surf-clam meats have exceeded those of hard clams since 1977 (surf-clam landings have historically exceeded hard clam landings). Imports of various clams and clam products have increased significantly since the mid-to-late 1970s, but comprise only about 10 percent of total supplies in 1986-88.

Potential

Assessing the potential for expanded clam culture is somewhat risky, as investors know. Aside from production risks associated with water quality, predation and potential diseases, projecting long-term prices is itself uncertain at best. There are factors, however, that influence expected future prices, discussed below.

First, and perhaps most important, are the potential effects on prices from increases in production. Increased production may originate from increased culture and growout on leased bottom, from increased depuration of clams grown on polluted, public bottom, and perhaps from stock-augmenting state agency management of public bottoms. Predicting the future supplies of each is again risky business, but we can speculate.

Future supplies of clams may be increased from depuration, holding of shellfish in clean water to allow bacteria purging and other pollutants. However, depuration requires extra handling, whether done on shore, or "relay"ed to cleaner water in bays before harvesting. Some price advantage for depurated clams or regulation may result in more depuration in the future. This increased quantity of clams could have future price effects, but we do not know the level of these potential quantities. However, larger scale relay or shore depuration would result in significantly higher production costs. While we might expect some increase in the near future in South Atlantic supplies of hard clams from depuration, it is unclear just how large they will be.

Growout on leased bottom does serve a storage/speculative function as well as a production function (Agnello and Donelley, 1975; Easley, 1982). This advantage is not generally available to the fishermen harvesting from public bottom due to the open access/common property nature of the fishery. Given significant price fluctuations through any given year (discussed later), this advantage may be important, since clams can be held in protected natural conditions until prices are favorable.

As production grows, what are the likely consequences on prices for clam producers? While this question cannot be definitively answered with the existing knowledge of clam markets and data, there are several studies that bear on the question. First, evidence suggests that marketing Florida clams to northeastern markets enhanced harvesters' prices in 1978-85 (Adams and Busby, 1986). Given the relatively high-valued product, it is not surprising that shipments occur across states and regions in response to higher prices.

The characteristics of the demand for hard clams largely determines price effects from increased production. Brown and Folsom (1983) estimated that the wholesale price of littlenecks would fall by .56 percent if landings increased by 1 percent, holding other factors constant, such as income. With this estimated effect, gross revenues to the industry would increase with small increases in output. However, since it is not known how costs respond, it is difficult to predict the effect on industry net revenue. It does appear reasonable to speculate that expansion in culturing output could be accomplished at relatively constant marginal costs. This may not be true of increased output from naturally-occurring wild stocks.

North Carolina hard clam producers were found to be "price takers" relative to the U.S. market during 1960-82 (Hsiao, Johnson and Easley, 1986). North Carolina quantities landed did not exert the expected negative effect on the state's
Figure 10. U.S. Landings of Hard Clams

Quantity (Million pounds meat)

1960 - 1988
<table>
<thead>
<tr>
<th>Year</th>
<th>Beginning Clams</th>
<th>Apparent Consumption</th>
<th>Exports &amp; Other</th>
<th>Total Stocks</th>
<th>Canada (pounds)</th>
<th>U.S. (pounds)</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>1986</td>
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<td>72</td>
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<tr>
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<tr>
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<td>72</td>
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<td>72</td>
<td>72</td>
<td>9,383</td>
<td>9,383</td>
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</tbody>
</table>

**Source:** NMFSP, Fishery Statistics of the United States, Provisions of Fishery Products, Imports and Exports of Fishery Products and Fisheries of the United States. Imports converted to meat weight using the following factors: 0.40, shell or shucked; 0.53, canned clams; 0.80, canned chowder or juice. Landings for 1978 onward subject to revision.

**NOTE:** Reproduced from Votava (1989).
Investing in Commercial Hard Clam Culture

prices. Changes in hard clam landings in other states did negatively affect North Carolina prices, and to a lesser degree, so did landings of soft and surf clams (possible substitutes). North Carolina price was estimated to rise 1.13 percent in response to a 1 percent decrease in other states' hard clam landings.

These studies, as expected, suggest a negative effect on price for increased clam landings. However, both Brown and Folsom (1983) and Hsiao, Johnson and Easley (1986) found large positive effects on price for income increases. Over time as income increases, the demand for clams increases, resulting in higher prices. Hsiao, Johnson and Easley (1986), for example, found that North Carolina prices were bid up by 3.36 percent for a 1 percent increase in U.S. real per capita income. Thus, even if increased production reduces prices in the short run, increased income over time more than offsets this through a demand increase. Future prices may largely depend upon the relative sizes of these two opposing effects.

Observations on early growers' experiences suggest that growth in demand has been at least as great as growth in supplies. Some producers are contracting for prices year round that may exceed wild-harvest prices much of the year. Consistency in supplies and high-quality products appear to be motivations behind buyers in such contracts.

Clams are now being marketed in new areas. Markets have historically been the eastern coastal states. Future efforts to expand beyond traditional markets suggest that larger quantities (exact level not known) can be marketed without adverse price effects.

Another factor that will affect long-run profitability in the industry as quantities produced (and consumed) expand is the cost at which growout firms can be replicated. If this cost is fairly constant, long-run real prices may not increase a condition similar to what occurred in the catfish industry. However, if new entrants enter the industry with successively higher costs, early entrants may well earn above-normal returns.

Recent U.S. Prices

Clams are marketed by size, with the smallest market-size clams commanding the highest prices. Size categories according to Brown and Folsom (1983) are decided by the clam's largest dimension, and are: littlenecks, 1 3/4 - 2 1/2 inches; cherrystones, 2 1/2 - 3 inches; and chowders, over 3 inches.\(^1\) Average wholesale prices at New York for 1988 for a bushel of live clams by size were: littlenecks,\(^2\) $104.52; cherrystones, $31.75; and chowders, $16.82. Such a price structure reflects consumer size preference, and supplies by size classes. Much stronger preference for the small clam is of obvious importance to the culturist, as growout time to the littleneck size is much shorter than for the larger classes.

Figure 11 presents recent wholesale prices for littlenecks and cherrystones.\(^3\) Several points are worth noting. First, there is significant variability in wholesale prices through the year, with major peaks occurring each winter. This may be due to some seasonality in demand, but is also affected by reduced supplies from northeastern states during the winter months (Brown and Folsom, 1983). South Atlantic producers with small acreages may take advantage of these large variations by timing harvests during periods of higher price. Larger producers, however, may have to harvest year-round and are less able to fit production to periods of high prices.

Other points worth noting from Figure 11 are

---

\(^1\) Florida uses even larger numbers of size classes, with three categories within the littleneck, (personal communication, Mr. Stu Kennedy, Florida DNR), including littleneck, middleneck, and toplneck. Other Florida grades are cherrystone, chowder and ungraded, employed in pricing harvests at the vessel level.

\(^2\) Littlenecks are 480 count per bushel.

\(^3\) Prices by these size categories are not available at the vessel (or fisherman) level. State-level prices (presented later) represent a blend price for all sizes harvested. They not only reflect higher-level market prices, but also differences in the proportion of harvests made up of the different size classes. Thus vessel-level prices may not provide potential investors with as much information as wholesale littleneck prices adjusted for mark-ups and transportation costs from the reader's region.
Figure 11. Monthly Wholesale Prices of Live Clams in New York, 1983 - 1988

Prices are dollars per bushel

that prices of the different-size clams tend to move together, perhaps reflecting the fact that all size classes are harvested simultaneously from public waters and may be substitutes in consumption.

There also appears to be an upward trend in prices during the six-year period beginning in 1983. These are nominal prices, however, and reflect general inflationary forces as well as changes in clam-market forces. Figure 12 presents deflated wholesale prices (deflated by the producer price index for finished consumer goods) for live clams. Real prices for littlenecks have increased significantly over time, particularly from the mid-1960s through the early 1970s, the late 1970s, and 1985-87.

Hard clam prices in recent years have risen significantly relative to other shellfish. Table 11 presents recent exvessel price indexes for hard clams and total edible shellfish (which also includes clams). Note that average prices for 1989 for hard clams are 45 percent higher than in the base year of 1982. The final column in Table 11 shows the ratio of the hard clam index to the total edible shellfish index. This ratio of indexes shows that hard clam exvessel prices have risen relative to shellfish in general. The probable explanation for this is that the demand for hard clams has been increasing more rapidly than has the demand for all shellfish.

