North Central Regional
Aquaculture Center

Fact Sheet Series

Small-Scale, Year-Round Shrimp Farming in Temperate Climates

Introduction

Interest in indoor shrimp aquaculture as a means of producing high-quality, fresh, never-frozen marine shrimp in practically any location is growing. Indoor shrimp production allows farmers to tap into niche markets where consumers are willing to pay a higher price for top-quality, locally grown food products. The North Central Region of the United States has a variety of consumer markets that may be well-suited for the production of fresh shrimp, although there are some unique challenges that must be addressed to produce shrimp year-round. The purpose of this publication is to inform readers about some of the specific techniques that can be used to produce shrimp indoors. While a variety of approaches exist to produce shrimp, this publication focuses on one particular method. Farmers should study the topics mentioned, such as water quality dynamics, interactions between water quality and animal production, as well as detailed business planning specific to their location and potential market outlets in greater detail. As with any type of farming, shrimp farming has inherent risks such as crop failure or the inability to sell products at a profit. People interested in shrimp farming should do substantial research before making an investment. Risks can be minimized by starting small.

System design

Buildings

In temperate climates, an insulated building is appropriate for year-round shrimp production. The consistent environment of an insulated building facilitates faster growth rates in shrimp than greenhouses or ponds, even in the warmer months. The building should be ventilated to prevent the buildup of carbon dioxide and excess moisture. Carbon dioxide can be toxic to workers and will drive down pH and dissolved oxygen (DO) in the shrimp tanks. Moisture will lead to the growth of mold, which can cause disease if mold-containing water drips into the tanks. Surfaces in the building should be protected against the moisture that exists in indoor aquaculture operations. Since it contains salt, moisture generated in a shrimp farm is especially corrosive to metal and damaging to wood. For more details, see the North Central Regional Aquaculture Center (NCRAC) publication FS128 Buildings for Aquaculture Operations.

Tanks

Swimming pools make inexpensive tanks, and the cost savings over other types of tanks make them a favorite choice for many small-scale farmers. However, the long-term durability of swimming pools is uncertain since liners can leak and metal supports can rust. Pool liners should not contain algaecides or other chemicals intended to reduce the growth of microorganisms because these chemicals can be toxic to shrimp. Care should be taken to protect liners from abrasion, or heavier pond liners can be used. Liners should be rinsed before use, and all equipment should be food grade.

The ideal height for pools is about four feet and the normal water level should be about three feet. This depth allows adequate contact time for air bubbles moving through the water column.

Pools should be covered with netting that has a mesh size small enough to prevent shrimp from escaping, but large enough to allow feed to pass through. Shrimp jumping out of the pool becomes more of a problem as the animals get larger.

Aeration

The simplest way to aerate the water is with a regenerative blower. There are a variety of options regarding blowers. Manufacturers should be able to recommend a model for specific applications based primarily on the volume of air produced and the pressure required. Generally, three cubic feet per minute (CFM) of air is needed per pound of feed per day. With regard to pressure, make sure to calculate the depth of the water and add about another 15% to the calculation to account for resistance in the air lines and ceramic-type diffusers; add more pressure if a large number of bends exist in the lines.

A large diameter, thin-walled, metal cooling pipe is recommended between the blower outlet and the polyvinyl chloride (PVC) airline piping (Figure 1); otherwise, hot air from the blower can damage the PVC. At the tank, valves should be installed so the amount of air to each diffuser can be adjusted to regulate pressure changes in the line depending on water depth and the cleanness of the diffusers.

Vinyl tubing should be used to connect the PVC pipe and ceramic diffusers. Diffusers should be placed on the bottom of the tank and evenly spaced. Diffusers occasionally clog and should be removed and cleaned as needed with a dilute acid (such as muriatic acid).

Solids filtration

Particles (solids) in the water should remain in suspension; if solids accumulate on the bottom of the tank, they can generate ammonia and may cause the system to have low oxygen or become anaerobic. Anaerobic solids may produce hydrogen sulfide, which is very toxic to shrimp and can be detected by a rotten egg smell. If such an odor is present, try not to disturb the sludge that is producing it and try to prevent the material from mixing with the water. In addition, excessive solids in the water can lead to gill clogging, low DO, and bacterial infections.

