Where Are We Now? How One SARE Grant Spurred Advances in Low Cost Aquaculture Operations.

In 2008 Bill West of Blue Iris Fish Farm was awarded a Farmer/Rancher SARE grant to investigate methods for the elimination of parasites in yellow perch and bluegill. That grant (FNC08-731) was completed in 2009. By using pond-side tanks for grow-out of perch, Blue Iris was able to demonstrate 100% elimination of both yellow grub and black spot infestations even if the infective stage of the parasite was present in the water. It was believed that the design of the tank system which created a tangential flow within the tank resulted in no deposition of parasites on the fish. A second year of investigation wherein the flow was reduced to purposely encourage infestation demonstrated the affects of flow on the incidence of infestation.

Because of this success Blue Iris decided to raise all of its fish (those intended for food fish) in pond-side tank systems. The purpose of tank culture is to incorporate as many of the benefits of indoor culture and outdoor culture into one system.

So what are the benefits of tank culture?

1. Just like in indoor systems, we know exactly how many fish are in the tank and can provide the exact amount of feed needed on a daily basis.
2. Because we provide water from a pond to feed the tanks, the water exchange rate is one tank every one to two hours – a 1000 gallon tank will get from 500 to 1000 gallons per hour. Because of the exchange rate, there is no need to aerate any of the tanks i.e. the mass of the fish cannot deplete the oxygen in the supplied water. There is a need for emergency backup but that may never need to be used.
3. Continuous feeders provide 100% of the daily requirements.
4. Water spin spreads out the slow sink feed both vertically and horizontally so that even less aggressive fish are fed.
5. Tanks are automatically cleaned daily and manually cleaned weekly if needed.
6. A single pump can supply 3-6 1000 gallon tanks at about $1.00 per day electrical usage. We limit the pump capacity to under 70 gpd to avoid regulation based on Great Lakes Initiative (Wisconsin regulation).
7. Fish tested so far (perch and bluegill) both have achieved one inch per month growth.
8. There is no pond maintenance for weed control
9. A one to three tank system can be purchased and installed for under $10,000
10. Trials indicate that as many as 1500 perch can be raised in a single tank at 8 inches. If it is assumed that there are about 3.5 perch to the pound, 1500 perch is equivalent to about 430 pounds of fish per tank (can be scaled for bluegill or saugeye).
11. Blue Iris currently has a six tank system which operates using water supplied by a quarter acre pond. This system significantly reduces the footprint necessary to operate comparable open pond grow-out systems.
12. In a typical pond, water temperatures in July and August can reach high 70s and low 80s. This time window has been known to cause fish to go off feed. There may be several factors at play here but we know that oxygen transfer is reduced and becomes a limiting factor. This causes a window of reduced growth for the fish which may last from three to

five weeks. In the pond-side tank system, we have not seen any reduction in feed uptake during this time period and it may be because of the continuous water recirculation.

Using tank culture, Blue Iris conducted additional research. Two concepts that needed to be researched included:

1. Determine what water velocity was optimal to prevent parasitic infection but resulted in the greatest fillet yield.
2. Determine the shortest possible grow-out window for getting a perch from egg to market.

Evaluating water velocity needs

This project has a number of aspects. For many years, feed that is provided by the major feed companies was a modified trout feed. It was noted that perch required a higher amount of protein than trout (40% or higher) while bluegill require less protein (38%). In addition, most of the trout feeds with lower protein are a floating feed while some salmon diets with higher protein are extruded pellets that are a slow sinking pellet. Blue Iris prefers to use a slow sink pellet in the tanks especially for perch which normally feed toward the bottom. Because most trout feeds are not ideal perch or bluegill feeds, when fed to pond dwelling fish we tend to see copious amounts of fat buildup in the fish tissues. In recent years, diets have been more closely matching perch and bluegill needs.

Based on observations, water velocity will provide several functions:

1. Minimum velocity will eliminate parasitic infestations from yellow grub and black spot
2. Velocity sufficient to change the water once per hour eliminates the need to have aeration in the tank.
3. Velocity to spin the water will provide adequate feed distribution horizontally and vertically to satisfy most of the fish
4. Velocity sufficient to require the fish to swim and/or maintain water position will hopefully result in creation of greater mass. This is difficult to measure without a more sophisticated research project, however, it is noted that fish do grow an inch per month.
5. Whether we can prove that we have converted more fat to protein or not, we do know that the average fillet yield in perch has gone from between 42 and 45% yield to over 50% yield. Moreover, we do not see fat deposits anymore. This may or may not be due to velocity or perhaps just better tailor made feeds.

