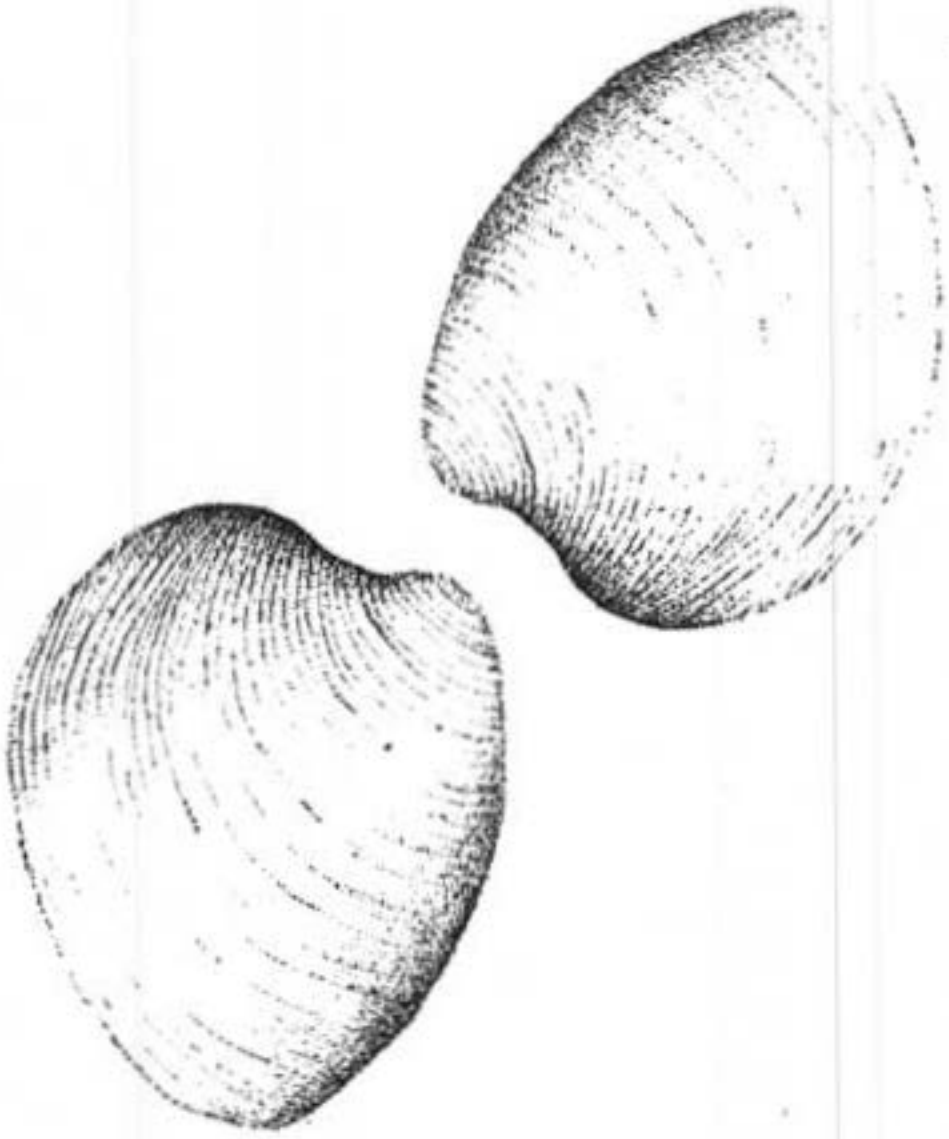
Intensive Hard Clam Mariculture: A Primer For South Carolina Watermen



South Carolina Sea Grant Consortium
Marine Advisory Publication 81-01

Credits:

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INTRODUCTION

Mariculture implies the farming or husbanding of aquatic organisms (animals or plants) in marine or brackish water environments. It also implies a more intensive culture than is available under natural conditions. Just as a farmer might expect a better harvest from his peach orchard than what might be available from wild peach production, a mariculturist attempts to improve on conditions for greater production.

Culturing shellfish has been practiced for thousands of years. There are references to both oyster and clam culture by the Romans and ancient Chinese. Clam culture in the United States started early in this century, primarily in the Northeast. Today, many townships in New England and New York have active clam planting programs, and several commercial hatcheries are producing young clams (set or seed) for sale.