### Historical Price Overview by State

While landings of hard clams were relatively stable during the 1960s and early 1970s, they have been lower in the late 1980s (Table 10). Regional landings for Virginia through Florida, on the other hand, have increased from about 1.5 million pounds of meat in the mid-1970s, to 3.5 to 4.0 million pounds in the mid-to-late 1980s. Table 12 presents landings by state for the region. U.S. landings have gone down since the late 1960s-early 1970s and South Atlantic landings have risen. The share of total U.S. landings accounted for by South Atlantic landings has increased significantly. Regional landings accounted for about 10 percent of total U.S. landings in 1975-76, and had increased to just over 30 percent in 1986-87 (see Table 12).

Increased landings have resulted in large part from increased clam prices. Higher prices may be due to several factors, including population and income growth in the region and stable-to-downward landings elsewhere in the country.

Figures 13-17 present nominal (current dollar) and real prices (adjusted to remove general inflationary effects) for 1973-88. Note large increases in the real, or adjusted, prices from 1976-78, and 1985-87. Both these periods coincided with reduced landings in other regions. Real prices fell in Virginia, North Carolina and South Carolina from 1980-81. This may be due to a relatively large

### Table 11. Indexes of exvessel prices for hard clams and total edible shellfish, 1980-89.

(1982 = 100)

<table>
<thead>
<tr>
<th>Year</th>
<th>Hard Clams</th>
<th>Total Edible Shellfish</th>
<th>Hard Clams x 100 Total Edible Shellfish</th>
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<td>79</td>
<td>68</td>
<td>116</td>
</tr>
<tr>
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<td>85</td>
<td>78</td>
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<td>1989</td>
<td>145</td>
<td>108</td>
<td>134</td>
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</table>

Figure 12. Real Wholesale Prices of Live Clams in New York, 1960 - 1988

(1987 Dollars per bushel)


<table>
<thead>
<tr>
<th>Year</th>
<th>Virginia</th>
<th>North Carolina</th>
<th>South Carolina</th>
<th>Georgia</th>
<th>Florida</th>
<th>Total</th>
<th>Share of U.S.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Thousand pounds of meat</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Percent</td>
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<td>272</td>
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<td>3,267</td>
<td>26.4</td>
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</table>

Source: Various state fishery statistical programs.

increase in U.S. landings in 1981. Real prices also fell in several South Atlantic states from 1987-88.

Some care should be exercised in interpreting changes in vessel-level prices by state. These prices represent composite or average prices across the size classes harvested. As noted earlier, there are very large price differences between littlenecks and chowders, for example. Thus, a year-to-year change in average clam prices for a state may reflect real market forces at work, or reflect a change in the composition of landings. For example, an increase in price from one year to the next might be explained by an increase in the share of landings of smaller and higher-priced clams, with no change in overall market demand.

Similarly, variation in annual prices across states may be due largely to changes in the size composition of landings. A good example of this effect may be the comparison of Virginia and North Carolina prices. Real prices are reasonably similar from 1973-77, with Virginia prices higher in three of the five years. But since 1978, North Carolina prices have exceeded those in Virginia by a significant margin. The Virginia industry includes soup/chowder producing plants, which may prefer the larger and lower-priced chowders, whereas the North Carolina industry does not include such plants. Thus, marketing related to different sizes and prices of clams influences average or composite vessel-level prices.

Seasonal Price Variation

Price variation through a year (or seasonal variation) is important to the timing of harvest by a lease-holder unless the grower is selling at a contracted price. As noted earlier, the lease provides growers the opportunity to time their harvests for higher prices, because they have property rights to the clams and control access (unlike the fisherman who harvests off public bottom). Also noted earlier, there is significant variability in wholesale prices through the year (recall Figures 11 and 12). Much of the wholesale price variability is translated into vessel-level price variability.

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Figures 18-20 contain monthly vessel-level prices for two recent years for Virginia, North Carolina, and Florida, the three largest clam-producing states along the South Atlantic. Note that those shown for Florida are for the East Coast which accounts for 90 percent or more of the state's landings.

The major reason for presenting these prices is to illustrate some of the variability from month to month and through the year. Note that there is little consistency in monthly price patterns among the years presented. However, given the variability, the clam producer will want to pay close attention to local prices in timing harvests, especially in states that have important wild harvests.
Figure 18. Monthly Clam Prices for Virginia
1987 and 1988

Price
($ per lb. Meat)
Figure 19. Monthly Clam Prices for North Carolina 1987 and 1988

Price
($ per lb. Meat)
Figure 20. Monthly Clam Prices for Florida East Coast
1984 and 1985

Price
($ per lb. Meat)
IX. FINANCING THE CLAM CULTURE VENTURE

Obtaining capital for clam culture can be a formidable task for current and prospective culturists. Major problems are the perceived high risk and high investment and low return on investment associated with clam culture.

Individuals considering commercial hard clam culture should be financially sound because the capital investment can be higher than for most other agricultural or aquacultural enterprises. Prospective producers should not start hard clam production undercapitalized or unsure of funding sources. Unexpected cash flow or capital equipment needs may cause failure.

Most lenders are unfamiliar with hard clam farming and will have made very few loans to clam culturists. In areas where hard clam culture is unproven or a successful track record has not yet been established, lenders are usually cautious with new operations and financing may be difficult to obtain. The clam culturist should educate the lender about production, financial and marketing factors.

Lending criteria and requirements for aquaculture credit are generally varied. Profits and return on investment, while important, are not the only criteria that influence the decision-making process. Aquaculture and individual risks are also considered. Other factors include the borrower's character, repayment capacity, collateral and equity capital, as well as the nature of the enterprise.

The prospective borrower should have adequate collateral for the loan requested. The borrower must provide current accurate financial statements and supporting records, professionally prepared. A balance sheet, with supporting schedules and inventories, is essential. A projected income statement and a projected cash flow for the business are needed. A five-to-ten-year projected cash flow period may be required. Use realistic figures that represent average values rather than inflated figures unlikely to be obtained. The financial analysis should reflect the specific farm situation. The borrower must provide a marketing plan explaining to whom, at what price, and how the hard clams will be marketed. Letters of reference from professionals or seafood brokers or other

market customers supporting the business can be helpful. Any actual experience producing hard clams commercially or participation in hard clam culture educational programs should be noted. The character of the principals in the business is of major interest to the lender. The producer must be willing to keep records, inform, listen to and work with the lender.

Once credit is obtained, properly managing it becomes a major challenge. Three basic financial statements - balance sheet, income statement and cash flow statement - are used to monitor the financial strength of your business. A successful business must exhibit strength in repayment ability and capacity, liquidity and solvency, profitability and financial efficiency.

Credit is available for hard clam culture from a variety of sources and for a variety of purposes including farm ownership and facility construction and for operating or producing the hard clam. A loan may be a direct, insured loan or a guaranteed loan. Sources of credit for aquaculture include:

1) Farm Credit System (funds typically used for operating loans, to purchase or improve real estate or refinance debt),

2) Bank for Cooperatives (loans to agricultural and agribusiness cooperatives)

3) Commercial banks (operating, non-real estate and real estate loans)

4) Farmers Home Administration (farm operation and ownership, limited resource, economic emergency, business and industrial)

5) Small Business Administration (guaranteed and direct loans)

6) Life insurance companies (first mortgage real estate loans)

7) Savings and loans associations (first mortgage real estate loans)

8) Merchants and dealers (agribusiness firms provide credit to purchase inputs and equipment)

9) Individuals (real estate purchases and operating loans)
10) Venture capitalists and equity capitalists (venture financing for growth companies)

11) Private companies/consulting firms (private agricultural and agribusiness companies and consulting firms are providing technical services and loans for emerging companies)

12) State assistance programs (credit for new aquaculture enterprises)
X. DEVELOPING A CLAM CULTURE BUSINESS PROPOSAL

Developing a clam culture business proposal can be difficult. For culturists searching for start-up capital or simply organizing their approach to a new venture, proposal preparation can be tedious and cumbersome. Many areas of business expertise are required to properly organize a proposal so that a particular idea may be evaluated and acted upon. For the greatest chance of success, a logical, conscientious effort from idea to proposal should be used.

Readying a proposal for presentation to a financial institution requires several steps:

1) An idea becomes the business desire of the principal(s).

2) Idea is converted into long- and short-term goals.

3) Goals lead to the formation of a basic plan of action to be analyzed, producing various alternatives for goal attainment.

4) Decision is made for the best alternative depending on the principal's(s') particular circumstances.

5) Financing proposal is written with an organized purpose and logical plan of action.

