OHIO STATE UNIVERSITY EXTENSION

Buckeye Aquafarming

Ohio State University South Centers

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Welcome to the first edition of Buckeye Aquafarming. In addition to our online presence, Extension Fact Sheets, and availability for phone calls and personal visits, the OSU South Centers will now be publishing an Extension aquaculture newsletter three times a year. The intention of this newsletter is to promote farmer education in Ohio and remind everyone of time-sensitive fish farming matters. See our insert on page 6 for the upcoming water quality workshop at the South Centers. For more aquaculture information please visit southcenters.osu.edu/aquaculture/extension. If you have any questions, feel free to contact us. We are here to help.

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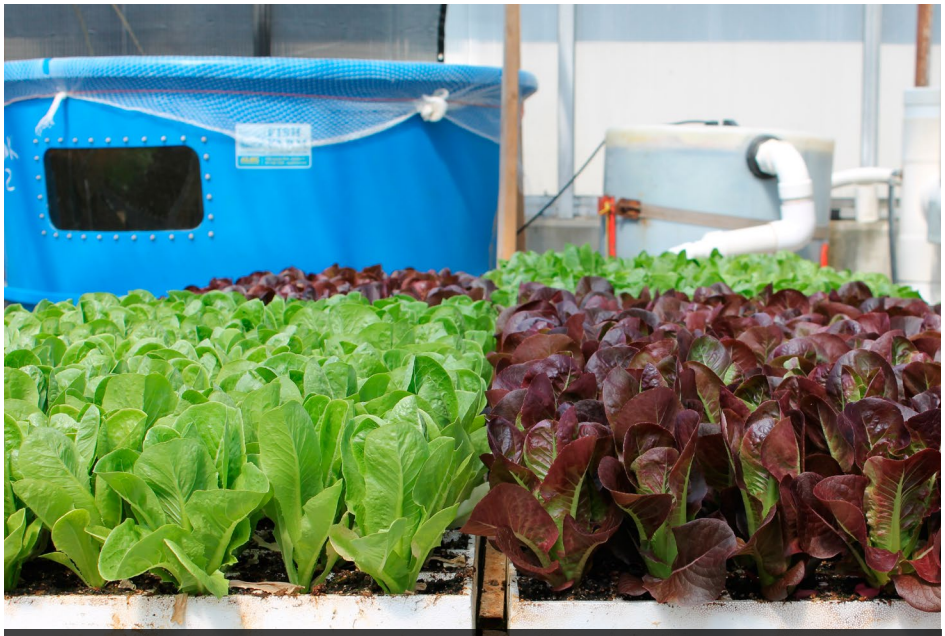
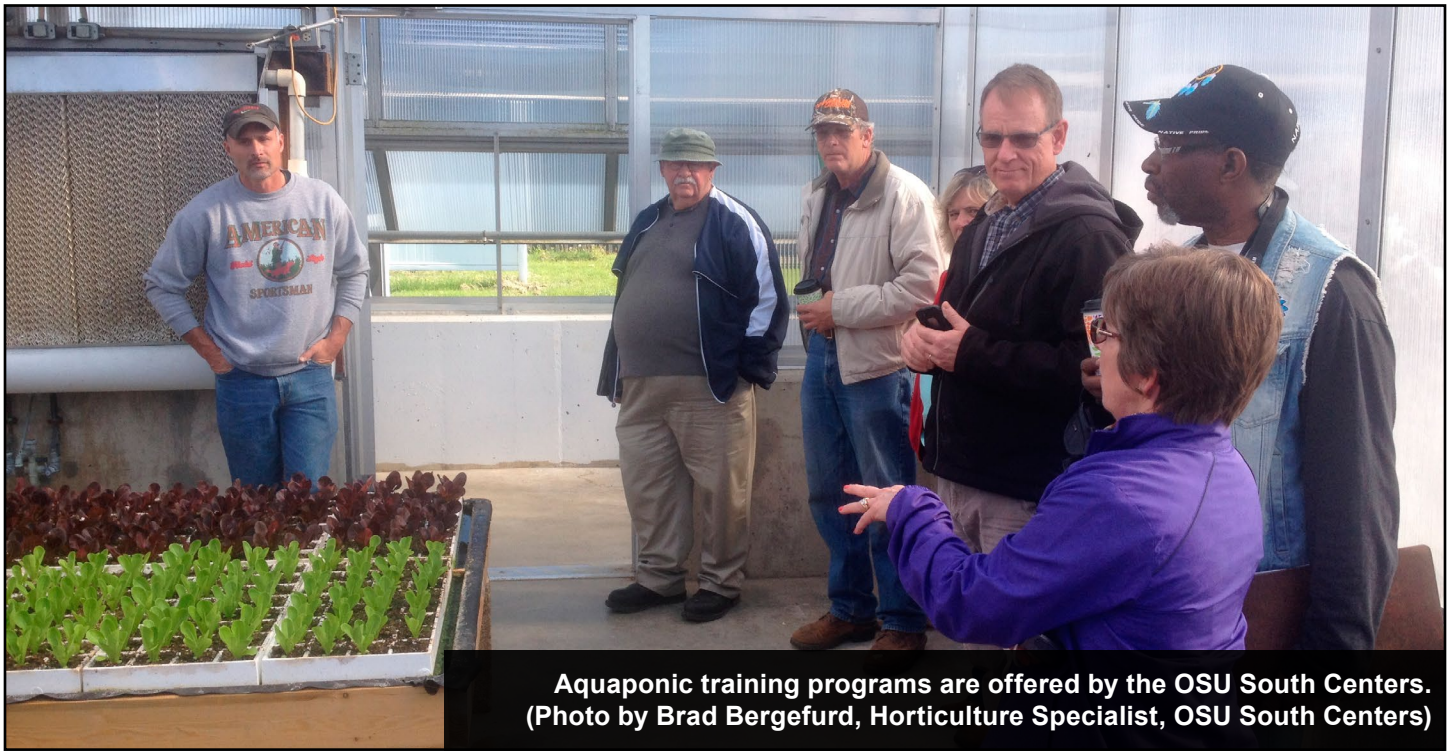