Historically, the majority of U.S. hard clam landings have been made along the Atlantic coast from Virginia northward to Massachusetts. Recently, however, the hard clam fisheries in the North have experienced decreased or level production. This has resulted in an appreciable increase in demand and price (often not passed on to the fisherman) for southern clams.

Because of this, Southeastern states have experienced a significant increase in their hard clam fisheries, and hard clam culture is being considered by an increasing number of people in the area..

For example, the 1974-1975 hard clam harvests for South Carolina were the largest ever recorded for the state. These two harvests were almost equal to the combined harvests of the previous four seasons.

Research into hard clam culture in South Carolina began in earnest in 1975 and a commercial scale demonstration was initiated in August 1980. This booklet attempts to present a summary of the procedures involved in establishing this demonstration project. Information is also presented which may be pertinent to readers who wish to try their hand at intensive hard clam culture.

MERCENARIA MERCENARIA

The hard clam is a bivalve (two shells) mollusk found in protected coastal areas where the salt content of the water exceeds 20 parts per thousand (freshwater equals 0 parts per thousand and oceanic waters equal 35 parts per thousand). The scientific name for the hard clam is *Mercenaria mercenaria*, a Latin term possibly relating to one of the traditional uses of the shell (L. mercenariush merces, pay or wages) such as the American Indians' use of the shell as wampum.

The sexes are separate in hard clams, and spawning activity is regulated by environmental conditions. Males and females normally spawn simultaneously in the same vicinity, and the resulting mixture of eggs and sperm produce fertilized eggs or zygotes within 24 hours. Zygotes develop into free swimming larvae, called veligers, which are only about 1/360" (70 micrometers) in size.

During the next one to two weeks these small larvae live and grow by consuming microscopic plant life (phytoplankton). Although they are capable of swimming, most of their movements through tidal creeks and estuaries are governed by currents and tides.

At the end of this period they develop into pediveliger larvae (veligers with a functional foot) and have grown to about 1/100" (220 micrometers) in size. The pediveligers now metamorphose, or change, from a free-swimming lifestyle to a sessile or somewhat more stationary life on the bottom.

In South Carolina, clams begin to spawn in May and continue through the summer and early fall. Clams are capable of producing large quantities of young. The average female can produce as many as 20 million eggs in a single spawning, although only a very small percentage become fertilized and survive the larval stages to become set (recently metamorphosed clams). Set and young juvenile clams are called seed. As seed grow, they are commercially categorized into market grades. Clams 2"-2½" (50-65mm) are called little necks; clams 2½"-3¼" (66-79 mm) are called cherry stones; and clams larger than 3¼" (80 mm) are called chowders. Clams are normally sexually mature when they reach a size of 1½" (37 mm).

In the Northeast it can take as long as four years for a clam to reach minimum market size (1" thick). Our experience, however, indicates that the relatively warm coastal waters of South Carolina are capable of producing market-size clams in as little as 18 months.

CLAM FARMING IN SOUTH CAROLINA

Whether you are interested in a small clam garden for your personal consumption or a large clam farm for potential profit, certain requirements are common. This section will discuss these requirements and provide some of the information necessary for you to get started. Remember, no matter what your intended scale, you *must* start small. There is no need to jeopardize thousands of dollars worth of seed clams to determine if your site is usable or your methodology practical. Use your first crop or two to test locations or refine your techniques. If you are conscientious and methodical, you can learn as much with a thousand clams as you can with a million.

Site Selection

Your first step is to locate an area which is appropriate for clam farming. Certain characteristics are essential for a successful clam crop and violating any of these could doom your venture before you begin. Most individuals will be limited in the sites available to them, and it is important to know before you begin if the area is capable of supporting dense hard clam populations.

The salinity or the salt content of the water should not regularly drop below 25 parts per thousand (about ⅔ oceanic salinity). The area should be fairly well protected from wave action but should have a good unrestricted tidal exchange.

Avoid areas where pollution may be a problem and where soft bottoms or high siltation rates are prevalent. Finally, the site should be readily accessible for the routine inspection and maintenance that is required of any garden. Perhaps the easiest way to determine the suitability of a location is the presence of natural clam populations. Although this is not an indication that the location can support high density clam culture, it does show that clams survive and grow at the site.