Long- and short-term goals set the direction by which the culture venture can become a reality. Long-term goals are accomplished over several business cycles, while short-term goals create a path to the attainment of the former, and are accomplished in a shorter time period.

An example of long- and short-term goals for a clam farmer may be:

Long-term goal number 1: Hard Clam Inc. proposes to own and operate a commercial hard clam growout operation.

Short-term goals:

1. Site research and selection by July 1.

2. Analysis of alternate growout systems by August 1.

3. Selection and design of growout system by October 1.

4. Seek financing for operation by February 1.

5. Startup activities by June 1.


Long-term goal number 2: This operation is to pay back the initial investment within seven years after operation begins.

Short-term goals:

1. First three operational years, 20% paid back.

2. Fourth year, 40% paid back.

3. Sixth year, 80% paid back.

Long-term goal number 3: The owner-operator would like to make a salary of $45,000 per year.

Short-term goal:

1. Same as long-term goal.

Once goals are set, a basic plan, including alternatives, is developed. All alternatives should be evaluated using criteria developed from the goals. The analysis of the alternatives should be consistent for comparisons ("apples to apples") and should produce one or two "best" plans. Types of alternatives are highly dependent on the nature of the culture activity (i.e., location, scale, level of integration, technology).

After identifying various alternatives, set criteria by which they can be compared. Because most goals are financially oriented, one set of criteria is financial statements (other criteria, such as production goals, should also be considered). Pro forma financial statements include cash flow, income statement, balance sheet, and the statement of changes in financial position. Specific criteria, such as internal rate of return, payback period, and financial ratios, can be adopted from these statements. These criteria can then be used by the
principal(s) to select one or two "best" plans from the alternatives.

General environmental and industrial factors, which are external to, but nonetheless impact on, the proposal, must also be considered. The general environment can be viewed through cultural, economic, government, technology, and international issues. The industry can be examined by competitive forces affecting market performance.

The following general outline is useful as a guide for the contents of the proposal. Specific sections and tables from this guide of use in preparing the business plan are shown in parentheses.

Title Page
Table of Contents
Statement of Purpose
Executive Summary
The Business
  Industry Status (I) - current status of the business and organization
  Operations (location, facilities, production cycle, permits) (III, IV, V, VI, VII)
  Market (VIII)
  Marketing (VIII)
  Competition and Risks (I, III, VIII)
  Management
  Personnel
  Research and Development
  Financing Arrangements and Ownership (IX)
  Development Schedule
Summary
Financial Plan (XI)
  Sources and Use of Funds (IX)
  Capital Equipment List (Tables 14, 18, 22, 26, 30, 34, 38, 42, 46, 47, 48, 49, 54)
  Break-even Analysis (Tables 58, 59, 60)
  Pro Forma Balance Sheet
  Pro Forma Income Statement (Tables 17, 21, 25, 30, 33, 41, 45, 53, 57)
  Pro Forma Cash Flow (Tables 16, 20, 24, 28, 32, 36, 40, 44, 52, 56)
  Historical Financial Statements
  Equity Capitalization (Tables 16, 20, 24, 28, 32, 36, 40, 44, 52, 56)
  Debt Capitalization
Supporting Documents
XI. FINANCIAL FEASIBILITY ANALYSIS FOR HARD CLAM CULTURE SYSTEMS

Introduction

Interest in the culture of hard clams has caused the development of technology resulting in a variety of hatchery, nursery, and growout systems. Understanding the differences in these is important to a potential hard clam culture investor. Further, a potential investor wants to understand how the economic performance of each technology differs. Current clam culturists may also increase the efficiency of existing production systems using this information. The following discussion focuses on the systems' economic and financial characteristics.

Baseline Assumptions

A wide variety of production systems are currently used for hard clam culture in the South Atlantic region. This analysis attempts to emphasize those systems recognized as especially technologically and financially promising. Therefore, only a select set of hatchery, nursery, and growout methods are examined, with respective harvest capacities, as follows:

- Hatchery: Milford method (24 million)
- Nursery: Upflow method (12 million)
  Raceway system (1 million)
  Raceway system (12 million)
  Field-tray method (12 million)
- Growout: Pens (1 million)
  Soft trays (1 million)
  Bottom nets (1 million)

Each method is examined independently. In addition, two integrated systems (i.e. hatchery, nursery, and growout) are assessed. These integrated systems include specific combined technologies (at a harvest capacity of six million each) and are described as follows:

- Milford hatchery
  Upflow nursery
  Pens

- Milford hatchery
  Upflow nursery
  Soft trays

Each system is assessed under a specific set of descriptive, operational, and financial baseline assumptions. These assumptions will be covered before discussing each respective system. A more general set of assumptions applying to the overall analysis follows:

Production

- All hatchery and nursery systems are in production only six months of each year.
- Planting occurs yearly with increasing acreage seeded until year three. First harvest is in year three and each year thereafter.
- Mortality is assumed to be 50 percent at each production level, with the exception of the field-tray nursery (refer to that section).
- Growout systems are stocked at a density of 100 seed clams per square foot.
- Growout harvest size is 45-50 mm (longest dimension of shell).
- Harvested clams are assumed to all be of a given size (i.e. growout systems produce only littlenecks).
- Operation size will be measured in terms of annual output goals from the growout stage of the operation. Excess capacity has been built into the hatchery and nursery stages of the operation for system expansion and sale of seed. Annual production goals from each stage of the operation are shown below:

Production Schedule (Millions of Clams)

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<tr>
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</tbody>
</table>

53
Financial

- Harvest volumes, revenues, and operational expenses for each system are assumed to be constant across years (costs and prices are for 1990).

- All loans (i.e., capital and operational) are at 12 percent.

- Capital loans are for 10 years.

- Initial start-up capital loans assume 65 percent of cost financed (i.e., 35 percent owner financed). Capital asset loans required for capital replacement assume 100 percent borrowed capital.

- Owner equity is defined as the sum of owner financing (i.e., 35 percent initial capital requirements) and any start-up costs, which may include permitting fees, legal costs, consultant fees, survey costs, etc.

- The opportunity cost of owner equity (i.e., the next best investment alternative) is defined to be a 12 percent annual rate.

- Capital assets are depreciated using the straight-line method. Salvage value is zero for all capital assets.

- An operating loan covers all cash shortfall (zero minimum cash balance).

- Each system is managed by an owner-operator, whose cost of management skills is not included. Therefore, final returns are to owner-operator's management and risk. Additional labor requirements for each system are presented later.

- Returns are before taxes (i.e., state and federal income and property tax). This is necessitated due to the variability in applicable income and property tax rates.

- Because of the extreme variability in cost likely encountered for acquiring waterfront property within the South Atlantic Region, the cost of land has not been included in the analysis.

- The discount rate for net present-value computations is 15 percent.

- The stream of values used for the internal rate of return and net present value computations is the "ending cash balance" contained in the cash flows.

Other

Pomeroy and Manzi (1990) served as the basis for some of the assumptions regarding the computation of labor and salaried benefits, repair and maintenance costs and derivation of certain other production, salary and wages, and overhead costs. These include:

- Annual maintenance costs for pens, nets, and trays are assumed to be 5 percent of total initial investment. These costs may be higher in different locations under different conditions.

- Annual maintenance costs for trucks, boats, trailers and motors are assumed to be 10 percent of total initial investment.

- Electricity costs for pumps are computed on the basis of 24-hour pump use at a given horsepower rating, where one KWH = one HP @ $0.063 per KWH.

- Labor was included at $5.00 per hour, given a six-day week (i.e. 48 hrs.).

- General manager salary is assumed to be $32,000 per year.

- Technician salary is assumed to be $16,000 per year.

- Benefits on hourly labor and salaried personnel are computed as 10 and 13.5 percent, respectively, of the total annual charge.

- Miscellaneous costs are included to cover other minor costs and are assumed to be 3 percent of operating costs. This value includes annual lease fees, which may be a negligible cost on a per-acre basis.

Financial Statements

The financial statements used in this analysis
include a statement of operational expenses, initial capital investment requirements, capital asset addition schedule, annual cash flow (10 years), and an income statement (year five). These financial statements are presented for the hatchery, each nursery, and each growout system, as well as for the two integrated systems. In addition, enterprise budgets for year five are presented for each of the standalone growout systems.

A reference guide useful in locating the financial analyses for each system is provided in the Appendix in Table 13 along with all the financial analysis tables. This table cross-references the financial analysis tables with the production system of interest. Also, a brief description of the kinds of financial information contained within each table is provided.