Solids filtration is best achieved through the use of both a foam fractionator and a settling chamber. Fractionators remove smaller particles while settling chambers remove larger particles. Having both types of filters allows better management of the system. Store-bought fractionators can be cost-prohibitive; do-it-yourself (DIY) units can be just as effective for a fraction of the cost (Figures 2 and 3 illustrate one type; Venturi nozzle-driven fractionators are another option). Cone-bottom tanks work best as settling chambers, but a standard liquid storage drum is a suitable alternative (Figures 4 and 5). The appropriate size for the settling chamber is about 1.25% of the total volume of the shrimp tank it serves; multiple in-line filters can be used. Larger shrimp tanks or tanks that are stocked at higher densities will require more robust solids filtration. Typically, the fractionator is kept separate from the other filters so that the flow rate through the fractionator can be adjusted independently.

Figure 1. A regenerative blower with a cooling pipe. Two air filters prevent debris from entering the blower and should be examined regularly and cleaned if needed.

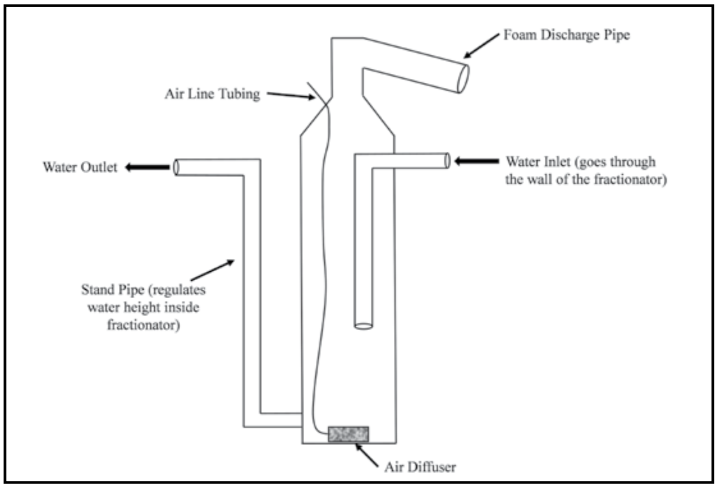

Figure 2. A diagram of a homemade foam fractionator. Inlet and outlet pipes go through the body via rubber gaskets or bulkheads. The outlet is a stand pipe; by turning it at the bulkhead, the water level inside the fractionator is adjusted.

Figure 3. A homemade foam fractionator. A valve near the inlet is used to adjust the flow rate. A submersible fountain pump delivers water to this filter.

The sludge that forms on the bottom of the settling chamber should be removed regularly. Having a drain on the bottom of the settling chamber helps with this. The most water-efficient way to remove the sludge is to pump the relatively clear water from the top of the filter, then dump the remainder (the thick sludge) through the bottom drain. The chamber should be allowed to settle for at least 30 minutes prior to sludge removal to ensure that the solids have had time to become compacted. Fractionators and the diffusers inside them also need to be cleaned and adjusted periodically to ensure production of a thick foam.

The simplest way to measure solids is using an Imhoff cone. One of the drawbacks to an Imhoff cone is that some material may remain in suspension, which produces an incorrect reading. To measure solids, one liter of water from the shrimp tank is poured into the cone and allowed to settle for one hour. The amount of settled solids is read on the side of the cone in ml/L. Settleable solids should be kept below 15 ml/L, and in systems with an external biofilter, solids should generally be kept as low as possible. With experience, managers can consider the clarity of the water as another indicator of solids levels. A turbidimeter, which usually measures in Nephelometric Turbidity Units (NTU), is a good way to measure water clarity, although these machines are somewhat expensive.

Biofiltration

Primary biofiltration refers to the process of removing or converting ammonia (NH_3). Ammonia is excreted by aquatic animals and is highly toxic. Operating an external biofilter is the simplest way to resolve the issue of ammonia accumulation, although the "biofloc" approach is an alternative that some farmers use. Biofloc refers to managing the microbial community in the water column to perform biofiltration. Due to the relative complexity of the biofloc approach, it has been difficult for new aquaculture farmers to implement. Therefore, the focus of this publication is on external biofiltration to reduce risk.

The purpose of the biofilter is to harbor a community of nitrifying bacteria that convert ammonia to nitrite (NO_2) and subsequently convert nitrite to nitrate (NO_3). Both NH_3 and NO_2 compounds are toxic at relatively low concentrations (Table 1). As long as the nitrifying bacteria are provided the correct environment and allowed time to colonize the filter biomedia, ammonia and nitrite should not accumulate.