Leasing and Permitting

At this writing several changes in lease and permit regulations are being considered by the state legislature. These changes may make it easier to initiate mariculture ventures in South Carolina. At present, leasing and permitting are major obstacles which must be addressed before any real consideration of commercial clam farming is made. There are several state and federal agencies with responsibilities in coastal areas, and your first activity should be to contact these agencies to determine if hard clam farming is appropriate for your selected site(s).

The South Carolina Wildlife and Marine Resources Department* can help you with shellfish lease arrangements and necessary licenses. South Carolina residents are eligible for both commercial and reparian leases. These leases require a yearly rental fee of $1.50 per acre and a yearly planting requirement of 65 bushels of shell per acre of productive shellfish bed. If a lease is not available, the Department may be able to aid you in obtaining a sublease or making other arrangements with the present lease holder.

The South Carolina Department of Health and Environmental Control* should be consulted early in site selection to determine sanitary conditions. The Department is responsible for shellfish sanitation and will guide you in fulfilling requirements for harvesting and landing clams in South Carolina.

If your culture procedures result in any modifications (use of cages, nets, baffles, gravel, pilings, etc.) to the site, you will have to obtain a ruling or permit from the South Carolina Coastal Council* and the U.S. Army Corps of Engineers*. In addition, if your modifications pose a danger to navigation, you will also need to contact the U.S. Coast Guard.*

The permitting process can be quite lengthy and it may take as long as six months to complete all leasing and permitting requirements. If you are planning to try your hand at clam farming, plan ahead and take the necessary steps to ensure that your venture is an approved marine resource activity. The Marine Advisory Service can be of great assistance in the leasing and permitting process. You can contact your local agent through the South Carolina Sea Grant Consortium.*

*See appendix for addresses.

Seed Clams

Natural reproduction in hard clam populations occurs almost continuously throughout the late spring to early fall in South Carolina. Retrieving small seed from this natural spawning would, however, be a monumental task.

Where then, can seed be obtained? The answer is commercial hatcheries. These facilities control the spawning and larval cycle of clams and produce large numbers of seed in several size categories. A recent sampling of prices showed the following ranges:

SEED SIZE (mm)	(in)	PRICE RANGE $/1000 seed
0.5	1/50	$1.50 - 4.00
1.0	1/25	3.00 - 9.00
2.0	1/12	4.00 - 12.00
3.0	1/8	5.50 - 15.00
6.0	1/4	7.50 - 20.00
9.0	3/8	12.50 - 30.00

As these prices indicate, the larger the seed size, the higher the price. Seed that is smaller than 1 mm (1/25") in size can often be purchased for less that 1/2 cent apiece, but if you want the larger sizes be prepared to pay up to 3 cents for each seed clam. A listing of the larger commercial hatcheries on both the east and west coasts is presented in the appendix.

Unfortunately, most studies have indicated that the larger seed (8-10 mm) are much better suited for field planting in mariculture projects. If you are planning a large venture, one way to cut your seed costs would be to construct a small nursery where you can raise small seed to more reasonable planting size. This way, you can purchase 1 or 2 mm seed and hold them in your nursery until they reach 8 or 9 mm. You will most likely suffer some seed loss in your nursery, but your total seed costs will be substantially lower than if you tried to purchase all your seed at planting size.

Another advantage to a nursery is that it gives you an opportunity to store your seed while you prepare your field site. In this way the seed becomes acclimated to the area before it is planted in a field growout system. Simple plans for the construction of a small nursery system are presented in the appendix.

The described nursery outlines the use of either shallow trays or upwelling tubes (silos) as alternative methods of holding and growing small seed to larger sizes. Both techniques require high-salinity, good-quality water which is passed over or through your seed populations, thus providing food and oxygen to your seed in a controlled and protected environment.

Your total seed requirement will of course depend upon the size of your farm. There are, however, some reasonable rules of thumb which should help you decide how many seed are necessary to purchase.

First, it is likely that you will only harvest about 50 percent of the seed you plant. This means that you will probably need to purchase 10,000 seed if you want a harvest of 5,000 clams.

Second, your initial planting densities in the field can vary between 100 and 1000 clams per square foot, depending on the support characteristics of your site and your field growout methods. If you elect to plant at a high density, then your field plots will have to be thinned as your clams reach an inch or so (25-30 mm) in average size.

Finally, your eventual densities for growout to harvest size will be directly related to the suitability of your site. Our experience indicates that a resonable harvest density is 50-100 clams per square foot. Your site, however, may be capable of supporting even higher densities or perhaps densities much lower than you believed would be acceptable, considering the cost of your operation.