Aquaponic research trials being conducted at OSU South Centers. (Photo by Thom Harker, Research Assistant, OSU South Centers)

Sustainable aquaponic vegetable and fish co-production in Ohio

By Brad Bergefurd, Horticulture Specialist
(OSU South Centers, Piketon)

Producing vegetables and fish in a linked hydroponic plant and aquaculture fish co-production system is call aquaponics. Plants can use the water and nutrients from the aquaculture tank, thus reducing water and fertilizer requirements and significantly reducing waste discharges from the aquaculture system. Producing plants hydroponically and farming fish using aquaculture have their own special requirements in order to properly manage each system. When combining the two, it adds a layer of complexity for the commercial grower when systems are maintained at plant and fish population levels recommended for maximum yields. This article provides some basic aquaponic guidelines that have been developed from research conducted by the Ohio State University Piketon Research and Extension Center. *(continued on page 2)*



Aquaponic training programs are offered by the OSU South Centers. (Photo by Brad Bergefurd, Horticulture Specialist, OSU South Centers)

Sustainable aquaponic vegetable and fish co-production in Ohio *(continued)*

Aquaponic Systems

The most common aquaponic systems currently in use employ either a media-filled plant bed, nutrient-film technique (NFT), or a floating raft system for the plant growing area integrated with a recirculating aquaculture tank system (RAS) for the fish production area. Almost any type of vegetable production system can be linked to an aquaculture system, including open field production, if recycling water back to the aquaculture unit is not required. This technology is young and trialing is recommended, especially for untested systems.

Plant and Fish Crop Choices

Any plant commonly grown in hydroponic systems will adapt to aquaponics including the most common types – leafy salad crops, herbs, tomatoes, peppers, and cucumbers. The most commonly cultured fish in aquaponic systems is tilapia because it is relatively tolerant to poor water quality, has an established market, and grows fairly quick. Other fish adapted to aquaponics but requiring more stringent water conditions than tilapia are largemouth bass, yellow perch, bluegill, goldfish and koi. As interest in aquaponics increases, so will research on alternative plant and fish species.

If you are interested in learning more about aquaponics and research that is being conducted, if you would like to join our Ohio Aquaponics or Horticulture email listserv, or for more information, visit the OSU South Centers website http://southcenters.osu.edu/horticulture or contact Horticulture Specialist Brad Bergefurd, Bergefurd.1@osu.edu or call the OSU South Centers 1.800.860.7232 or 740.289.2071 ext. 132.

Suggested Readings

Beem, M. 2014. *Aquaculture: Realities and Potentials When Getting Started.* SRAC Publication No. 441. Southern Regional Aquaculture Center, Stoneville, MS.