From this work then we know that tank culture has resulted in a significant increase in the fillet yield of the fish. There have been other facilities which have indicated fillet yields over 50% (all farm operations) but not in a pond setting.

Determining Grow-out Time Windows

There are a number of factors which determine the time it takes to grow fish from an egg to market size. Such factors include environment, sexual dimorphism, temperature, feed abundance and availability, predation, parasitism etc. In an outdoor pond environment, many of these

factors cannot be controlled. In fact, some of the reasons for going to a pond-side tank system were to get around most of the environmental factors. Whether one uses 100% tank systems to hatch and grow out fish or use a hybrid system to use pond culture for early stage culture followed by tank system grow-out, the obvious benefit is to reduce or eliminate for the most part adverse environmental factors. Regardless, it is a well known fact that in perch, females grow faster and in bluegill, males grow faster. Therefore, somewhere in the early stages of rearing, one should be size grading fish to keep similar sized fish together.

At Blue Iris, egg hatching and fry culture has been conducted in both 100% pond settings and 100% tank settings. More research has to be done in this area to optimize early stage survival but it is clear that no one has perfected an early diet for either perch or bluegill and reliance on live cultures (zooplankton) as a mainstay or supplement is mandatory.

Blue Iris does have the luxury of having several ponds and can conduct fry/fingerling production onsite. Such production is necessary to be able to re-supply next year's grow-out crop as well as have feed trained fish available to other farmers who would like to try tank systems, who have indoor recirculating aquaculture systems (RAS), or most recently, aquaponics facilities who are moving away from tilapia.

Typically in a first year run, we see spawning (central Wisconsin) occurring from the last week of March to the second or third week of April. We do not like to see any significant warm spells in March to advance the spawning because invariably there will be a cold nor'easter which will wipe out all the zooplankton and these will not be available when the fry hatch. Timing is everything. Likewise, we have seen really warm temperatures in April accelerate algae growth and fungus on eggs. It is possible that the later in the spawning season the less fertilization occurs and the more fungus one sees.

Assuming we get most of the hatch occurring by May 1, we can use that as the start date for growth. I generally raise the first year fish in rearing ponds which are drained each fall. These fish are either sold to indoor facilities or transferred to over winter ponds where they will be assessable the following spring for grow-out. Based on harvest records, there will at least 10% of the young of the year fry that will exceed five inches (some larger than six inches). There will be a significant number of fish in the 3.5 to 5 inch class. These are next year's premium class and they will be size graded in the following spring to be put into the pond-side tanks as graded.

From the first year assessment, we find that the average perch grown in a pond is just under an inch per month – May through September is five months. We know that we can exceed that growth in about 10% of the fish. However, based on observations, if we take fish out of the pond after two months, size grade them, and keep them in separate size graded tanks, the growth rate will be at least an inch per month. The only thing that seems to slow them down is the fact that they may get large enough in the first year to become sexually mature. If this happens, weight gain is sacrificed for egg mass and actual spawning the following spring. This situation could be controlled if the larger fish were transferred to an indoor system with controlled light and temperature where the fish just continued to grow out to market size.

Based on the observed growth rates, a research project was initiated at Blue Iris which was designed to determine what could be accomplished by way of growth with perch under controlled design. In this case we wanted to test the efficiency of the pond-side tanks. For this project Blue Iris partnered with the Milwaukee School of Freshwater Sciences. Milwaukee has a substantial research aquaculture facility and has the ability of conducting out of season spawning of perch. Blue Iris wanted to test a six tank system using an even age class from Milwaukee. Fish were delivered in mid-May when temperatures of the pond were high enough to match Milwaukee indoor culture systems. At that point, the fish were delivered at about five months of age and were approximately 3.5 inches average. During this test we also compared a fish meal diet versus a non-fish meal diet so three of the tanks were randomly selected for each treatment. All other conditions were the same. Dissolved oxygen and temperature were measured daily, nitrogen series weekly, and flow rates were set at about one tank (1000 gallons) per hour. As noted, no aeration was ever supplied to the tanks nor was it needed. Why is this important? We believe that it is important to have sufficient flow to continuously remove waste solids before they become dissolved solids. In doing so, it is much easier to remove waste from the water and much less costly for wastewater treatment. Aeration in the fish tank does nothing more than beat up the solids so that you have to add more expensive treatment down stream.