The bottom line is that you will probably be best served by a much smaller initial venture than you would like. This pilot or test farm could save you much time, effort, and money and will provide the information you need in deciding if clam farming is going to be a worthwhile venture.

Hard Clam Culture Methods

If you have selected your site, obtained the necessary lease and permits, and have ordered your seed, how do you proceed with your clam farming venture? Several methods have been used successfully on small scale clam culture. These include bottom planting with gravel, fencing, trays, rafts, cages and racks. The following section outlines methods which show promise for use in South Carolina. More detailed descriptions and additional technical information are available through the publications which are listed in the appendix (Additional References).

Regardless of the method that you select, the primary goal of your procedure will be to provide an appropriate environment for maximum seed growth and protection against predators for maximum seed survival. In South Carolina the principal clam predators include blue crabs, stone crabs, mud crabs, whelks, moon shells and rays. In addition, certain birds, mammals and fish are clam predators.

These, however, are not the most serious predator. Whether through curiosity or intentional vandalism and theft, man is your greatest potential danger. While protection against other predators is possible, controlling vandalism or poaching is a difficult task. Perhaps the most effective deterent would be a sympathetic waterman who would note any unusual activity on your culture site.

In South Carolina, three field culture methods appear promising: tray (or cage), bottom and raft culture. Tray and bottom culture can be performed in either the intertidal zone (the area between high and low water) or subtidal zone (the area below low water).

Intertidal culture has certain advantages. Fouling is greatly reduced and predator control is facilitated by placing your units in the lower intertidal zone. Experience to date also indicates that seed growth in the intertidal zone is not noticably reduced in comparison to subtidal and raft culture. Access to your culture units and subsequent inspection and maintenance is also easier in intertidal culture. The one great disadvantage is that intertidal units are more susceptable to poaching.

Bottom culture, because it is the least expensive, might be a good procedure for your initial planting trials. A low intertidal or high subtidal area should be staked off and cleared of potential predators. A floor of plastic mesh with 4 mm square openings (6 to the inch) should be positioned to cover the bottom area intended for use, and a thin layer (2") of crushed stone, pea gravel, or crushed oyster shell placed over the mesh. Seed clams 8-12 mm (⅓"-½") can be evenly spread over the aggregate at densities of 400 to 1000 clams per square foot.

The area can be protected from predators by fencing (vinyl coated wire, 2-inch square) lined with plastic mesh or full covers made of the same material. If you choose to fence the area, be sure to extend the top of the fence to a height that will be above the water at all times. A full cover can be covered by water but must be supported above the substrate by internal stakes or floats. This insures that your seed will not be pushed below the accumulated silt by sagging mesh or vinyl wire.

Trays and rafts are more expensive to build but generally afford greater predator protection than bottom culture. The cost of floatation and the difficulties in permitting make raft culture the least attractive method of clam culture at this time. If you would like more information on raft culture, consult the appropriate references in the appendix.

Tray or cage culture has received considerable attention in South Carolina. This method requires the construction of individual trays, which can be lifted and moved as a unit. Usually the trays are constructed of molded plastic (if purchased) or fabricated with wood or steel frames and plastic or wire mesh. Trays can be stacked, suspended from poles or docks, or placed on the bottom in either intertidal or subtidal areas.

A rough design for a tray presently in use by the South Carolina Wildlife and Marine Resources Department is presented in the appendix. Although this design is for a fairly large tray, its basic characteristics can be used in a tray of any size or configuration.

In general, trays should be constructed of materials that will have some longevity in seawater. They should have enough structural integrity to be moved as a unit and should be of sufficient size to provide an economically realistic planting area. The unit presently used by the Department is 8-feet square (64 square feet) with 8-inch sides. It is composed of a steel reinforcing rod frame (½" rods) which supports an internal cage of 2" by 2" vinyl-coated wire which is lined with plastic mesh (six strands to the inch). The unit is covered with a plastic mesh/vinyl-coated wire firmly sealed to the sides.

Most of the experimental clam culture performed in the state indicates that fairly large seed are best suited for intensive clam farming. A nursery, as described earlier, could allow the capability of producing these large seed from smaller less expensive seed. The Department uses both silos and raceways to raise 1 mm (1/25") clams to the 8-10 mm (⅓-½") planting size. This takes from 2½ to six months, depending on season and capabilities of the raceway. If the cost of larger seed is prohibitive and you want to avoid a land based nursery, it is feasible to use small well-constructed trays for initial seed growout. These trays can be planted at very high densities, but must be checked and rinsed of silt regularly. Growing very small seed to planting size is certainly feasible using this method, but it is likely to produce a larger than desired mortality in the nursery segment of your operation.