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Sell it before you grow it

By Christie Welch, Direct Agricultural Marketing Specialist (OSU South Centers, Piketon)

If you are considering getting into the aquaculture industry, I am sure you have done your research on different production methods, species, and resources required to produce your chosen product. Just as important is researching the potential, or lack thereof, markets for your product. Producers often begin an enterprise because they love the idea or actual task of producing the crop. However, many fail to consider where they will sell their fish or shrimp and to whom. If you are simply looking for a hobby, by all means, move ahead and conquer your venture. But, if you are depending on the income generated from the enterprise to grow and sustain itself, then you must take the time to conduct market research before you begin production.

Many small producers have taken advantage of the increase in demand by consumers for access to locally produced foods. The difference between aquaculture production and fruit or vegetable product relates to the amount of money and infrastructure needed to enter the industry.

Let's consider the individual that has enjoyed gardening all their adult life. Maybe they have recently retired from a different profession and have decided to take advantage of the current opportunities to turn their hobby into an enterprise. Typically small fruit and vegetable production can be undertaken will little to no capital investment. Likewise, there are a myriad of ways fresh unprocessed fruits and vegetables can be sold. Ohio ranks seventh in the country for the number of farmers' markets operating in the state. This producer can also participate in one or more farmers' markets in their region with little capital investment required. They many only require a tent, table, and produce to participate. In addition, the producer can receive direct feedback from customers on their products. This allows them to grow those items customers demand.

Now, contrast this with an aquaculture enterprise. There is a great deal of investment needed before a crop is ready to sell. Whether they chose to use pond production techniques or recirculating systems, the required capital to construct the facilities, purchase the fry, feed, and other necessities to produce the product all come with a cost. In addition, there will be expenses prior to having income for your enterprise. This can be especially troublesome with many aquaculture products taking one to three years to reach market size.

The old adage, "build it and they will come" does not necessarily hold true. Businesses may have a great product that is healthy and grown sustainably but if the customer does not know about it or is not willing to pay the necessary costs for the product, then the business will not be profitable. This will eventually lead to a failed business if the problem cannot be addressed.

As you have now realized conducting the necessary market research is just as important as the research you conduct on how to produce the product. And, there are additional considerations. While fruit and vegetables are perishable, there are even greater considerations for post-harvest handling of aquaculture products.

Businesses may have a great product that is healthy and grown sustainably but if the customer does not know about it or is not willing to pay the necessary costs for the product, then the business will not be profitable.

One question to answer is where will the product be sold? If it is a live product, the producer will be required to ensure proper handling procedures are in place long before the first harvest. Knowing what permits, licenses, training, etc. will be required to follow to offer the product to the consumer is also important. This will dictate to a great extent where you will interact with your potential customers. If you are planning to raise fresh water prawns, you will most likely be selling them live from the pond on harvest day. Are there a sufficient number of customers that will travel to the farm, pay the price necessary to make a profit, and be willing to handle and prepare live or freshly chilled whole shrimp? How will these potential customers know when, where, and how they can purchase your product? Unlike the fruit and vegetable producer who can travel to the customer and store their product for a day or two if needed, handling live fish or shrimp requires a very different method. An Ohio fish farmer's aquaculture permit enables the farmer to sell their product live or whole on ice. This approach may work well at farmers' markets where the customers desire a live or whole product. To sell fish like this, producers will need to take into consideration how to transport the product, keep it alive or chilled, and "package" it for the customer. Providing a processed product is a bit trickier. *(continued on page 4)*

Examples of seafood sold to a processor. (Photo by Matthew A. Smith, Extension Aquaculture Specialist, OSU South Centers)

SELL IT BEFORE...*(CONTINUED)*

To sell a processed product off the farm in Ohio, that product must be processed, packaged and labeled at a Hazard Analysis Critical Control Point (HACCP) approved processing facility. Once processed, the fish or shrimp will need to be transported, stored, and marketed, which are all important questions to answer well in advance of the first harvest.

So, while you are hoping to take that love of producing aquaculture products and turn it into a successful enterprise, don't neglect the importance of conducting as much market research on to whom and where you will sell your product as you do researching how you will best produce that product. If you need assistance in conducting your market research, the OSU Direct Agriculture Marketing website offers some resources to help, southcenters.osu.edu/marketing. You can also email welch.183@osu.edu for additional information about direct marketing your agricultural products.

If you need additional information on aquaculture production visit southcenters.osu.edu/aquaculture/extension or contact Extension Aquaculture Specialist Matthew Smith at 740.289.2071 ext. 121 or smith.11460@osu.edu.