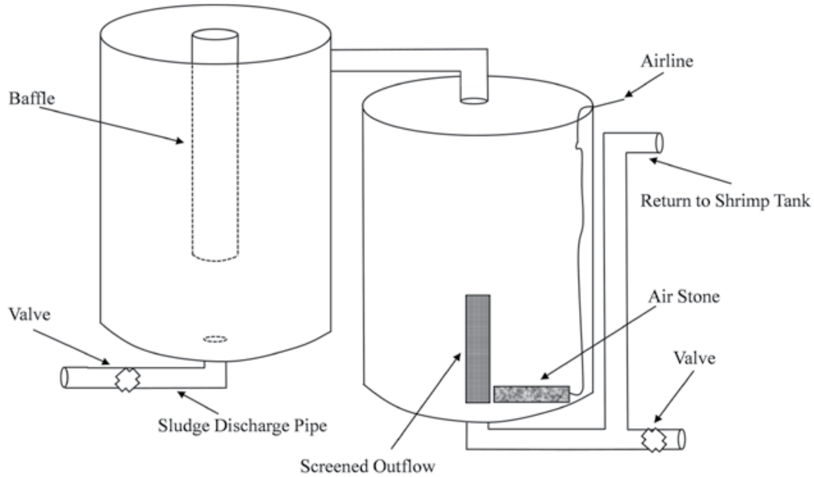

Figure 4. A diagram of a simple settling chamber and biofilter combination. Water enters the settling chamber baffle (a larger diameter pipe or corrugated pipe) which causes velocity to slow and solids to settle. The water then flows through the biofilter and back to the shrimp tank.

Figure 5. A simple settling chamber and a biofilter. The settling chamber is higher to allow water to travel to the biofilter via gravity. The filters are supported by concrete blocks. Note the protected surfaces in the room and covered tank.

An external biofilter can be constructed from a 50-gallon storage drum, similar to a settling chamber (Figures 3 and 4). The biofilter should contain specially designed small plastic media (often referred to as biomedia), roughly ¼ to ½ inch in size, which provide extra surface area for bacterial colonization. Established media will have a brown slime growing on it. The media should be kept moving and aerated by placing a 12-inch diffuser on the bottom of the filter. A diffuser of this size delivers about one CFM of air, which is appropriate for a 50-gallon drum biofilter. However, if water mixing is too aggressive, the bacteria may be dislodged from the biomedia. Water should move through the entire volume of the container to maximize contact time. A screened outflow pipe should be used to prevent biomedia from leaking out of the system (Figure 6). Generally, biofilters need to contain about one cubic foot of biomedia for every 0.75 pounds of feed provided per day. Biomedia typically has a surface area of approximately 250-300 ft^2/ft^3, although check with the manufacturer to determine what they report and recommend. About 50-70% of the total volume of the biofilter should be filled with biomedia. If it is overfilled, the media will not move well and water contact will be limited.

Figure 6. A screened outflow in a biofilter, an underlying, PVC-coated wire frame gives it the cylindrical shape. This can be placed on the tank bottom to allow water to pass through but not biomedia. Also note the small biomedia, most of which has turned brown, indicating a population of helpful bacteria is established.

As with settling chambers, the solids that accumulate on the bottom of biofilters should be removed regularly. If the biomedia appears to become clogged, it should be gently agitated to dislodge some of the bacterial biomass. The dislodged bacterial biomass should be removed along with the sludge on the bottom. The flow rate should be set so that the entire volume of the shrimp tank moves through the filters at least three times per day. Always keep the biomedia wet; if it dries out the bacteria will die.

Water quality factors

Temperature

Temperature has the greatest direct effect on shrimp growth rate because it directly affects animal metabolic rate. Maintaining a temperature of 83°F (28.5°C) will result in optimal growth rate. However, when shrimp are being handled, or if there are problems with other water quality parameters, the temperature can be lowered gradually to reduce stress in the animals. A temperature of about 79°F (26°C) will reduce the amount of stress considerably. Since the metabolic rate is reduced at this lower temperature, feed rate should likewise be lowered at this time.

Figure 7. A household water heater with a circulation pump which also has a timer so it can be operated for a set period of time each day. The water travels to coils of polyethylene (PEX) pipe in each shrimp tank, then back to the water heater.

An economical approach to temperature control for small-scale operations is to use a water heater connected to cross-linked polyethylene (PEX) tubing connected to a circulation pump that moves heated tap water through the PEX tubing (Figure 7). A coil of PEX tubing placed inside each shrimp tank will radiate heat to the tank water (Figure 8). Temperature can be regulated by controlling water flow through the PEX at each tank with a valve. During hot weather, the room should be well-ventilated to allow plenty of cooling capacity and bring necessary fresh air into the room.