Once planting size clams are available you can distribute them at densities of 400 to 1000 clams per square foot in your culture area. At these densities they will grow at an average annual rate of approximately 1.8 mm (1/14") per month (slower in the winter, faster in the spring, summer and fall). In our better growout areas, clams planted at high densities begin to show reduced growth rates when the average population size exceeds 25 mm (1"). Clams should then be thinned to densities no greater than 200 per square foot. If you start with a reasonable larger size seed the average growout time to minimum harvest size (littleneck) is about 18 months. This of course depends upon the time of year you begin and the characteristics of your growout area.

SUMMARY

Remember, clam farming is certainly feasible provided you have selected an appropriate location and your procedures are adequate for predator control. The economics of clam farming have not, however, been proven, particularly for large-scale commercial operations. Therefore, we strongly recommend the following:

(1) start small,

(2) make sure you have the legal right for use of your selected site,

(3) be certain you have any permits and/or licenses necessary and that you have notified the proper state and federal agencies about your activity,

(4) construct your culture units with predator control and maintenance as primary considerations, and

(5) be prepared to dedicate sufficient time for regular and complete inspection of you site.

Personnel with the Marine Advisory Services of the S.C. Sea Grant Consortium and with the Marine Resources Research Institute of the Wildlife and Marine Resources Department can provide much help with getting your project off the ground. Nevertheless, while they can supply you with the latest information available, it will still be your time, money and dedication that will be required for successful clam culture.

The outlook for hard clam culture in South Carolina appears promising. It is still, however, a very "high risk" venture and any serious thought about a commercial venture should be tempered with a few years of experience with your own small-scale clam garden.

APPENDIX

COMMERCIAL SEED CLAM SOURCES

Aquacultural Research Corporation
P.O. Box 597
Dennis, Ma 02638
(617) 385-3933

Bluepoints Company, Inc.
West Sayville
Long Island, NY 11796
(516) 589-0123

Bristol Shellfish Farms
Moxie Cover Road
Round Pond, ME 04564
(207) 529-5634

Coast Oyster Company
Hatchery Division
P.O. Box 635
Ocean Park, WA 98640
(206) 665-4075

Frank M. Flower & Sons
P.O. Box 92
Bayville, NY 11709
(516) 628-2077

Intertide Corporation
North Harpswell, ME 04079
(207) 833-5047

Marine Bioservices Co.
High Island
South Bristol, ME 04568
(207) 644-8537

Pigeon Point Shellfish Hatchery
921 Pigeon Point Road
Pescadero, Ca 94060
(415) 879-0391

Shinnecock Indian Tribal Project
P.O. Box 670
Southampton, NY 11968
(516) 283-3776

ADDITIONAL REFERENCES

Castagna, M. and J.N. Kraeter. 1981. Manual for Growing the hard clam *Mercenaria*. Special report No. 249. Virginia Institute of Marine Sciences, Loucester Point, Va. 110pp.

Castagna, M. and J.N. Kraeuter. 1977. *Mercenaria* culture using stone aggregate for predator protection. Proceedings of the National Shellfisheries Association, Volume 67: 1-6.

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Foster, J.E. 1981. Clam Gardening. UNC Sea Grant Publication 81-03. UNC Sea Grant College Program, 105 1911 Bldg., North Carolina State University, Raleigh, NC 27650.

Kraeuter, J.N. and M. Castagna. 1980. Effects of large predators on the field culture of the hard clam, *Mercenaria mercenaria*. Fishery Bulletin, Volume 78(2): 538-541.

Manzi, J.J. 1983, Clam Aquaculture in the United States. *In* (Hunter and Brown, eds) Invertebrate Aquaculture in the United States. AVI Publishing Co., Westport, Ct.

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Whetstone, J.M. and A.G. Eversole. 1978. Predation on hard clams, *Mercenaria mercenaria*, by mud crabs, *Panopeus herbstii*. Proceedings of the National Shellfisheries Association. Volume 68: 42-48.