Size matters in fish, so does genetics

By Paul O'Bryant, Research Assistant and Hanping Wang, PhD, Senior Scientist (OSU South Centers, Piketon)

With any successful aquaculture operation, farm pond or general hobbyist, there comes a time when the person asks "What can I do to make my operation better and grow fish bigger?" The obvious answers that first come to mind should be: I will feed my fish the best quality feed; I will monitor my water quality and address issues before they become problems; I will invest adequate resources to obtain quality eggs or fingerlings; I will acquire the best genetically selected stock that I can find to use in my operation. Wait! What!? Genetically selected brood stock is not an obvious thought when a farmer first thinks about improving their enterprise and increasing their profits, but it is one that can be highly beneficial if applied in the right circumstances. This article will discuss some of the benefits of using genetically selected fish for your farm operation and how to maintain a healthy genetic diversity.

One of the first things that need to be mentioned is that a genetically selected organism is different from Genetically Modified Organisms or GMOs. A GMO is an organism that has been genetically altered or changed to exhibit a quality it does not normally have. A familiar aquaculture example of a GMO would be the brightly colored fluorescent GloFish® that are found in most pet stores. These fish do not naturally exhibit this bright color but have been modified to do so through genetic modification. Another aquaculture example would be salmon, although Gino salmon are currently unable to be imported into the United States, per the Food and Drug Administration. A gene has been added which enables faster year-round growth.

(continued on page 5)

Size matters in fish, so does genetics *(continued)*

The purpose of this article is not to discuss the positives or negatives of GMOs but only to briefly define what they are, as to not confuse genetically modified organisms with genetically selected organisms before we talk about genetically selected fish.

In contrast, www.medicaldictionary.com defines a genetically selected organism as "selecting animals as breeding stock on the basis of known inherited characteristics". This can easily be viewed in other animals of the agricultural setting such as cattle, poultry, hogs, etc. An example of genetic selection in the beef cattle industry would be bull selection. Bulls are chosen on muscle mass, body structure, body size and even scrotal size! Livestock records can be traced back many generations and meticulous records are kept to ensure the best quality end product. However, with fish and aquaculture, that is a different story.

Best advice is to RECORD EVERYTHING!

In recent years, most fish obtained for an aquaculture operation have been purchased based on availability, price and location. The mantra of "it's close and you have it" is what drives the purchase. However, this may not be the best practice for obtaining a high quality stock to use in your operation. These fish may be leftovers from a previous year or graded-out smalls that are being sold as younger stock. One of the first steps to take is purchase from a reputable fish hatchery. Ask the seller where they get the fish for his/her operation. How long have they been in business? Do they raise the fish they sell or purchase them elsewhere? These can be small clues to the quality of stock you will receive.

Once a quality stock has been purchased, there are a few steps that can be taken to ensure high quality stock from your operation for years to come. Unlike other agriculture operations where a bull or roosters can be kept separate from the herd or flock, it is somewhat impractical to separate and raise males or females for spawning and breeding purposes in fish. It is also not necessary, as most fish spawn only at certain times of the year. However, it is highly advantageous to purchase two or more different stocks of fish from unrelated sources. Using two or more unrelated stocks of fish can reduce inbreeding in the population, and reduce the chance that undesirable traits appear in the offspring.

Another step in maintaining a healthy genetic population is to select for the traits that you desire in your population. As in most cases, if larger and unrelated fish are selected in the population, this can help the offspring become larger in turn. If color is the desired trait, such as in koi breeding, then selecting the parents based on desired color will increase the chances of the desired color displaying in the offspring.

Finally, as with any successful operation, keep thorough records. Record where fish are located, and the origin if known. Keep records on age of fish and sizes. When spawning, record what fish groups were mated and where the offspring are located. The best advice is to RECORD EVERYTHING!

If these few steps are followed, a diverse population of fish can be maintained in your operation. For information on genetic selection in general or on the genetically selected yellow perch and bluegill housed at the Ohio Center for Aquaculture Research and Development at OSU South Centers, please contact Dr. Hanping Wang at 740.289.2071 ext.125 or wang.900@osu.edu.