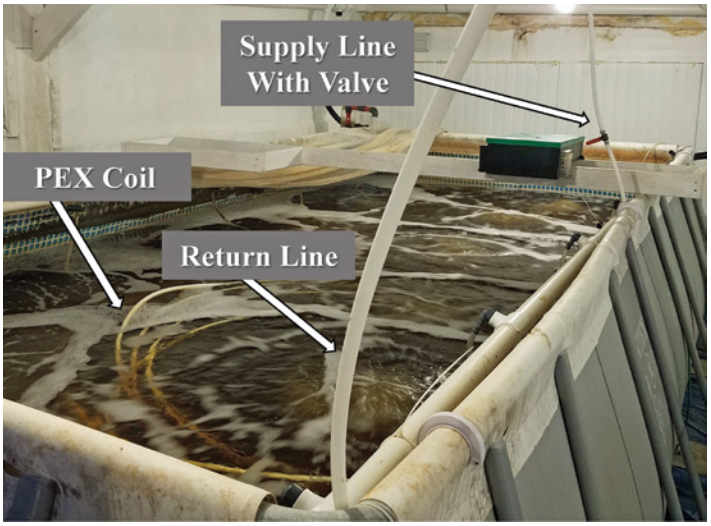

Figure 8. A shrimp tank with PEX piping that carries hot water to heat the tank. A valve controls the flow rate of water. In this case the coil of pipe is loose in the water; however, it may also be bundled together to keep the coil more contained.

Dissolved oxygen (DO)

DO is the most critical factor in intensive shrimp farming. If DO drops, the shrimp can die quickly. DO should be maintained above 5 mg/L; lower concentrations are acceptable for short periods of time, but having a goal of keeping DO above 5 mg/L will help managers maintain a safe environment for their animals and optimize growth rates. Levels below 3.5 mg/L are critical. It is important to note that temperature, feed rate, CO_2 accumulation in the tank room, stocking density, solids concentration, and the addition of sugar all negatively affect DO concentration. The higher these variables, the lower the DO concentration will be.

Aeration must be maintained at all times in the shrimp tanks and biofilters (short periods with no aeration in the biofilter are fine, but keep the media wet). As little as 15 minutes without aeration can cause shrimp mortality. For this reason, it is important to have backup blowers and an emergency generator with a power transfer switch to operate the blower(s) during power outages. Another good investment is one or two large tanks of pressurized oxygen; these can be connected to a regulator and ceramic fine-pore diffuser(s) to deliver pure oxygen to tanks if needed.

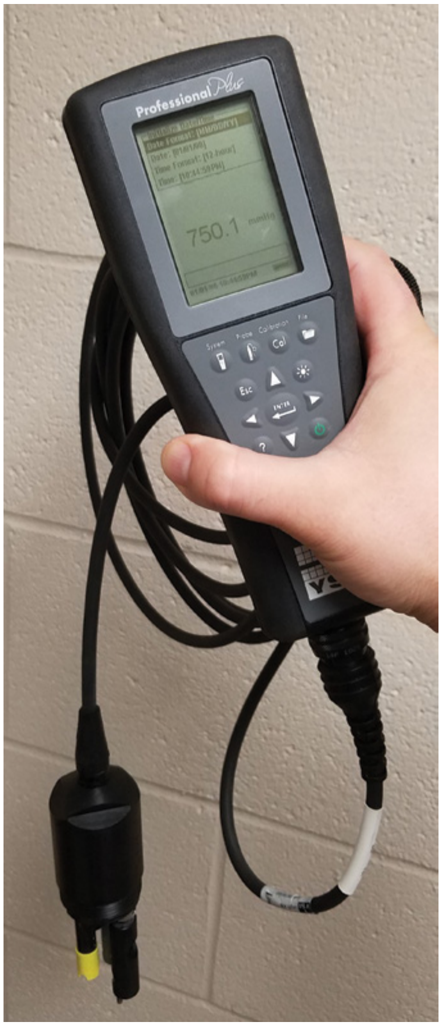

Figure 9. A multi-parameter water quality instrument. This unit measures temperature, pH, DO, salinity, conductivity, and barometric pressure. This type of device is expensive but it quickly measures some of the most critical life-sustaining parameters.

pH

The pH of shrimp aquaculture water should be maintained between 7.5 and 8.0. This will ensure that shrimp are healthy and have firm exoskeletons. CO_2 produced by shrimp and bacteria, as well as the nitrification process, decreases pH. Sodium bicarbonate (baking soda) is the most widely used compound to buffer against decreasing pH; food-grade baking soda can be purchased in bulk. Monitor pH and add incrementally larger amounts of baking soda until the pH is stable. Depending on building ventilation and solids concentration (containing bacteria), baking soda may need to be added at a rate of up to 50% of the weight of the feed.