Finally, several terms are used repeatedly in the discussion of the financial analyses. Brief definitions of each of these terms are below (Beierlein, Schneeberger and Osburn, 1986):

- **Opportunity cost**—what the owner could have earned with the available equity in the next best investment alternative.

- **Net present value (NPV)**—the difference between the current value of an investment’s annual incomes and the current value of annual costs.

- **Internal rate of return (IRR)**—the discount rate that makes the current value of annual incomes equal to the current value of annual costs. Projects that have an internal rate of return greater than the opportunity cost of an investment will have a positive net present value.

**Hatchery System**

The hatchery system employs the Milford method for producing required seed quantities. The system is designed to produce 24 million seeds of one mm size. The facility is assumed to be in operation six months per year. The total “annual” production quantity is, therefore, 24 million seeds.

The capital investment requirement for start-up is significant. Total initial investment required shown in Table 14 is $242,474. (Recall that only 65 percent of this total will actually be financed through a lending institution.) The most costly individual items are the required building, support lab, and heat exchanger. The building may have to meet FEMA flood zone standards. If this is the case it may result in higher construction costs. Pumps, seawater transmission systems, and water treatment systems also represent a major component. The system also requires investment in equipment for brood-stock maintenance, algal culture, larval culture, and post-set maintenance. Timely reinvestment in some of these and other capital items dictates a constant debt burden. Approximately one-half acre of shore-side property is required, the cost of which is not included in the analysis.

A major production-cost category is utilities (Table 15). The requirement for water movement necessitates using many pumps, resulting in a large utility cost for these pumps. Instead of purchasing algae, this proposed system is assumed to produce all needed algae. For the sake of simplicity, however, all algal production costs are lumped into one production cost category (Pomeroy and Manzi, 1990). Algal costs for brood-stock maintenance and larval culture represents another major expense, as do general supplies and heat exchanger costs. Labor costs are the single largest operational expense. The system is assumed to require two full-time technicians and a general manager (one-half year each). Total annual operating expense (the sum of production costs, salaries and wages, and overhead costs) is $70,751.

The anticipated selling price for one mm seed is assumed to be $0.003 each. Therefore, annual revenue for the system is $72,000. Given the assumptions regarding initial investment, reinvestment needs, magnitude of operating expenses and production capacity, the system remains in a negative cash flow position over the entire 10-year planning horizon (Table 16). The inability of the system to generate a positive cash-available value necessitates an operating-loan to be advanced each year. However, since the cash available position remains negative, the operating-loan debt cannot be retired and the operating loan interest accumulates. The income statement for year five further demonstrates the inability of the system to produce a positive net return, particularly when non-cash expenses such as depreciation and the opportunity cost of owner capital are considered (Table 17).

**Nursery Systems**

Three nursery methodologies are examined in this report: upflow, raceway, and field tray. All
nursery systems are assumed to be in production for only six months per year. Labor and salaried workers are included on a full-time basis, but only for six months per year. In addition, all nursery systems require one-half acre of shore-side property, whose cost is not included in the analysis.

Upflow Method

The upflow nursery uses a combined forced/passive upweller system. The operation is assumed to purchase one mm seed from a hatchery and grow the seed to eight mm. Annual production capacity is 12 million seeds. Given that assumed mortality is 50 percent, the annual purchase of 24 million one mm seed is required.

The major capital investment requirements for the upflow nursery include the passive-flow systems, pumps, building and pad (Table 18). In addition, a small dock and pump house are needed to place the required pumps over water. The total initial investment for the system at the stated capacity is $171,150. A major reinvestment every three years is required for the main pumps. Replacement of other capital equipment within the first 10 years is also required.

The acquisition of seed clams represents the largest share of the total operating expenses (Table 19). Given the 50 percent mortality rate, 24 million seed clams one mm in size must be purchased at $0.003 each at a total cost of $72,000. Electricity for pumps, as well as labor and salary, represent other major operational costs. Additional personnel (other than the owner/operator) are assumed to be one laborer and technician. Note that interest payments on an operating loan are paid for years one and two. These payments reflect an operating loan taken within each of the first two years to cover preproduction costs. The loans are phased out over the two-year period. These interest payments are included as operational expenses. Annual operational expenses total $102,097 for year three and beyond.

The system generates an annual revenue of $240,000, resulting from the sale of 12 million seed clams (8 mm) at an anticipated price of $0.02 each. Given the assumed magnitude of operational expenses and debt retirement obligations, a positive cash flow results beginning with year one and through the 10-year planning horizon (Table 20). With the ability to produce a positive value for available cash at the end of each year, no operational loan is required. NPV for the upflow system is $2.3 million, while IRR is 121 percent. The income statement for year five indicates a favorable net-earnings ability under the given set of assumptions (Table 21). After accounting for non-cash depreciation "charges" of $28,057, the net returns for year five total $97,586. However, when the opportunity costs of investing the owner's initial equity elsewhere is considered, net returns fall to $90,398.

Field Tray

Initial capital investment requirements for the field-tray system are substantially less than those for the upflow system (Table 22). Whereas capital expenditures for the upflow system were for shore-side facilities (without accounting for the cost of land), the majority of the capital expenses for the field tray are boats for tray maintenance and harvesting on the bottom lease. Major capital requirements include the trays (2.5' x 4'), barge/shaker, and dock. The barge must be big enough to accommodate temporary storage of trays and gravel/sand, as well as have enough deck space for a mechanical shaker for sorting. The dock must be large enough for movement of trays and equipment on and off the barge during harvesting, including a front-end loader to move gravel/sand from on-shore storage sites. A total of 550 trays are required for stocking the initial 24 million seed. Initial investment requirements are $80,250. Significant capital replacement is also required for the boat, motor, and trailer needed to tend the trays in the field.

The operational expenses for the field-tray system are approximately twice as large as those estimated for the upflow system (Table 23). Differences include costs of operation and maintenance of the barge, boat, and motors, as well as additional labor for tending and harvesting the trays. The system is assumed to require three full-time laborers and a technician for six months, in addition to the owner-operator. However, the major operational expense is the cost of seed-clam acquisition. Instead of stocking one mm seed in shore-side upwellers for the upflow nursery, the field-tray system is assumed to stock three mm seed. However, because the seed is stocked at a larger size, anticipated mortality is reduced to only 25 percent. Therefore, only 16 million seed clams are required for the target output of 12 million clams. The price for three mm seed clams is assumed to be $0.01
each, annually totaling $160,000. Total annual operating expenses are estimated at $206,525 for year three and beyond.

The field-tray system is assumed to produce 12 million seed clams. The seed clams are larger (15 mm) than those produced by the upflow system, as they are stocked in the trays at a larger beginning size. The anticipated price for the 15 mm seed clams is $0.03 each, resulting in an annual total revenue of $360,000. Given the assumptions regarding operating expenses and debt retirement, this relatively large annual revenue produces a positive cash position for every year in the 10-year plan (Table 24). As with the upflow system, no operating loan is required. NPV for the field-tray system is approximately $3 million, while IRR is estimated to be 23.8 percent. The income statement for year five further indicates a positive net return after depreciation and opportunity costs of $133,138 (Table 25). This high IRR reflects "favorable" conditions resulting from the set of base assumptions. The result of less-than-favorable conditions is discussed later.

Raceway (one million seed output)

The raceway system consists of four-tier wooden racks, with each tier consisting of a 4' x 20' raceway about six inches deep. Water is pumped shore-side through main PVC pipes from pumps in a pump house on a small catwalk over the water. The water is distributed to each four-tier rack and then further distributed via a PVC piping system to each raceway at a rate of 40 gpm. The effluent is channeled through PVC pipes down from each raceway to a small aluminum culvert for drainage back to the water source. The raceways are stocked with about 1,000 seed clams per square foot.

Initial capital investment for this relatively small-scale facility is $27,200 (Table 26). The largest capital expenditures are for the wooden-rack systems, a truck and the PVC seawater system. Trays and racks are assumed to have a six-year life. Therefore, replacement costs associated with the wooden racks, as well as a new truck, are major items.

The raceways are stocked with 2 million one mm seed clams. At $0.003 each, seed-clam acquisition is the major operational expense (Table 27). Others include electricity for pumps and fuel for the truck. No labor cost is charged since the owner/operator is assumed to supply the system's manpower. Total annual operating expense is $11,395 in year three and beyond.

