Reasons Why Food Fish Production in RAS Often Fails to be Viable

By David R. Russell

July 15, 2015

Continual advances and innovations in Recirculating Aquaculture System (RAS) technology have resulted in it being the preferred method of juvenile production by large mainstream aqua farming businesses. Evidence of such is seen globally with investment measured in the hundreds of millions of dollars and with early adopters making more significant investments after having seen the advantages of earlier use. Although the technology has been used successfully for the full life cycle production of many species, including salmonids, its use in the production of marketable food size fish has had a checkered past. Examination of the failures usually can identify multiple contributing factors from a list of a couple dozen. The cited causes of failure usually are interrelated and may not even be the cause as much as they are consequences of much bigger problems that were created at inception.

Getting it wrong from the start: A time tested and proven recipe to destine one's farm for failure is to exclude input from seasoned RAS operators and aquaculturists in the business model, site selection, and RAS design process. Seasoned professionals who have seen both failures and success can help one from trying to re-invent the wheel and thus avoid costly mistakes. Although disease may be the most cited reason for failure, the two most common root causes of RAS business failure are poor species selection and poor site selection. Both of which also happen to increase the likelihood of suffering significant disease losses. Most newcomers to aquaculture learn this after considerable investment already has been made, and the point of no return has been passed. Most, not wanting to accept the need to change course, press on anyway in the hope that professional assistance can turn things around. However, even the best operators can do only so much with the limitations and handicaps of a poor concept. In some rare cases, when failure is just related to poor species selection, new investment can make a go of it with a change of species, system modifications, and a new business model. Profitable farms have had their start this way, but for a new farm it is much better to get it right from the start by avoiding the mistakes others have made.

Selecting the right species: Certain species are proven performers in RAS, whereas others are not. Other species may be highly promising, but often lack some critical components of the production cycle to make them a near-term success. Marketing plans are essential, but they often overestimate selling price and underestimate the cost of production. Selecting a fish just based on the high selling price in the market has resulted in more than one failure. Fish with a high market price may not be so advantageous if they are very slow growing, cannot tolerate reasonably high stocking density, have unknown disease risks, and require too much additional R&D work to complete their domestication. When selecting a fish for producing fillets for sale rather than selling whole or into "live" markets, the fillet yield of the fish being grown needs to be factored in as well. The species selection criteria listed below are crucial for minimizing the risk of business failure in RAS.

- The species should have broad consumer appeal with known markets and market prices,
- Should already be a major aquaculture species with well-understood cultivation needs,
- Should already have a track record of being grown in RAS,
- Should be tolerant of moderate to high stocking density and have a high rate of growth.
- Stock for grow-out is available not just from one, but multiple hatchery sources.
- The source for stocking is preferably from eggs, which can be disinfected.

- The source for stocking should be from a facility with a multiyear history of being disease-free.

Salmon is one of the best species for RAS production of food fish: Salmon is one of the few species that meet all the criteria for success, and for this reason multiple companies have tried farming, are currently farming, or are in the process of developing farms for growing salmon in land-based RAS. Unfortunately, there have been more failures than success, and the reasons for it are mostly related to site selection, but the design and operating flaws are also partly to blame.

Selecting the right site: Although RAS technology is highly efficient with water use, economically competitive RAS aquaculture is very much dependent on the quality and quantity of water available and the ability of the operation to discharge the water after use. For salmon, a site with seawater access is important because their performance and the quality are much better in seawater than in freshwater. Equally important is having the ability to use much more water than is needed for water quality, as it is very useful in eliminating the need for chillers and high electric costs for cooling in summer. It also makes it much easier to produce a great-tasting product. Too many farms are making the mistake of building at inland sites with limited freshwater resources in warmer climates. These farms have extra costs for buildings, equipment, and electricity to maintain temperature and also have had significant issues producing a quality tasting product, affecting marketability. As compared to saltwater RAS, off-flavor is a much bigger problem in freshwater and much more difficult to address in a manner that doesn't add cost and complexity. Adequate purging of off-flavor in freshwater requires single pass use of freshwater and more time, which also results in greater levels of weight loss during purging.