CONTACT AGENCIES

South Carolina Sea Grant Consortium
Marine Advisory Service
221 Ft. Johnson Rd.
Charleston, SC 29412
(803) 795-8462

Marine Resources Research Institute
South Carolina Wildlife & Marine Resources Department
P.O. Box 12559
Charleston, SC 29412
(803) 795-6350

South Carolina Department of Health and
Environmental Control
Bureau of Shellfish and Recreational Waters
2600 Bull St.
Columbia, SC 29201
(803) 758-5551

South Carolina Coastal Council
Summerall Center
19 Hagood St., Suite 802
Charleston, SC 29403
(803) 792-5808

Department of the Army
Charleston District Corps of Engineers
P.O. Box 919
Charleston, SC 29402
(803) 724-4330

Seventh U.S. Coast Guard District
51 SW 1st Avenue
Miami, FL 33130
(305) 350-5621

NURSERY SYSTEM AND FIELD UNIT DESIGNS

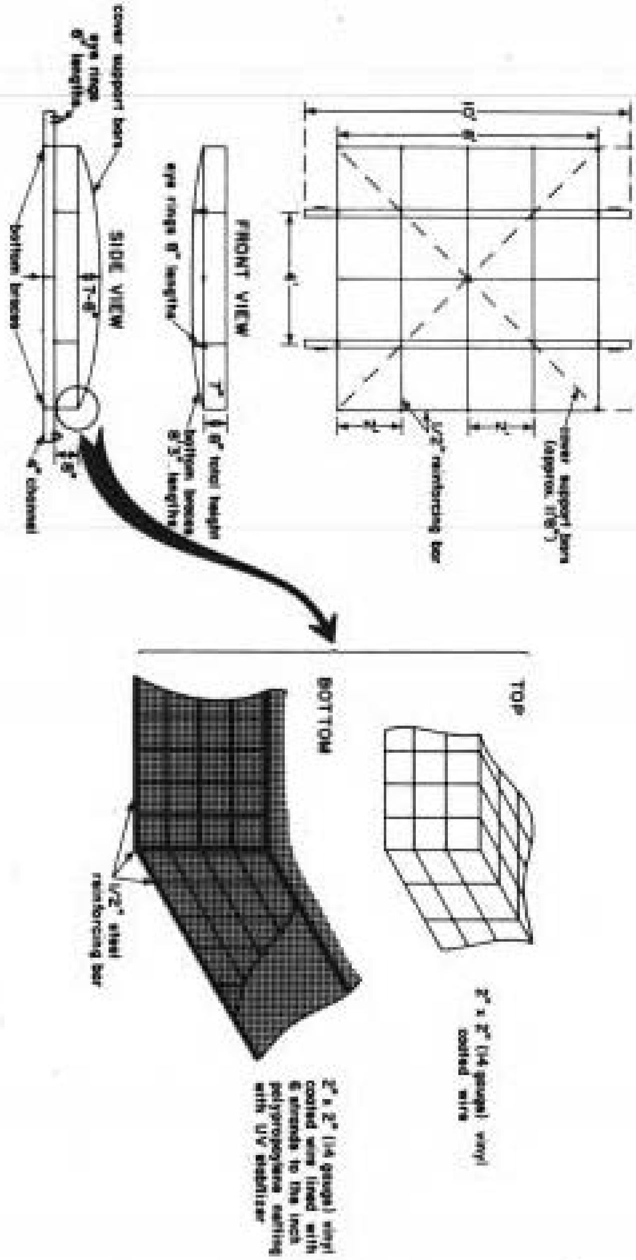
The following drawings illustrate the construction details of nursery system components and field units presently in use by the Marine Resources Research Institute in their hard clam mariculutre project. These are rough construction drawings intended only to give the reader a starting point rather than strict guidleines for constructions.

If you elect to include a nursery in your venture, remember that it will be necessary to have high land or a dock with access to high quality, high salinity water. The upwelling tubes (silos) or raceways can be positioned on the dock or adjacent high land and water pumped to them at a rate of 3gpm (silos) or 10 gpm (raceways). The initial stocking densities (with 1.0 mm or 1/25" seed) can be as high as 500,000 per silo or 2 million per raceway. You will need to reduce the densities as the seed grow.