Salinity

Salinity should be maintained at about 15-20 parts per thousand (ppt). Lower salinity levels can be used with shrimp; however, compounds such as ammonia, nitrite, and nitrate are more toxic at lower salinity. Most hatcheries ship shrimp in full-strength seawater (about 35 ppt); but these animals can be slowly adjusted to a lower salinity over about one week. Recent research conducted at Kentucky State University suggests that homemade salt mixtures may be just as effective as off-the-shelf complete sea salt formulations and homemade mixtures can be 60% less expensive.

Figure 10. A pH and temperature meter. This type of meter is much less expensive than a multi-parameter style unit. Similar instruments can measure DO and salinity. Follow manufacturer's recommendations to calibrate all probes often; this ensures that they are accurate.

Ammonia and nitrite

It is important to have a basic understanding of the nitrification process to understand how to prevent ammonia or nitrite accumulation in the system. Ammonia is the most toxic nitrogen-based compound and should be maintained at less than 0.2 mg/L, while nitrite should be maintained at less than 1 mg/L, although short periods of elevated concentrations should not pose much risk. Lower salinity makes these compounds more toxic. Higher temperature and pH both make ammonia more toxic.

If ammonia or nitrite reach high concentrations, managers have a few options. Feeding rate can be reduced, which lowers the amount of nitrogen being added to the system. Additionally, if possible, slowly reducing the water temperature (approximately 14°F/5°C per day maximum) will lower the feed consumption rate of animals, which reduces ammonia toxicity and overall stress for the animals. In some cases, water with high amounts of ammonia or nitrite can be exchanged with clean water; however, this is expensive and overall less effective than solving the cause of the problems.

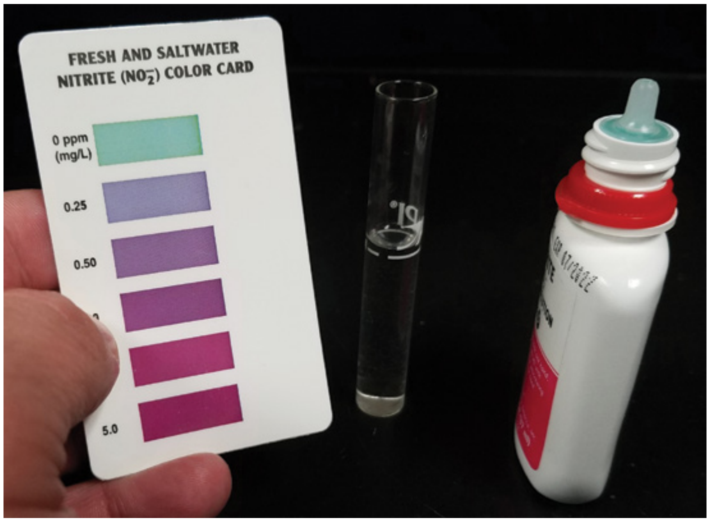

Figure 11. A common type of test for parameters such as ammonia, nitrite, and nitrate. This particular test measures nitrite. Drops of a chemical are added to the water sample and the resulting water color is compared to the chart. Water should be filtered to remove solids if possible before these tests are conducted; turbid water can interfere with the test. If concentrations are out of range, dilutions should be made with deionized water; the results of a 50/50 percent dilution (50% tank water and 50% deionized water) would need to be multiplied by two for instance.

Adding sugar to the system stimulates bacteria to take up nitrogen compounds from the water, thereby reducing ammonia and nitrite levels. Household white sucrose is effective and can be added at up to 50% of the weight of feed or slightly more to quickly drive down ammonia and nitrite. Caution should be taken when using sugar since it will reduce the DO concentration and increase the amount of solids in the water. A small amount of sugar, around 100 grams (3.5 oz) for a 4,000-gallon pool, should be added at first. This amount can be increased incrementally as needed. Sugar should not be added within an hour of feeding since feed also leads to lower DO concentrations.

Nitrate

Nitrate is the end result of the nitrification process. Nitrate accumulates as the biofilter works. Nitrate is much less toxic than ammonia or nitrite, but it may start to lower growth rates at about 250 mg/L NO_3-N, depending on salinity.

Denitrification can reduce nitrate accumulation by essentially performing nitrification in reverse. In an anaerobic (oxygen limited) environment, under the proper conditions, nitrate can be converted to nitrogen gas, which is harmlessly released to the atmosphere. Denitrification can be facilitated in a container similar to the aerobic biofilter described above. A 50-gallon drum filled with biomedia can be used, although no aeration should be provided in this system. Care should be taken not to introduce much air or disturb the water surface. Flow rate should be slowed so that the DO from the water can be consumed by the bacteria on the biomedia. The DO concentration should be maintained below one mg/L.