Suggested Readings

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Eenennaam, A.L. 2005. *Genetic Engineering and Fish.* University of California, Davis. Pub. No. 8185. http://anrcatalog.ucanr.edu/pdf/8185.pdf (May 16, 2016)

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OHIO STATE UNIVERSITY EXTENSION

Water Quality Workshop for Fish Farmers

Join us to learn about the importance of water quality management:

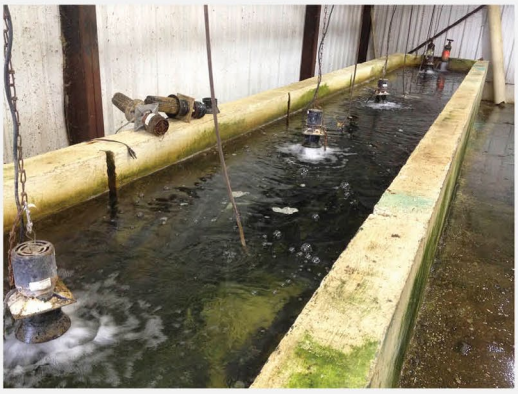
Each participant will receive lunch and an informational flash drive. Registration includes a tour of the aquaculture research facility and aquaponic greenhouse. Come out and learn from our research and Extension experts! Speakers range with backgrounds in Aquaculture, Horticulture, Small Business Development, and Soil & BioEnergy. The workshop will include PowerPoint lectures, but will also include hands-on work identifying water and weed problems applicable to fish farmers in Ohio.

Recording and interpreting water quality parameters are essential to running a successful fish farm in a sustainable manner. Stressed fish due to poor water quality do not grow well! Whether you have been in the business for many years, just starting out, or haven't broken ground yet, it is important to understand what parameters are important to fish and plant crops so that the business or hobby will succeed. We look forward to seeing you there!

What we will cover:

- Understanding and interpreting WQ parameters necessary for fish production
- Understanding your water quality analysis report from the South Centers
- How does poor WQ affect your wallet?
- Hands-on testing of key WQ parameters
- Fish WQ management in RAS/aquaponics
- Plant WQ management in aquaponics
- Hands-on aquatic weed identification and treatment options

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES



Saturday, August 6, 2016

8:30 am - 5:00 pm

Location: OSU South Centers

1864 Shyville Rd., Piketon, Ohio 45661

Large Auditorium (Research Building)

Cost: Early registration before July 16
$35

Registration after July 16
$45

All registrations due by noon, July 29

Limited space: 30 participants

To register: Contact Sarah Strausbaugh
strausbaugh.54@osu.edu
740.289.2071 x112

Testing your water quality and maintaining good records

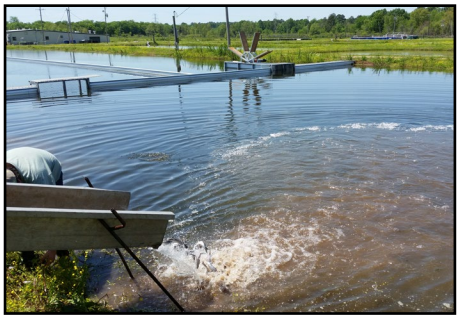
By Matthew A. Smith, Extension Aquaculture Specialist (OSU South Centers, Piketon)

Summer months can be a very joyous time for farmers as they feed their fish every day and watch them splash at the surface competing for pellets. This joy is brought on not only by the thought of the crop making money for the farmer, but also because they genuinely enjoy being a farmer and seeing their crops grow. Preparation for these moments is either continuous or seasonal (prepping for the production season in winter and spring). Will the supplier have enough fingerlings? Are my tanks or ponds ready for the introduction of a fresh crop? Will enough people be available to help me stock, sample, and harvest my fish? Do I know where I am selling my crop? These are examples of stressful questions that should be thought about and answered before this time of year.

What is often overlooked, misunderstood, or just not cared about is water quality. There are three time frames in which losses to water quality are most frequent: 1) stocking 2) in the heat of summer when feeding rates and oxygen consumption are at their highest, and 3) harvest when they are in the seine and hauling truck.

1) Preventing loss of fish at stocking

Whether fish (generally fry or fingerlings) are brought onto the farm from another farm, transported on the same farm from inside the hatchery to outdoors, or even moved from one tank or pond to another of the same, it is necessary to temper fish. Because fish are cold-blooded (like reptiles) they do not regulate their own body temperature like humans do and are very sensitive to abrupt changes in water temperature. A quick check with the thermometer can save thousands of dollars and many hours of the farmer's time. If the temperature difference between where the fish are currently held and their destination is more than a few degrees different (~2 °F), then take the time to conduct a partial water exchange. Replacing 10 – 15% of the water where the fish are being held every 15 minutes should allow the fish to properly acclimate.