If you have high survival and want to keep seed in your nursery until they are a minimum of 8 mm (1/3"), you will need approximately a ten-fold increase in your nursery system to maintain the larger seed. That means if you begin with one 8-inch silo holding 500,000 1 mm seed, you will need 10 silos to maintain the same number of seed when they reach an average size of 8 mm. Since most readers will consider only very small scale projects, it would be possible to utilize a single raceway or double silo nursery system. A single 8-foot raceway can be initially understocked with 40,000 small seed (1mm) and still be able to maintain that density when the seed reach an average size of 8 mm. The same population can be maintained in two silos by using a similar initial understocking technique.

Whatever your decision, remember that the following drawings should be used only as rough guidelines for construction. Build your system to take advantage of readily available supplies and equipment, and be prepared to build prototypes to test your ideas before investing your time and money in substantial structures.

FIELD CULTURE UNIT

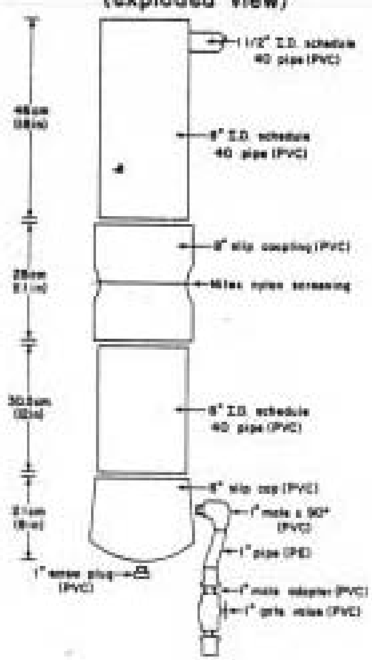


SILO CONSTRUCTION COSTS*

Item	Amount	Unit Cost	Total Cost
8" I.D. schedule 40 PVC pipe	3½ ft.	237.00/100ft.	8.30
8" PVC slip coupling	1	9.70	9.70
8" PVC slip cap	1	13.30	13.30
1½" I.D. schedule 40 PVC pipe	VARIABLE	28.20/100ft.	
1" PVC screw plug	1	0.73	0.73
1" PVC gate valve	1	5.30	5.30
1" PVC male adapter	2	0.13	0.26
1" PVC male x 90°	1	0.48	0.48
1" I.D. PE pipe	VARIABLE	6.75/100ft.	
"Nitex" nylon screening (HC-3)	20 in.²	9.40/40"x36"	3.63

*Prices listed are actual prices incurred Oct. '80-Jun. '81. Reference to trade names does not imply endorsement by the State of South Carolina or the NOAA Office of Sea Grant.

CULTURE SILO
(exploded view)



DOUBLE RACEWAY (16 FT.) CONSTRUCTION COSTS*

Item	Amount	Unit Cost	Total Cost
4'x8', 5/8" A-C exterior plywood	2	18.35	36.70
4'x8', 3/4" A-C exterior plywood	1/8	21.60	2.70
2"x4"x8' (untreated)	1	1.55	1.55
2"x4"x16' (untreated)	3	3.10	9.30
1¼" #12 flat head wood screw	100	0.025	2.50
3/4" galvanized pipe strapping	3 ft.	0.08/ft.	0.24
1" #12 round head wood screw	16	0.03	0.48
silicone caulk	1 tube	4.75/tube (11 oz.)	4.75
2" PVC slip coupling	2	0.40	0.80
polyurethane wood adhesive	1/3 tube	7.00/tube (11 oz.)	1.40
"Gluvit" (epoxy base)	1 gal.	18.90/gal.	18.90

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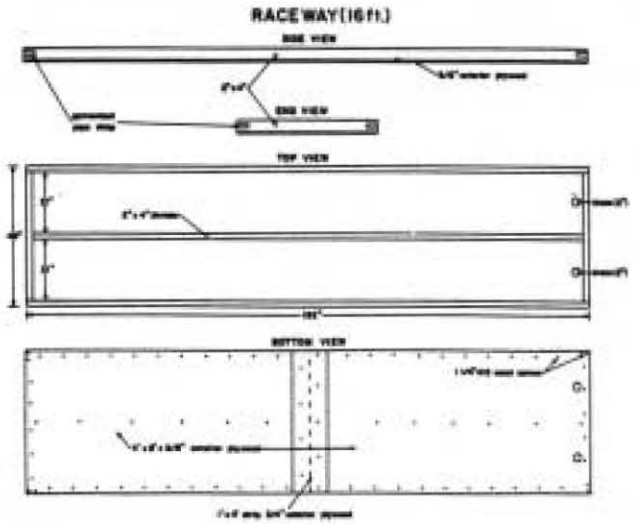