A positive cash position is achieved for every year in the planning horizon (Table 28). No operating loan is required, because sufficient cash is generated to cover operational expenses and retire long-term debt obligations. NPV for the raceway system is $69,768, while IRR is about 48.8 percent. The values reflect the assumed favorable conditions. The income statement indicates a net return of $2,078, after depreciation (Table 29). Again, recall that this represents returns to owner/operator capital, management, and risk. Accounting for opportunity costs (i.e. subtracting from net returns what the owner/operator could earn in the "next best" investment alternative) results in a true economic loss of only $28.

Raceway (12-million-seed output)

The 12-million-seed output raceway is simply a scaled-up version of the previously discussed system. Note that the initial investment reflects virtually a linear scale-up from the smaller-size facility (Table 30). Total initial investment is $246,386. The major cost items are the wooden racks and pumps. In addition, the seawater transmission system, consisting of large quantities of various sizes of PVC pipe, valves, and "fittings" represents a sizeable investment. Due to continuous use in a seawater environment, the pumps are only given a three-year life, so capital replacement costs will be high.

In contrast to capital expenditures, operating expense increases do not represent a linear scale-up from the smaller raceway system. In fact, expenses increase by a larger order of magnitude than does output. The most important categories are electricity for the pumps, seed cost, and labor/wages (Table 31). Five 30-hp pumps (including one additional back-up) must run 24 hours a day to provide adequate water exchange, resulting in an annual utility cost of $40,824. Twenty-four million one mm seed are required for initial stocking. The anticipated price of these seed clams is $0.003 each, resulting in an annual seed cost of $72,000. Four full-time laborers and one technician are required for six months to properly maintain the raceways and constantly clean the seawater transmission system pipes, incurring $36,580 annually. Total annual
operating costs for the scaled-up version of the raceway system is $168,523 for year three and beyond.

The system will produce 12 million seed clams annually. The anticipated market price for 8 mm seed is $0.02 each. Thus, annual revenues are $240,000. Given assumptions regarding operating expenses, initial capital investment, and debt retirement, the system produces an ending cash balance of $33,021 in year one (Table 32). The system continues to produce a positive and increasing ending cash balance for the remainder of the planning horizon. Only an operating loan to cover preproduction costs is required. These positive results, however, can be misleading. Although the system produces a positive cash position for each year, annual net returns are somewhat less (Table 33). In fact, net returns in year five are estimated to be -$8,088 as compared to a cash available position of $178,728. This results from large non-cash cost recovery (depreciation) for capital replacement, particularly for pumps and the opportunity cost associated with the large initial owner-equity requirement. After accounting for these non-cash costs, the system produces negative true economic profit. This particular scaled-up raceway system may not be justified because it isn't profitable enough for its size, investment and capital replacement. NPV for the system is $419,472, while IRR is about 40.4 percent. The values reflect the favorable base assumptions.

Growout Systems

The analyses assume that the growout systems are stand-alone facilities, i.e. hatchery and nursery systems are not in the operation. Therefore, seed clams are purchased for stocking. The three systems analyzed include pens, bottom nets, and soft trays. For each system, the growout period is 24 to 36 months, with an average of 30 months. None of the growout systems receive income until their third year. Production is assumed to be 1 million clams which are 45-50 mm in size (little necks). The anticipated selling price for these is $0.17 each for unsorted clams. Thus, annual gross revenue for each system for year three and beyond is $170,000. Each system assumes plantings during years one, two and three to maintain constant production levels for year three and beyond. Because the pens, bottom nets, and soft trays will increase during years one, two and three, operating expenses will also rise during these years. For each system, two million 8 mm seed clams are purchased for stocking each year at $0.02 each, costing $40,000 annually. Seed-clam purchase is the largest single production cost for each of the growout systems. Boat/truck and growout system maintenance, fuel/oil for the boat and truck, and insurance represent other major production costs for each system. Annual operating expenses increase up to year three due to planting and harvesting more seed as production phases up to a consistent level. The following discussion focuses on year three when operating expenses will stabilize. Annual production for each system is one million clams. Note it is assumed only the owner/operator handles each system, therefore, no labor cost is in the analysis. Additional labor may be required during planting and harvesting. These potential costs are not included but should be noted. All net returns are to owner/operator management and risk. No shore-side facilities are required, except a suitable location to launch a small boat for site maintenance and harvesting. Each system requires a three-acre bottom lease. Security can be a potential problem in certain locations. The owner/manager should be aware security needs to be considered in the siting and management of the clam lease. Providing security can cause additional operational costs. These costs are not included in the following analysis.

Pens

Total investment cost for 115 pens to allow harvest of one million clams is $46,600 (Table 34). The major initial capital investment is for the ground plants or pens, which are 24' x 8' and made of a PVC frame with plastic mesh. Additional pens are purchased in years two and three for $27,600, to maintain a constant yearly production level. The pens have a useful life of six years. In addition, a boat, motor and trailer to manage the pens are required.

Annual operating expenses for year three and beyond total $47,720 (Table 35). Seed-clam purchase (two million eight mm seed clams at $0.02 each) is the largest single expense. Fuel and oil for truck and boat, as well as maintenance for the truck, boat, motor, and pens, represent another large cost.

The first harvest, and thus income for the operation, does not occur until year three. An operating loan is required to carry the operation during the first two years (Table 36). The receipts from harvest in year three are used to retire the
operating debt. Therefore, the first positive ending cash balance occurs in year four and for every remaining year in the planning horizon. The pen system generates NPV of $853,083 over the ten-year planning horizon, with IRR of 76.9 percent. These values reflect the favorable base assumptions. The income statement for year five indicates a net return of $99,045 after depreciation and opportunity cost of owner equity (Table 37).

**Bottom Nets**

Initial capital investment required for bottom nets is substantially less than pens (Table 38). Total capital outlay in the first year is $20,470. To achieve a constant annual level of production, a complement of nets is put into production during years two and three. The initial cost of bottom nets is substantially less than that for the pens, as the former are simply 30' x 8' reinforced plastic nets placed over the bottom and staked down. Twenty-five bottom nets are needed. The major capital investment is the boat, motor, trailer and truck. The nets are given a three-year life and therefore represent a significant replacement cost every year.

Operating costs for year three and beyond total $46,352. As for the pen system, the largest single cost is seed clams (Table 39). Fuel and oil for the boat and truck, as well as insurance and miscellaneous overhead costs, are also sizeable expenses. Repair and maintenance costs are reduced in comparison to the pens due to the nets' simple and inexpensive construction.

The operation produces a positive ending cash balance of $8,235 in year three, one year earlier than the pen system. This value remains positive and increases in remaining years in the planning horizon (Table 40). An operating loan is also used to cover costs incurred in years one and two, before revenue generation. The bottom-net system generates NPV of approximately $1.1 million, with IRR of 115.2 percent. These values reflect the favorable base assumptions. The net returns in year five total $114,570 (Table 41), significantly greater than the pen system. This is primarily due to reductions in operating costs and debt retirement.

**Soft Trays**

The initial capital investment required for the soft-tray system is $38,037, which is less than that required for the pen system, but more than for the bottom-net system. The major capital expense is for the 4' x 4' soft trays or bags made of plastic mesh (Table 42). A specific mesh size is required to grow the clams from 8 mm to 15 mm, while another is required to grow the clams from 15 mm to 50 mm. A total of 156 small and 1,250 large mesh bags is needed for this size operation. As for the other two growout systems, a constant level of production is attained by putting an additional complement of trays into production in year two and three. A boat, motor and trailer are required for tray maintenance and harvest. The trays are also given only a three-year life. The replacement of the trays, due to damage from handling and predators, result in a significant annual cost for year four and beyond.

Total operating expenses for the system are $47,250 in year three. As for the other two growout systems, the acquisition of seed for stocking is the largest single production cost (Table 43). Fuel, oil and maintenance costs represent additional significant production costs. The operating costs for the soft-tray system are only slightly exceeded by those of the pen system.

A positive ending cash balance occurs for years four and beyond (Table 44). Returns above the operating costs for year three are not enough to sufficiently retire the operating loans incurred during years one, two and three. Positive net cash flow improves during years four through ten. The soft-tray system produces a 10-year NPV of $876,261, with estimated IRR of 84.3 percent. These values reflect the favorable base assumptions. Returns above operating costs, debt, depreciation and opportunity cost for year five are $96,814 (Table 45).