The process of denitrification has some potentially serious risks, including the production of ammonia and hydrogen sulfide. For this reason, water should ideally be moved to a separate container with no shrimp in it for denitrification. As with nitrification, the biomedia must have a brown film on it to be effective.

Feeding and health

Indoor shrimp farming is most commonly conducted in two phases: a nursery phase and a grow-out phase. The nursery phase can be stocked at up to ten times the density of the grow-out phase. An appropriate starting density for the nursery phase is 2,500 shrimp/m^3 or about 9.5 shrimp/gallon. Higher densities can be used as managers become more familiar with the production systems.

During the nursery phase, the shrimp are normally fed based on percentage of biomass. At first, the feeding rate can be as high as 15% of the biomass of the shrimp per day. Through the nursery phase, this should be gradually reduced to about 3% biomass per day (Table 2). Depending on density and management, shrimp will be in the nursery phase for about 40 days before producing a one-gram animal.

Table 1. The most important water quality parameters. Temperature, DO, and pH should be measured at least daily and must be measured in the tank. In other words, water should not be removed and tested elsewhere. Salinity, ammonia, nitrite, and solids should be measured at least weekly. Nitrate should be measured every other week. Parameters should be measured more frequently if problems are detected. Refer to Figures 9, 10, and 11 for examples of water quality testing supplies.

Parameter	Measurement	Ideal	Danger
Temperature	Probe or thermometer	82-84°F (~28.5°C)	Under 64°F (18°C), over 92°F (32°C)
DO	Probe	Over 5.0 mg/L	Under 3.5
pH	Probe	7.5-8.0°C	Under 7.0, over 8.5
Salinity	Probe or refractometer	10-20 ppt	Under 5
Ammonia	Color change test	Under 0.2 mg/L	Over 1.0
Nitrite	Color change test	Under 1.0 mg/L	Over 5.0
Nitrate	Color change test	Under 100 mg/L	Over 250 mg/L
Solids	Imhoff Cone	15 ml/L	Over 25 ml/L
Turbidity	Turbidimeter (if available)	30 NTU	Over 80 NTU

Providing some freshly hatched *Artemia* (about 1,800/gallon/day) for about the first week after the shrimp are received from the hatchery will improve survival, especially if the post larvae are small. During this time and throughout the initial stages of the nursery phase, shrimp should be provided a high-quality crumbled feed with about 50% protein. The crumble size of the feed should be decided based on visual observations of the shrimp size. Shrimp transition to larger crumble sizes as they grow and gradually they should be phased into consuming a pelleted diet with a lower protein content. This diet should consist of approximately 35% protein through the late nursery and grow-out phases.

During the grow-out phase, shrimp feeding is based on feed conversion rate (FCR), survival, and growth rate (Table 3). Estimates of each of these factors are used to calculate the feed rate. For instance, if the FCR is assumed to be 1.5:1, growth rate is 1.5 g/week, and the tank contains 4,000 shrimp, the calculation is 1.5 x 1.5 x 4,000, which equals 9,000 grams per week. Feed should be applied

Table 2. Snapshot of an example feed sheet for the nursery phase. This is only an example of how a feed sheet may be structured.

DAY	STAGE	WEIGHT	SURVIVAL	ORIG#	#SHRIMP	BIOMASS (g)	% BIOMASS	FEED/DAY (g)	FEED SIZE (µm)
8	PL15	0.01	98.26	30000	29479	295	0.150	44.2	50% 400-600 50%<400
9	PL16	0.02	98.02	30000	29405	588	0.150	88.2	60% 400-600 40%<400
10	PL17	0.03	97.77	30000	29332	880	0.140	123.2	70% 400-600 30% <400
11	PL18	0.04	97.53	30000	29258	1170	0.130	152.1	80% 400-600, 20%<400
12	PL19	0.05	97.28	30000	29185	1459	0.130	189.7	90% 400-600 10% 600-850
13	PL20	0.06	97.04	30000	29112	1747	0.140	244.5	90% 400-600 10% 600-850
14	PL21	0.07	96.80	30000	29039	2033	0.135	274.4	80% 400-600 20% 600-850
15	PL22	0.08	96.56	30000	28967	2317	0.135	312.8	70% 400-600 30% 600-850
16	PL23	0.09	96.31	30000	28894	2601	0.135	351.1	60% 400-600 40% 600-850
17	PL24	0.10	96.07	30000	28822	2882	0.134	386.2	50% 400-600 50% 600-850

Table 3. A snapshot example of a grow out-phase feed sheet.