Stocking hybrid catfish in a research split pond at the University of Arkansas at Pine Bluff. (Photo by Matthew A. Smith, Extension Aquaculture Specialist, OSU South Centers)

The pH of the water is another reason to conduct a water exchange at such a slow rate. Abrupt, or quick, changes in pH levels can cause both acute and chronic fish losses. With a pH meter or water quality test kit, the pH of water can quickly be determined. Investment in a good water quality test kit will quickly pay for itself. The desired pH range for fish production is approximately 6.5 – 9.5; however, just because the hauling water and stocking waters fall within this range does not mean it is safe to stock. Frequently test the temperature and pH as water is slowly being exchanged in the hauling water. This is a tedious task, especially during the busy stocking and spawning season, but should be done properly to ensure that minimal fish loss occurs during stocking. Even if pH and temperature are very close between the same waters, it is a good idea to temper anyways in case the minerals or nutrients in the water are vastly different, which could potentially cause mortality as well. An example of this could be salinity.

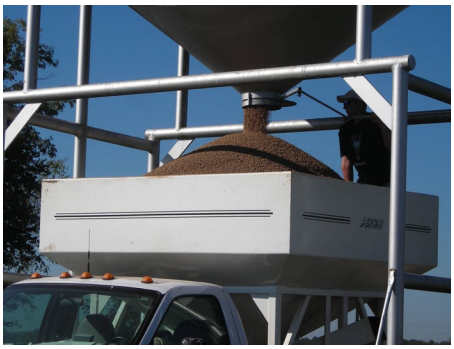
2) Preventing loss during high feeding rates in the summer

During the peak hybrid catfish (♂ blue catfish; ♀ channel catfish) growing season in the south, it is common for large commercial farmers to feed well over 150 lbs/ac/day. This can be done successfully without causing high mortalities by keeping good records and frequently testing important water quality parameters, such as temperature, dissolved oxygen (DO), ammonia, nitrite, and pH. With good records, an experienced fish farmer can examine their water quality results and see the "health" of each pond. Understanding the records can help prevent and limit the stress that poor water quality brings on fish.

Although farmers in Ohio may not reach such extreme feeding rates, the potential for degrading water quality is still there. As water temperatures and feeding rates increase, so does the consumption of oxygen in the water. *(continued on page 8)*

Testing water quality and maintaining your records *(continued)*

It is well established that the warmer the water the lower the oxygen saturation point. This means that warmer water can hold less oxygen; any excess added is usually bubbled off in a pond setting. Add the lower oxygen saturation point to the increased feeding rates and mortality due to low oxygen can occur. Some believe that if fish are not "piping" at the surface or washed up dead on the shore, then fish are not stressed due to low oxygen concentrations. Recent research out of Stoneville, Mississippi has shown that hybrid catfish held in high DO (minimum >3.8 mg/L) pond water gained an average of 44% more weight compared to the same fish at low DO (minimum 1.6 mg/L in year 1 and 1.3 mg/L in year 2). From stocking to harvest, survival was a minimum of 87%. Although hybrid catfish are not really grown in Ohio, these types of results are likely to be applicable to many of Ohio's cultured species.

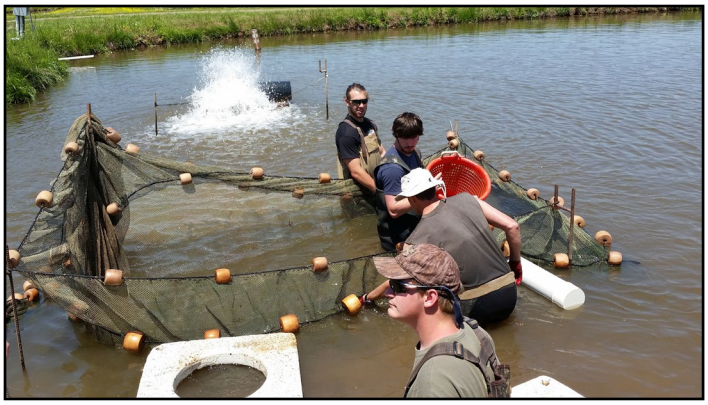


A commercial size feed truck being filled on a farm in Alabama. (Photo by Dr. Luke A. Roy, Extension Aquaculture Specialist, University of Arkansas at Pine Bluff, Lonoke AR)

In addition to oxygen problems, nitrite (the toxic un-ionized form of ammonia; NH3) and pH can cause fish kills during the heat of summer. Both temperature and pH determine how much of the ammonia is in the toxic form. Ammonia concentrations are generally lower in the summer than in the winter; however, the amount of ammonia in the toxic form is higher during warmer months. pH is highest in the afternoons due to microscopic organisms in the ponds. These organisms, mainly phytoplankton, use up acids (carbonic acid) in the water as part of their growth. As a result of their growth, they produce oxygen. This oxygen is necessary for fish, although removing acid causes the pH to rise, making the water more basic. "Swings" in pH should be limited as much as possible to reduce stress on fish. Shifts in pH can be minimized by maintaining pond alkalinities of at least 75 mg/L. Alkalinity "buffers" pond water, keeping pH at a more stable concentration. Agricultural limestone is usually added to ponds to buffer as needed.