Growing saltwater species inland: Limited ability to use seawater is the primary disadvantage of selecting an inland site. Some species require it and other species, such as salmon, do much better with it. Inland use of trucked seawater or artificial seawater mixes is very costly and requires the use of water reclamation technology. For many locations, the use of saltwater may not even be an option due to permitting constraints. Saltwater reclamation technology for the reuse of discharge is yet to be proven commercially viable and is associated with several multi-million dollar failures in non-salmonid species. For salmonid species, except trout, the facility really should be located on the coast, with seawater access, to succeed. However, coastal property with access to cool, pristine water is very expensive, except in Downeast Maine. Maine has been unfairly neglected from consideration partly because of its further distance from major metropolitan areas and partly because of a misconception of where seafood has to be for it to be considered "local."

For Seafood, "Locally Produced" means produced anywhere in the USA: In the USA, RAS often is promoted as a means of tapping into the locally produced, ultra-fresh, environmentally friendly, and antibiotic-free niche seafood markets that pay a premium above that for pen-reared imports. The mistake that investors make is thinking that the term "local" requires producing near the consuming market, whereas for most consumers, the term applied to seafood just means produced in the USA. This mistake results in selecting sites outside major metropolitan areas at sites with limited water resources and with other limitations that require greater levels of infrastructure investment, energy use, and adoption of practices that are inherently more risky. Although technologically feasible, the extra costs of being very close to market usually dwarf the delivery costs of supplying fish from a more distant site that is selected for low-cost production. Sites should be chosen based on attributes that lower the cost of production to increase profit margin and for enhanced operational flexibility.

More downgrades with freshwater production: Growing salmon in freshwater rather than saltwater results in a greater proportion of fish becoming sexually mature prior to reaching market size. This biological trait results in either very costly losses as near market size fish are downgraded from loss of pigmentation and undesirable flesh changes associated with the sexual development or in the forced use of more expensive all-female stock. The alternative is to sell fish at a smaller size, but smaller fish command a lower price per pound and are less desirable by the market.

The high cost of production: There are economies of scale that apply both to the cost of construction and to operating costs. Construction cost per unit of output decreases with increasing facility and tank size. Also, it takes the same amount of monitoring equipment and about the same amount of effort to manage small tanks as it does large tanks; thus larger is better for keeping costs lower. From a facility standpoint with 24/7/365 coverage, there are minimum labor requirements regardless of size. For RAS, labor is one of the larger production costs, and this is greatly minimized by producing more. Smaller farms, with limited finances to afford such coverage, will rely on automated monitoring, but instrumentation can malfunction and has resulted in a loss in unmanned facilities. The majority of RAS farms produce a million pounds of fish or less per year, and such a size is barely at a scale capable of producing a profit. Coupled with location site inefficiencies mentioned above, profitability is hard to achieve, and compromises are made.

Farm models, designs, and compromised practices that can lead to failure with salmon in RAS:

1. Choosing a freshwater site with limited ability to use and discharge water
2. Building at too small a scale
3. Building in a location that requires chilling
4. Building in a place with no existing aquaculture and associated support industry
5. Building a facility in a pre-existing building, for multiple reasons
6. Stocking the facility with live fish rather than starting with eggs, which can be disinfected
7. Skipping the use of vaccines due to the assumption that disease is a non-issue
8. Use of continuous production models with no extra infrastructure to allow for individual RAS system downtime for cleaning and system resetting to break disease establishment
9. Pushing the limits of system carrying capacity and stocking density
10. Use of continuous production models in which systems are always stocked, with no downtime for system cleaning and resetting to break disease cycles and to eliminate carriers of disease
11. Use of pressurized oxygenation systems with inadequate total gas pressure (TGP) regulation
12. Inadequate degassing infrastructure for CO_2 stripping and TGP associated with warming of cold source water
13. Skipping the use of pathogen control on the source water
14. Using cheaper lower quality feeds without consideration of impact on water quality