**Integrated Systems**

The integrated systems include: a hatchery producing 24 million one mm seed clams, a land-based upflow nursery producing 12 million 8 mm seed clams, and either a pen or soft-tray growout system, each producing six million market size (45-50 mm) clams. When integrating these various systems, common use of some capital such as pumps, piping, trucks, buildings, etc. can be realized. The capital and operational costs of the hatchery and nursery systems in Tables 14 through 33 reflect the shared use of some of the required capital. The values presented in these tables describe the hatchery and nursery operations common to both integrated systems. It is assumed that all
seed clams produced in the hatchery and nursery are used for growout; therefore, no seed clams are for sale. The growout systems differ from those previously discussed in that production is scaled up to six million clams, rather than one million produced by the stand-alone systems. In addition, note that a cost for full-time security is provided. The specific form of protection against vandalism and poaching may vary. The cost included in this analysis covers a houseboat on location. Finally, although the hatchery is not profitable (at the scale used in this analysis), it is included. The hatchery provides a consistent source of seed stock for the nursery system, thereby insulating as much as possible the integrated system from fluctuations in availability, quality, inappropriate size, and price changes for seed clams. Each integrated system requires a three-quarter acre of shore-side property, with at minimum an 18-acre bottom lease.

It should be noted that total project costs may be increased by up to 10 percent due to additional startup costs such as permitting, legal fees and engineering consultation. These startup costs were not included in this analysis.

An additional cost category found for the integrated growout is for depuration, purging, or some form of market preparation. The volume of clams produced by the integrated pen system, and therefore the revenue generated, is assumed to justify the necessary expense for product quality and safety assurance (Otwell, Rodrick and Martin, 1990). In the future, this form of product handling may be required by state or federal agencies.

Integrated Hatchery/Nursery/Pen Growout System

The total capital investment cost of the integrated pen operation is $611,674. The hatchery comprises seven percent or $44,524 of this total (Table 46). The nursery is 15 percent or $93,150 (Table 47). Associated support facilities (building, seawater transmission system, water treatment) are 41 percent or $253,200 (Table 48), and the growout is 36 percent or $220,800 of the total (Table 49). The principal difference between the stand-alone hatchery and nursery systems and those for the integrated system is the seawater transmission system supplying both the hatchery and nursery systems. The ground plants (pens) make up the single largest investment cost in the growout operation.

The largest operational expenses in the integrated hatchery and nursery are labor and algae (Table 50). Total annual operating costs for the hatchery/nursery are $132,341. An additional full-time hourly laborer is required to operate and maintain the support facilities. Cost categories for the integrated pen growout differ from those for the stand-alone pen growout in that labor cost is included. The largest operating cost for the growout component is also labor (Table 51). Personnel requirements for the 6-million clams capacity growout system are one full-time technician and three full-time hourly laborers. Total operating costs for the growout system in year three and beyond are $56,300.

Similar to the stand-alone growout systems, the first harvest of market-sized clams occurs in year three, with the same level of production occurring for every year beyond year three (Table 52). Therefore, no income is received until the third year in the planning horizon. Annual revenues are $1,020,000, assuming a per-market-size clam price of $0.11. The actual price received for the market-sized clam may depend on a number of factors, some of which may be influenced by the seller. These include targeted market (i.e. retail, wholesale, broker, etc.), scale of operation, current market conditions, and others. For example, a small-scale operation may be at the mercy of a market dominated by a few large producers. However, a small-scale firm may be better able to engage in local, low valued, direct marketing to receive a more favorable price. Direct marketing, however, may erode management time and increase account receivable problems. Prices may also vary in time, such that forward contracting may be useful. The convenience of dealing with wholesale buyers alternatively, may result in a lower average price. The importance of developing a marketing strategy should be clear.

Operating loans are obtained in year one and two to cover cash flow needs. The operating loans are repaid by the fourth year. A positive ending cash balance is obtained by the integrated-pen system in the fourth year of operation. The 10-year NPV is estimated at $5.3 million, with IRR of 59.2 percent. Net returns for year five are $602,695 (Table 53).
Integrated Hatchery/Nursery/Soft Tray Growout System

Initial capital investment for the hatchery and nursery of the integrated soft-tray system are the same as those for the integrated pen system. However, capital costs associated with the growout component are less. Total capital investment cost for the 6-million clam capacity soft-tray growout system is $165,722, significantly less than for the pen system (Table 54). The trays need to be replaced every three years, resulting in a sizeable and constant capital reinvestment cost for years four and beyond. Total initial capital investment in the integrated soft-tray system is $556,596.

Variable costs for the hatchery and nursery also remain the same as the integrated system. Operating costs for the growout component, however, are reduced somewhat to $65,199 in year three for the soft-tray system (Table 55). The largest single operating cost is labor, representing approximately 75 percent of the total variable and overhead costs. Annual depuration costs total $1,900. This estimate includes only the operational costs of electricity and maintenance, and does not include labor, costs of capital, loss due to handling, etc. Depuration can be a very complex process. A more complete discussion of the costs associated with depuration can be found in Roberts, Supan and Adams (in press). Personnel requirements for the six million clam capacity growout system are one full-time technician and two full-time hourly laborers.

The integrated soft-tray system generates a positive cash flow in years three and beyond (Table 56). An operating loan is needed in years one and two to cover cash shortfalls, but is retired by year three. Production begins in year three, under the same assumptions regarding anticipated price for sorted and depurated market-sized clams. Total operating expenses for the fully integrated soft tray system are $197,540. Beginning with year three, the ending cash balance is positive and increases through the remaining years of the planning horizon. NPV for the 10-year planning horizon is estimated to be $5.8 million, with IRR of 64.9 percent. Net returns for year five are estimated to be $612,136 (Table 57). As with the other systems included in the analysis, these net returns are to owner/operator management and risk.

Enterprise Budgets

General enterprise budgets are compiled for each stand-alone growout system, describing the costs, earnings, net returns, and other values of financial interest. The values pertain only to the activity (or enterprise) under consideration, while disregarding any other production activity with which the firm may be involved. For example, if a firm is engaged in oyster and clam culture, a clam enterprise budget would examine only the costs and earnings associated with clam production. Examining the activities of the whole firm would involve both oyster and clam production enterprises. Thus, an enterprise budget provides a more focused view of the financial potential of a single economic activity.

Compiled for the pens, bottom nets, and soft trays (Tables 58, 59, and 60), the enterprise budgets apply to year five in the planning horizon. These budgets provide a more detailed view of the income statement. However, additional information is also provided. Note that the cost per clam, margin per clam, and break-even survival rate are presented. The cost per-clam is simply the total cost of producing the number of harvested clams on a per-clam basis. For the pen system (Table 58), the total cost of production is $65,719 (i.e., total fixed cost plus total variable cost). Given that one million clams were harvested, the total cost per clam is 6.8 cents. Note also that the cost per clam is equal to the break-even price per clam required for sale. The margin per clam is simply the difference between price received and production costs. This value (i.e., 10.2 cents is the pen system example) must at least cover taxes and the opportunity of the owner/operator's capital, management, and risk. Break-even survival rate is also presented. This value indicates the minimum survival rate, given the current market prices for clams and input costs, which would allow the operation to just cover expenses. Any increase in survival would generate positive net returns. The break-even survival rate for the pen system, for example, is approximately 20 percent.

The budgets are constructed so that readers can insert values more specific to their given situation. The various cost categories and revenues may be changed or deleted as necessary. Additional cost categories may be included. The resulting budget provides an assessment of the profitability of a more specific operation.
Sensitivity Analysis

Assumptions regarding such items as clam selling prices, survival rate and growout period in these budgets may be considered "favorable." Findings presented in previous tables suggest that hard clam culture can be profitable under these favorable conditions. However, "real world" market and environmental conditions may cause prices and survival rates to vary considerably. Allowing these parameters to vary around the assumed levels will provide some insight into how sensitive the profitability of hard-clam culture is to changes in market and environmental conditions. A sensitivity analysis was performed on each of the three standalone growout systems - pens, bottom nets, and soft trays. The analysis examines the effect of varying product price, survival rate, and growout period from the baseline assumptions mentioned earlier. The baseline scenario for output price assumes a price of $0.17 for a 45-50 mm clam. This was varied to $0.13, $0.15, $0.19, and $0.21, while holding all else constant. The base scenario for survival assumes a rate of 50 percent from planting to harvest. This assumption decreases to 30 and 40 percent, and increases to 60 and 70 percent, while holding all else constant except for packaging costs. The baseline assumption for growout length assumes a period of three years. This is varied to a two- and four-year growout period. To accommodate this latter change, however, allowances are made for associated changes in certain costs (discussed in detail below). The results of the sensitivity analysis are presented in an income statement for year five of the planning horizon.