DAY	SURVIVAL	#SHRIMP	INDIVIDUAL WEIGHT	BIOMASS (g)	FCR: 1	GROWTH/ WEEK	FEED/ SHRIMP	FEED(g)/WEEK
1	1.000	30000	1.270	38100	1.3	1.0	1.300	39000
2	0.900	27000	1.413	38147	1.3	1.0	1.300	35100
3	0.899	26973	1.556	41962	1.3	1.0	1.300	35065
4	0.898	26946	1.699	45770	1.3	1.0	1.300	35030
5	0.897	26919	1.841	49570	1.3	1.0	1.300	34995
6	0.896	26892	1.984	53362	1.3	1.0	1.300	34960
7	0.896	26865	2.127	57146	1.3	1.0	1.300	34925
8	0.895	26838	2.270	60923	1.3	1.0	1.300	34890
9	0.894	26812	2.413	64692	1.3	1.0	1.300	34855
10	0.893	26785	2.556	68454	1.3	1.0	1.300	34820

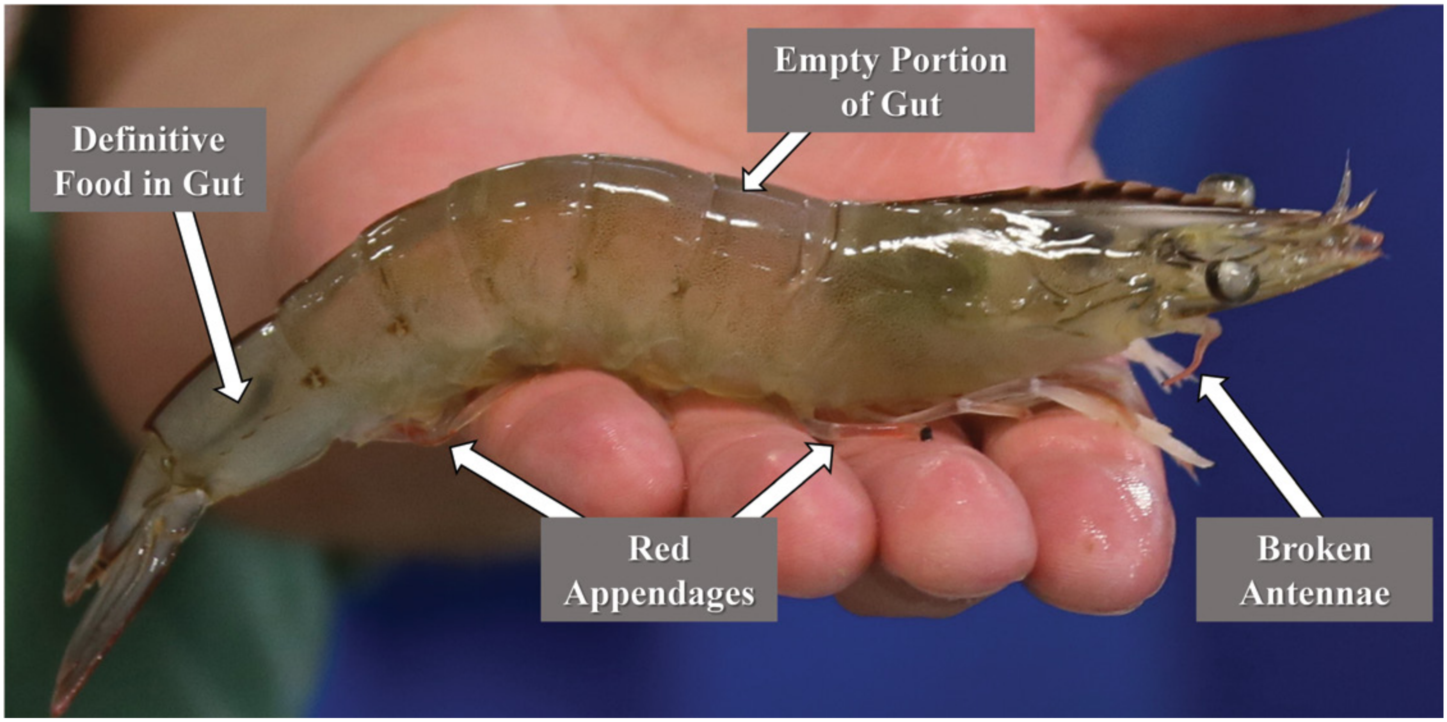

Figure 12. This shrimp has a partially empty gut, indicating the animal is slightly underfed. Broken antennae can be the result of high density culture. Red appendages can be a sign of bacterial activity; solids concentration may be high in the culture tank. The exoskeleton is firm though and the overall appearance is acceptable for harvest and sale.

frequently; automatic feeders are often used to accomplish this. For example, a farmer may check water quality parameters and feed 10% of the calculated feed ration by hand in the morning and place 30% of the daily feed ration on a 12-hour belt feeder. The farmer may repeat this process in the evening although they will add more feed for the night feeding since it is usually a longer time period.