RACEWAY (8 FT.) CONSTRUCTION COSTS*

Item	Amount	Unit Cost	Total Cost
4'x8', 5/8" A-C exterior plywood	1	18.35	18.35
2"x4"x8' (untreated)	3	1.55	4.65
1¼" #12 flat head wood screw	50	0.025	1.25
3/4" galvanized pipe strapping	3 ft.	0.08/ft.	0.24
1" #12 round head wood screw	16	0.03	0.48
silicone caulk	1/2 tube	4.75/tube (11 oz.)	2.38
2" PVC slip coupling	1	0.40	0.40
Polyurethane wood adhesive	1/10 tube	7.00/tube (11 oz.)	0.70
"Gluvit" (epoxy base)	1/2 gal.	18.90/gallon	9.45

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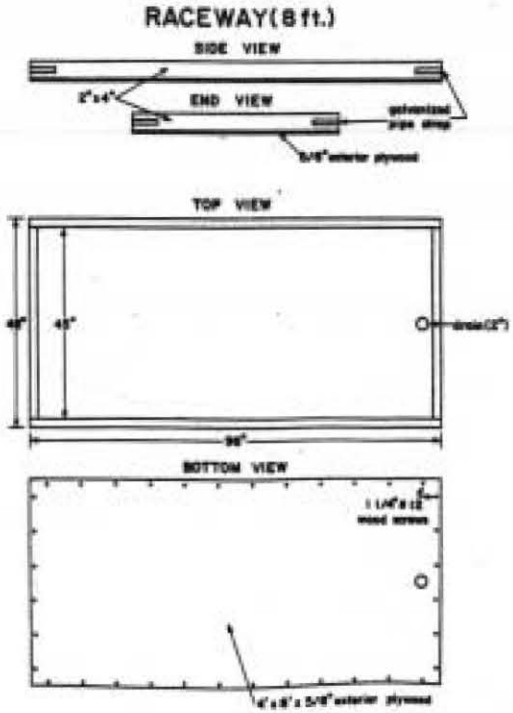
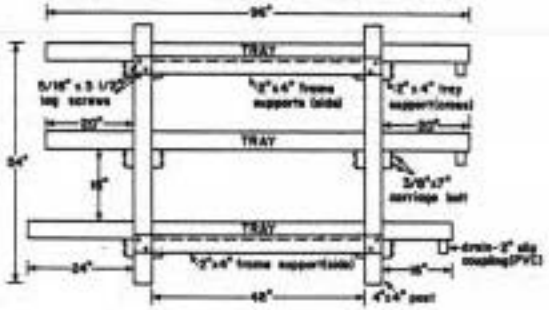


RACEWAY SUPPORT RACK CONSTRUCTION COSTS*

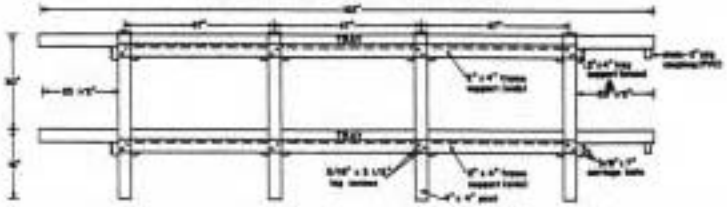
Item	Amount	Unit Cost	Total Cost
THREE TRAY (8 Ft.) RACK:			
4"x4"x12' (treated)	2	6.80	13.60
2"x4"x14' (treated)	5-1/3	3.65	19.45
5/8"x7" carriage bolt, nut, washer	24	0.50	12.00
5/16"x3½" lag screw	16	0.15	2.40
TWO TRAY (16 Ft.) RACK:			
4"x4"x8' (treated)	4	4.70	18.80
2"x4"x14' (treated)	9-1/3	3.65	34.05
5/8"x7" carriage bolt, nut, washer	32	0.50	16.00
5/16"x3½" lag screw	32	0.15	4.80

*Prices listed are actual prices incurred Oct. '80-Jun. '81. Reference to trade names does not imply endorsement by the State of South Carolina or the MUSA Office of Sea Grant.

RACEWAY SUPPORT RACK(8ft.)



RACEWAY SUPPORT RACK(16ft.)



NOTES

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