3) Preventing stress of fish during harvest to minimize loss during transport and restocking

There are many ways to harvest a pond. Depending on the size of the pond and the necessary pounds/quantity needed for harvest, water may be partially drained or partially harvested. If ponds are to be partially drained to facilitate easier harvesting, it is best to not start draining until the night before harvest. Knowing how soon to start draining a pond is not an exact science. Not all ponds drain at the same rate due to gravity, size of outflow pipe and pond, potential outflow blockage by debris, and slope of the pond. It is necessary to keep a close eye on the pond as it drains down to prevent letting out too much water, which could result in depleted oxygen and fish mortality. Partial draining activities should be limited to cool/cold months and partial harvesting without draining can be done during any month that it is safe to handle the specific species. The water can be drained down to make for easier harvesting but should stay deep enough so that when fish are crowded in a net they are not scraping the bottom of the pond. Bringing the lead line to the shore is necessary to keep fish from escaping but once all of the lead line is pulled up it is best to slide the pocket of fish to deeper water. Keep the pocket large when the fish are first seined. As pounds are removed, the pocket can be made smaller to allow for faster netting. This will mean a few more steps in between each bucket or netting but will help limit stress. Once fish are in the pocket it is necessary to move quickly and get them out of the net and into the oxygenated hauling truck. This crucial point in time is even more necessary if they are to be restocked somewhere else. *(continued on page 9)*



Summer fingerling hybrid catfish harvest in Arkansas. Note the placement of the aerator to limit stress. (Photo by Matthew A. Smith, Extension Aquaculture Specialist, OSU South Centers)

Testing water quality and maintaining your records *(continued)*

If fish are going to be held for any extended period of time in the large seine, it is necessary to set up a paddlewheel aerator about 10 – 15 feet away to direct oxygenated water towards netted fish. This will limit stress and prevent losses. Setting aeration up too close can toss the fish around and cause additional stress and mortality, while setting up too far away will not get enough aeration and water flow to the bag to be beneficial. Additionally, many fish species do not tolerate turbidity well. In shallow waters mud is kicked up by workers where the fish are held. Moving fish into slightly deeper water and turning on a paddlewheel can help push suspended solids away from where the fish are bagged.

> Once fish are in the pocket it is necessary to move quickly and get them out of the net and into the oxygenated hauling truck. This crucial point in time is even more necessary if they are to be restocked somewhere else.

Selling and marketing fish is one task; delivering healthy and hardy fish is entirely different. Even though the fish may not be dead in the seines or hauling truck does not mean they will not die after restocking. When stressed, fish lose some of their slime coat. This slime coat basically helps protect the fish from getting sick. Stressed fish are more susceptible to harmful bacteria, viruses, and parasites that may kill them over time. This is a chronic stress and is something every farmer should be concerned about when handling fish. Delivering healthy fish can help ensure future sales to that customer and to future customers. Word of mouth on a job well done will vastly improve sales.

Although this article gears toward pond farmers, necessary water quality considerations transcends into recirculating aquaculture systems, aquaponics, and cage culture.

Suggested Readings

Durborow, R.M., D.M. Crosby, and M.W. Brunson. 1997. *Ammonia in Fish Ponds.* Fact Sheet Publication No. 463. Southern Regional Aquaculture Center, Stoneville, MS.

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Agricultural Cooperatives and Ohio Aquaculture

By Hannah Scott, Ohio Cooperative Development Center Manager (OSU South Centers, Piketon)

As an emerging agricultural industry, Ohio aquaculture faces unique challenges ranging from limited capital to accessing appropriate technology and meeting market demand.[1] Historically, one of the methods American farmers have turned to in order to address challenges related to capital, marketing, and other issues has been the cooperative business model.