Price Changes

A $0.02 (13 percent) change in price from the baseline assumption results in an approximate $20,000, or 20 percent, change in net returns for each system (Table 61). Operating expenses, long-term debt interest, and depreciation remain constant as price varies. Also, no operating loan is required by year five regardless of whether price increases or decreases. In all cases for each system, the income statement indicates positive net returns. Note, however, that available cash (ending cash balance) is more sensitive to changes in market price. For the pen system, ending cash balance changes by approximately 67 percent as market price changes by $0.02 from the baseline assumption price of $0.17. This apparent greater sensitivity reflects the cumulative effect on cash surplus as market price changes.

Changes in Survival Rate

As the survival rate increases and decreases from the baseline assumption of 50 percent and the price per clam holds constant, the number of clams harvested and the gross returns increase or decrease, respectively (Table 62). A 10 percent change in survival results in a change in the number of clams harvested of 200,000 (recall that 2 million clams were stocked initially). The operating expenses are adjusted due to needing more bags to package and ship the harvested clams. Long-term debt and depreciation, as well as other variable costs, remain the same in each scenario. No operating loan is required during year five except for the pens and soft-tray system when a 30 percent survival rate is used. For those two systems, a decrease in survival of 20 percent below the baseline 50 percent reduces the ability to meet cash needs of the operation. In all cases for each system, the income statement in year five indicates positive net returns. A 10-percent change in survival (and conversely mortality) results in an approximate 34 percent change in net returns. A 20-percent reduction in survival, however, reduces net returns by 71 percent. As with changes in market price, ending cash balance is more sensitive to changes in survival rate than are net returns. For example, a 10 percent change in survival rate from the baseline assumption of 50 percent changes ending cash balance by approximately 40 percent for the bottom-net system.

Changes in Growout Period Length

The growout period is decreased to two years and increased to four years. Each case requires altering the harvest and revenue generation pattern realized under the baseline assumption of a three-year growout period (Table 63). Recall that under the baseline scenario, consistent production is achieved by rotating planting (P) 2 million clams in years one (P1), two (P2) and three (P3). In addition, harvesting (H) occurred in years three (H1), four (H2), and five (H3). This is then repeated. Since the purpose of a sensitivity analysis is to examine the effect of changes on a given operation design, this planting strategy was preserved under both the two- and four-year growout period lengths. As a result:
Two-year growout period - Production of one million clams (and thus revenue of $170,000) occurred in years two, three, five, seven and nine and is $340,000 for years four, six, eight and 10 (Table 63). Production costs for each system design are increased in year two to equal year three costs, while costs for years four, six, eight and 10 are increased by doubling all costs other than seed cost.

Four-year growout period - Initial production occurs in year four, with no production in year seven (Table 63). Production costs remained the same as under the baseline assumption three year growout period scenario.

The relative impact on year five net returns is greater for a one-year increase in the growout period than that realized from a one-year decrease in growout period (Table 64). For example, net returns for the pen growout system under the assumption of a three-year growout period are $99,995. However, as the growout period increases by one year, net returns in year five decrease by approximately $16,000 to $98,379, primarily due to an increase in short-term cash needs. As the growout period length is decreased to two years, net returns in year five remain at $99,995. Similar findings, with the exception of the requirements for an operating loan when the growout period is increased, are seen for each system design. Note the dramatic increase in ending cash balance for all systems as the growout period is reduced by one year. This reflects the doubling of revenue in year four and production occurring in year two under the two-year growout period assumption. Cash balance decreases by approximately 50 percent as the growout period is increased from three to four years. The scale-up strategy pursued to achieve consistent production will likely be modified to match the assumed growout period length. For example, the scale-up strategy would be used only in years one and two for an assumed two year growout period length. This would provide for consistent levels of production, rather than the doubling of production for every other year as seen in the above example. In addition, a four year grow-out period length may require planting in year four to avoid the absence of production which occurs in year seven.

Sensitivity Comparisons

The sensitivity analysis examines changes in per-clam selling price, survival rate, and growout period. The findings indicate that for unit changes in each of these parameters, while holding the others constant, net returns are more sensitive to changes in survival rate. Therefore, a prudent manager may experience greater returns to management and risk by reducing mortality by 10 percent, than by focusing on increasing selling price by 10 percent.

The Cumulative Effect of Less Than Favorable Conditions

Before the sensitivity analysis, the baseline assumptions maintain favorable conditions in the hard clam culture operation for every year of the planning horizon. That is, yearly fluctuations in market conditions, environmental factors, and management skills, which most likely would occur in a "real world" setting, are assumed to be absent. The sensitivity analysis allows for such change to happen, but only for one factor at a time, while all others are still maintained at favorable levels. In reality, several of these factors will be changing at the same time, resulting in a cumulative effect on the profitability of hard clam culture which may vary from year to year. This cumulative effect may have a significant impact on how financially promising hard clam culture appears to a prospective investor.

Many variable factors can have an impact on a hard clam culture operation's ability to achieve commercial feasibility. These include permitting, market conditions, personnel loss and attrition, poaching and vandalism, equipment changes and the inability to sell old specialized capital, insufficient financing, environmental conditions, availability of seed clams, catastrophic crop failure and current difficulty of acquiring clam-crop insurance, inflation, size distribution of harvested clams, and others. Probably one of the most important factors is the time required to achieve the necessary skills and knowledge to successfully operate and manage the hard clam culture process and business. Achieving these skills is often referred to as "getting up on the learning curve." In fact, several years may be required before management and staff have gained enough experience and knowledge to minimize overall mortality, maximize harvest efficiency, establish successful market contacts, and gain good business sense. Achieving these skills allows one to move farther up the "learning curve." Before having these skills, profitability of the busi-
ness may be constrained. As a result, the ability to pay back loans, meet necessary cash obligations, and, in general, operate the business in a profitable and commercial manner may be limited.

The learning curve demonstrates the importance of both management experience and ability in achieving improved survival rates. Two different learning curves are shown (Figure 21) with time measured on the horizontal axis and survival rate on the vertical axis (adapted from Thunberg and Adams, 1990). Assuming experience is gained with time, the difference between the two curves may be attributable to management ability. Thus, the curve labeled SLOW might represent average manager ability to adapt with experience while the curve labeled FAST might represent an individual with above average management ability. How differences in management ability translate into cost and returns is shown in Figure 22.

The annual net return to management and risk under two hypothetical managers can be substantially different. With the better manager, net returns are positive by the end of year four and continue to increase. Under the less-able manager the hypothetical business does not earn a positive net return until the end of year seven. During each year in which net returns are positive, the business with the better manager also earns a significantly greater return. Thus, the value of hiring a qualified and experienced manager or the time spent in learning about the production aspects of hard clam aquaculture before making the investment may be well worth the expense.

To demonstrate the cumulative effect of less-than-favorable conditions on the profitability of hard clam culture, variations in several key factors are imposed on the pen growout system. Specifically, (1) a "learning curve" effect is included, such that clam survival begins at 10 percent in year three and increases to 50 percent in years five and seven, (2) operating expenses are allowed to increase five percent each year due to inflation, (3) a catastrophic loss of clams occurs in year eight, with clam survival declining to 10 percent that year and increasing only to 40 percent by year ten, (4) due to the catastrophic loss in year eight, additional capital costs are incurred as a number of pens need to be rebuilt, and (5) market prices for littlenecks increase from $0.17 in year three to $0.18 in year four, but then decrease to $0.15 in year five before stabilizing at $0.17 for years six and seven. Prices increase to $0.20 in year eight, in partial response to the local decline in clams (remember...a catastrophic event!), but then decline to $0.18 by year ten.

When these less-than favorable conditions prevail, the impact on the revenue generation ability of the pen growout system is dramatic (Table 65) as compared to the performance under favorable conditions (Table 66). A positive cash flow does not occur until year four, which necessitates that an operating loan be obtained for years one through three. Repayment of these operating notes contributes to a zero ending cash balance until year seven. Note that operating expenses are increasing each year as inflation takes its toll. Also, the catastrophic loss in year eight reduces total cash receipts to only $40,000. This value actually would have been less than the $34,000 received in year three had it not been for the higher market price received for the remaining clams during year eight. NPV for the cash flow is $10,400, with IRR of 17.9 percent. These are considerably less than NPV ($853,083) and IRR (76.9%) found under the "favorable" conditions.