All feed calculations are estimates. Managers must monitor feed consumption periodically using a net with appropriately sized mesh to collect uneaten feed. All food should be consumed between feedings. Overfeeding is one of the most common reasons for poor water quality and unhealthy shrimp. Shrimp should normally have a full hind gut, which indicates they are eating and they are in good health (Figure 12). The exoskeleton should normally be firm; an occasional shrimp with a soft exoskeleton is not concerning, but finding multiple soft shrimp indicates that the tank may be stressed. The rostrum should also generally be intact and there should not be many lesions or scars on the shrimp. These are all indicators of shrimp health.

Economic Considerations

The importance of key economic factors varies considerably between farms based on scale, location, management style, sales price, and other considerations. One of the major capital costs can be the building to house the operation. Many farmers use existing structures to reduce costs while others use new construction. A simple pole barn structure with spray foam insulation on the interior makes a practical space for indoor shrimp production; packed gravel makes an adequate floor, although sand may be needed under each tank to protect the pool liners. Other major capital investments include the heating system, an electrical generator and circuitry, pools, reliable water quality meters, air blower(s), air diffusers, biofilter media, feeders, nets and netting, and plumbing supplies.

Some of the major operating and variable costs include feed, labor, post larvae shrimp, energy, artificial salt, water, and transportation costs. Overhead costs may include maintenance, insurance, and professional services (such as consulting fees). It may be possible to reduce some of these costs. For instance, evaluating the use of less expensive feeds or offsetting some electrical usage with renewable energy investments may reduce overhead.

Marketing Shrimp

At a stocking density of 250 shrimp/m^3 in the grow-out phase, with proper system management, farmers can expect to have approximately 80% survival. If the shrimp are grown to an average weight of 24 grams, the total harvest can be between four and five kg shrimp/m^3. With practice, farmers should be able to increase density and improve survival, resulting in about six kg/m^3 on a consistent basis. Higher harvest rates may be possible, but are not generally repeatable and therefore are not recommended.

Shrimp is one of the few products that can command a higher price for greater unit weights. The term "jumbo shrimp" is often used to refer to large shrimp, although the exact size at which the term is used can vary. Most farmers find it worthwhile to grow a larger animal; 24 grams is the routine target weight for market shrimp at Kentucky State University. There is usually some variability in the size of harvested shrimp and ranges of counts per pound (such as 20/24 count meaning that there are between 20 and 24 shrimp per pound) are common. Some customers will prefer shrimp that are larger than this size. To produce larger shrimp, the length of the grow-out phase will need to be extended. As biomass in a tank increases, the oxygen demand will also increase. If the shrimp are crowded, they can get scars from running into one another, which may reduce their customer appeal. Partial tank harvests can be implemented to reduce biomass, but care should be taken to limit the stress of the remaining animals.

Figure 13. Sales of shrimp at a farmers' market. Direct sales to consumers are typically the most lucrative way to distribute shrimp.

Most farmers target niche markets and attempt to supply shrimp directly to the consumer whole (usually fresh, on-ice) to optimize the sale price and limit processing costs; farmers markets are a good example of a direct sales venue (Figure 13). Onion sack-style bags are useful for packaging shrimp, as the animals can be buried in ice and easily recovered (Figure 14). Selling to restaurants or distributors usually reduces the sale price, and processing the animals will add to certification issues and labor costs. Check with local health department officials before freezing or de-heading shrimp since most areas have specific guidelines that must be followed.

It is important that customers understand that indoor systems allow tight control over system inputs and are an environmentally friendly food production strategy. Key selling points that should be made to potential consumers are that shrimp produced in these systems are raised without hormones or antibiotics and fed all-natural feeds, have extraordinary feed conversion rates (as low as 1.2:1), and use very little water. Most farmers can also emphasize that shrimp are locally produced. Offering tours of the farm, so long as safety is considered, can be a good way to build interest in locally grown shrimp.

Figure 14. Shrimp packaged in a small onion sack-style bag. This makes them easy to retrieve when buried in ice. Shrimp should be chilled in ice water for at least ten minutes immediately after harvest to euthanize them and cool the meat temperature, then stored on drained ice.

Suggested Resources

DeLong D.P., Losordo T.M. 2012. How to start a biofilter. Southern Regional Aquaculture Center Publication No. 4502.

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