During this study fish were weighed and measured monthly (approximately 15% per tank per month). From this, we observed a growth rate of about one inch per month. At the Blue Iris facility, is has been determined that about September 15 is this end of the growing season for fish. Therefore, we had exactly four months of growth to evaluate. If the criteria for market size is an eight inch fish, then theoretically none of the fish should have reached market size. However, in the fish meal diet, we found between 12 to 15% market sized. In addition, of the non-fish meal diet, we found about 10% made market size. We therefore know that these fish grew at least one inch per month once they were received by Blue Iris. The rest of the fish were over wintered in a separate pond, re-introduced to the tank system the next year and were all on the table within two months.

From this study, we find that we actually can obtain a market ready perch fillet in about one year from an egg. This has significant implications for real world applications. We need to add the final pieces to the puzzle and it seems as though it will take cooperation within the industry. As an industry we have to learn how to choose systems that have the best cost/benefit ratio. Indoor systems are great but expensive. Outdoor systems are very cost effective but are strapped with a host of environmental factors. What we do know is that early season spawning will add significant growing time to the cycle but at a cost and associated problems with first feeds i.e., there is little to no zooplankton available for the early hatch and supplements are necessary. We also see that if we could extend the growing season on the back end, we would not have to chance losing fish that are slightly below market size to overwintering issues. Moreover, if indoor facilities (RAS plus Aquaponics) took five to six inch fish into their system in the fall, they would likely have market ready fish just in time for lent – a perfect marketing match.

Developing Markets

Aquaponics:

About 20 years ago, there was a significant demand for feed trained fingerlings (particularly perch) when RAS systems became the hot topic. Due to the inadequate supply of quality feed trained fingerlings, the high cost of raising perch, and the high cost of RAS systems, several hundreds of millions of dollars in RAS systems literally went down the drain. Since that time, there has been a significant push to better understand the nutritional needs of several species including perch, bluegill, and saugeye. Moreover, the recent collapse of the Great Lakes perch stocks has boosted the price of wild caught perch to well over $10.00/pound. And this has leveled the playing field for farm raised fish from a price point. We no longer have significant RAS systems devoted to perch but there has been a significant movement in aquaponics to integrate their indoor systems to include perch. Therefore, we see the demand for feed trained fingerlings on the rise.

Community Supported Agriculture (CSA)

In the big picture, it seems that pond-side tank systems would be an ideal application for the CSA market. While Blue Iris has expanded its number of pond-side tanks to 12 now, a design model has been prepared so that a single unit can be constructed for well under $5,000. Just like in a vegetable CSA, shares of product can be sold in spring and depending on the size of the fish initially stocked in the tank, harvests can begin as early as July and continue into September. Multiple harvests are more conducive to a multi-tank system whereby fish are size graded. Therefore it is more likely that a single tank system would only be harvested once and certainly completely harvested by September. Since a single tank can hold 1500 market sized fish (8 inches), the CSA owner can sell multiple shares depending on the quantity required by each customer.

Conceptually, it is not inconceivable for one unit to feed a neighborhood. If a small family of three eat one pound of fish per week, that would equate to 52 pounds a year. Based on known production rates, a single tank system could generate 240 pounds of fillets each year. That is nearly enough for five families. In this scenario, five families would support the installation, operation, and production of their entire seafood needs for a year.

CSA is not the entire picture. There are thousands of small and large farms who already have a farm pond. These farm ponds generally go unused for fish production but may not always be conducive for raising fish in the pond. With pond-side tanks, we get around requiring fish to be in the pond and these ponds can still be used for stock watering, wildlife management, and irrigation (as long as there is always sufficient water to feed the fish tanks). The options are wide open.

Photo documentation of systems discussed in this submittal are provided below.

The original 3-tank system used for the parasite study. Water is Supplied via a common manifold and all water went back into the pond

The first three of six tanks. Photos shows inlet, plumbing, and green tank used to collect fish waste and solids.

Typical overhead view showing incoming water, center overflow, and belt feeder. Bottom drain not shown collects waste

These low profile tanks are used for suspending fish eggs, hatching and first feeding of fry. They can also be used for holding fish. A number of tanks make it convenient for size grading.

This fish was raised completely in tanks using a combination of zooplankton and a fortified fry feed.

Bill West
Blue Iris Fish Farm
N5811 Twelve Corners Road
Black Creek, WI 54106
blueirisenv@gmail.com
920-450-4641