The above examples take into account a number of assumptions reflecting less-than-favorable conditions and how this affects the economic condition of the business. Experience has shown that with beginning clam culturists, the "disaster scenario" may create an economic setback from which recovery is difficult. In some cases an "early" disaster may be so economically devastating that first harvest is never reached. It is worth demonstrating this potential with another hypothetical illustration (adapted from Thunberg and Adams, 1990). For this example (Figure 23), year five was arbitrarily selected as the year in which there is 100 percent clam mortality.

The 100 percent mortality requires complete replanting of all seed. Thus, no receipts from clam sales are received until year seven. The disaster analysis indicates that the hypothetical clam business can withstand a major setback and remain financially feasible. However, what is not shown is that the recovery indicated in year seven would only be possible if the owner were able to obtain substantial operating loans to cover the period over which cash receipts are zero. Thus, maintaining a reliable source of credit and a good credit record should be a part of a potential investor's business plan.
Figure 21. Learning Curve for Average and Above Average Management Ability.

Figure 22. Net Return to Management and Risk for Different Learning Curves.
This discussion should make it clear that a potential investor in hard clam culture should approach such an opportunity with caution. Under favorable conditions, hard clam culture appears very promising from a financial perspective. However, the very real possibility of changes in key market, environmental, and managerial factors can have a dramatic negative cumulative effect on profitability. Only those businesses that can quickly progress up the learning curve, and remain there, will be successful.

Summary and Limitations

This section has presented findings regarding the financial feasibility of hard clam culture in the southeastern U.S. The analyses provide considerable detail regarding the cost of capital (cash and non-cash), annual operating costs, anticipated net returns, and cash-flow characteristics for standalone and integrated hard clam hatchery, nursery and growout systems. The findings indicate that these costs and returns can vary with facility design and size. In addition, the financial performance of these production systems can be significantly altered by integrating the hatchery, nursery and growout processes. For example, while a stand-alone hatchery is not financially feasible, combining a hatchery with a nursery and growout operation contributes to a financially feasible integrated system. The reader should further note that all net returns have not accounted for owner management costs (i.e. living expenses or salary) start-up expenses, production risk, and cost of land. Including these factors in the analysis would decrease net returns, NPVs, and IRRs below the levels presented.

Table 66 provides a brief summary of key financial information for the various production systems examined. Although a variety of information is presented for each system, the "cost per clam" may be one of the most informative. For example, the cost of producing 1,000 seed clams with the hatchery system is $4.61, well above the average current market price per thousand for one
mm seed clams at $3.00. This supports the findings that the stand-alone hatchery system, or at least this study’s design and scale, is not financially feasible. Also, the upflow nursery system will produce 8 mm seed clams at a cost significantly below that for the raceway systems. Both raceway systems operate at a net loss, with the cost per clam at or near current market selling price, without any room for profit margin. Therefore, investing in stand-alone hatchery and raceway nursery systems at the scale examined in this study may not be advisable.

Several additional caveats should be mentioned regarding the analysis. The scale (i.e., harvest capacity) of operation (i.e., 24 million for the hatchery, 12 million for the nursery, and 1 million for the growout systems) was selected from what appeared to be realistic sizes. Further study is required to identify the scale of operation that maximizes production efficiency and profits. The appropriate scale of operation may vary due to local market and environmental conditions. Given that the hard clam culture industry is currently in a development stage, the systems examined in this study are basically hypothetical, yet based on information applicable to currently existing operations (although of different scale). As emphasized in the sensitivity analyses, input costs (i.e. labor, fuel, maintenance, clam seed, etc.) and selling prices for clams were assumed (under ideal conditions) to be constant over time and scale of operation. In reality, these costs and prices will be changing over time due to general inflation and market shifts. For example, the selling prices for clams, either for the seed or retail markets, will likely be affected by changes in local supplies. Whether or not these local prices will be stable under the production levels analyzed in this study is not known. Further studies on the nature of consumer demand for hard clams are needed.

Finally, this analysis initially examines financial, or economic feasibility. Financial feasibility analyses typically assume that the inconsistencies and vagaries of the consumer and supply markets do not exist. A business is commercially feasible if sufficient profits can be maintained over time, taking into consideration these real world changes. The importance of understanding how these real world changes can impact profitability cannot be over emphasized. This analysis does not attempt to sufficiently demonstrate commercial feasibility.
XII. CHANGING FROM ONE PRODUCTION SYSTEM TO ANOTHER

The economic budgets presented in this manual provide existing or potential investors and farmers in hard clam culture a useful guide in making the investment decision. Two basic decisions must be made. First, how much will it cost to enter the hard clam farming business, and second, how much profit can be made? The interested farmer and investor can go to extension agents, other clam farmers, equipment suppliers, etc., and the various sources mentioned earlier to get equipment investment costs for the current year. These can then be used to develop current capital costs which are specific to a given production system, location, etc.

Clam farmers who are already in the business might be considering a change in culture methods or expansion. To evaluate the economic consequences of this change, rather than estimate the entire investment requirements and cost and returns budget, the clam farmer would only want to analyze revenues and costs that would change with making the new investment or change in operations. To answer the questions, "will it pay to make the conversion?" the technique of partial budgeting can be used.

The partial budgeting technique analyzes only the costs and revenues that change. Losses occur from any increases in clam farming costs and decreases in income. Economic gains occur from decreases in costs and increases in income. If the gains are larger than the losses, the change is economically feasible. To analyze the changes:

\[
\begin{align*}
\text{Increased Costs} & \quad + \quad \text{Decreased Costs} \\
\text{Decreased Income} & \quad + \quad \text{Increased Income} \\
\text{Loss Effect} & = \quad \text{Gain Effect} \\
\text{Gain Effect} & \quad + \quad \text{Loss Effect} \\
\text{Net Profit From Change} & \quad = \quad 0
\end{align*}
\]

An example can be used to see how partial budgeting may be used. Consider a clam culturist who is currently operating a stand-alone, wooden pen, growout system. Further, assume that the culturist is operating at the scale described earlier in the discussions of growout systems (i.e., total initial investment costs of $47,720 and annual operating costs of $46,770). The culturist wishes to double expected production beginning in year five. The additional pens needed to double production will be constructed of a new plastic composite. The existing wooden pens will also be replaced with the new plastic pens as they are retired. The plastic pens last three times as long as the wooden pens. Fixed costs will increase (i.e., capital outlay, debt retirement, and depreciation), as will some annual operating expenses (i.e., seed costs, labor, supplies, fuel, harvest/packaging expenses, overhead, etc.). Repair and maintenance costs, however, will decrease. These values will vary with each individual system, so the manager must carefully estimate the timing and magnitude of each of these costs.

Given the planned changes to the current system, the increases and decreases in income and costs are shown in the example on the next page. Therefore, the "Loss Effect" is the sum of increased costs and decreased income, which is $62,330 + 0 = $62,330. The "Gain Effect" is the sum of decreased costs and increased income, which is $1,200 + $170,000 = $171,200. The net profit from changing the expected production to 2 million clams is the Gain Effect, minus the Loss Effect, which is $171,200 less $62,330 or $108,870. This value represents the net change in returns to owner/management and risk or profit. Careful examination of this net change may reveal more information than simply the change in profit. For example, note that a doubling of expected production (going from 1 million to 2 million clams) more than doubles profit! This is because costs associated with the added income (or clam production) is reduced through "economies of size." That is, as additional clams are produced, the cost to produce them goes down on a per-clam basis because of excess capacity in current equipment and labor.

The clam culturist should also consider a number of other factors before making the change. Can outdated equipment be sold? Is enough capital available to make the investment? Will changes and
pressures on the labor force cause problems? Are other culturists considering expansion which might cause a oversupply of clams on the market? All factors such as these, in addition to the anticipated profit increase, merit serious consideration before making any change.

<table>
<thead>
<tr>
<th>Increased Costs</th>
<th>Decreased Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>operating expenses</td>
<td>repair and maintenance $1,200</td>
</tr>
<tr>
<td>depreciation</td>
<td>$4,750</td>
</tr>
<tr>
<td>opportunity costs</td>
<td>$2,176</td>
</tr>
<tr>
<td>interest</td>
<td>$7,239</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$62,330</td>
</tr>
<tr>
<td><strong>Decreased Income</strong></td>
<td><strong>Increased Income</strong></td>
</tr>
<tr>
<td>none</td>
<td>additional clams $170,000</td>
</tr>
<tr>
<td><strong>Loss Effect</strong></td>
<td><strong>Gain Effect</strong></td>
</tr>
<tr>
<td>$62,330</td>
<td>$171,200</td>
</tr>
</tbody>
</table>

Gain Effect + $171,200
Loss Effect - 62,330
Net profit from change $108,870