Cooperative businesses market their members' products, purchase supplies for their members, provide their members a service, or some combination of these three functions. The businesses are owned and democratically controlled by those who use these services;[2] many also follow a set of cooperative principles that includes such guiding ideas as fostering member economic participation and providing cooperative education. Often, co-op businesses develop in response to market failures like missing markets or monopoly power, the development of new technologies, economic crises, and other forces.[3] *(continued on page 10)*

Agricultural Cooperatives and Ohio Aquaculture *(continued)*

For example, Southern States Cooperative was founded in 1923 by approximately 150 Virginia farmers who were trying to more easily procure seed by combining their resources. Today, the co-op is owned by over 200,000 farmers and purchases, makes or processes feed, seed, fertilizer, farm supplies, and fuel that members purchase at retail locations throughout 23 states.[4]

While Southern States was one of the largest cooperatives in the United States in 2014,[5] it was only one of 2,106 agricultural cooperatives representing close to 2 million members that year. Those co-ops marketed products like cotton, dairy products, wool, and vegetables, or supplied products like feed and seed. American agricultural co-ops had a total business volume of $246.7 billion in 2014.[6]

Keeping in mind that agricultural cooperatives are formed to help their members solve a common problem, how might the cooperative business model benefit the emerging Ohio aquaculture industry?

One way that co-ops create advantages for members is through pooling or aggregating resources. By combining their purchasing power, co-op members can offset the market power of suppliers and receive bulk discounts when purchasing large volumes of materials.[7] In aquaculture, this may apply to fingerlings, feed, seines, processing plants, and other commonly used supplies across the industry.

Similarly, marketing co-ops aggregate their members' related products in large volumes while maintaining farms as independent businesses, creating the potential to increase farmers' bargaining power with purchasers and lower the costs involved in marketing, such as distribution.[8] In Ohio aquaculture, this approach might allow farms to access high-volume markets that a single farmer may be unable to serve on their own. Additionally, marketing under, an industry brand program such as, "Ohio Aquaculture," can benefit the entire industry through consumer awareness. Pooling or coordinating marketing resources could allow the voice of Ohio aquaculture to be louder than if resources were deployed independently.

Some marketing cooperatives also process or add value to their members' products, which extends producers' control downstream in the supply chain and may allow them to realize additional margins.

While an individual farm might face major barriers to adding value on their own, including access to sufficient capital and raw product, a group of farmers may be better able to pool their resources to make such integration feasible.[9]

One way that co-ops create advantages for members is through pooling or aggregating resources.

Finally, insufficient information and limited knowledge have been identified as barriers to the development of Ohio aquaculture.[10] Co-ops sometimes work to address knowledge barriers through training, education, or consulting services that might help their members improve product quality, adopt new technologies, and increase their knowledge of business issues.[11] Member or producer organized educational efforts in Ohio, through a cooperative or other organizations could help individual producers become more effective.

If you have further questions about the co-op business model, the Ohio Cooperative Development Centers (OCDC) at the Ohio State University South Centers works with new and emerging cooperatives and cooperative-like businesses in an effort to support economic development. The center provides services and resource linkages, including formation counseling, member education, bylaw development, board training and assistance with feasibility studies, strategic plan development, business planning, and policy development. For more information, visit southcenters.osu.edu/cooperatives, call Hannah Scott at 740-289-2071 x227, or email her at scott.1220@osu.edu.

Suggested Readings

1 "Ohio Aquaculture Industry Analysis," (Report prepared for Ohio Department of Agriculture by Ohio State University South Centers, 2010), 7-8, http://www.agri.ohio.gov/public_docs/forms/Aquaculture/OhioAquacultureIndustryAnalysis%20(final).pdf

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Suggested Readings *(continued)*

2 U.S. Department of Agriculture, Rural Development, Co-ops 101: An Introduction to Cooperatives by Donald Frederick, edited by James J. Wadsworth and E. Eldon Eversull, Cooperative Information Report 55 (Washington, D.C.: United States Government Printing Office, 2012), 1 & 41-43, http://www.rd.usda.gov/files/cir55.pdf

3 Kimberly A. Zueli & Robert Cropp, "Cooperatives: Principles and Practices in the 21st Century" (University of Wisconsin Extension), 15 & 45.

4 "Southern States Heritage," Southern States, accessed May 8, 2016, https://www.southernstates.com/sscinfo/our-heritage/southern-states-today.aspx

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6 U.S. Department of Agriculture, Rural Development, Agricultural Cooperative Statistics 2014 by Carol Liebrand & James Wadsworth, Rural Development Service Report 78 (Washington, D.C.: United States Government Printing Office, 2016), 8-9, http://www.rd.usda.gov/files/publications/SR%2078%20Cooperative%20Statistics%202014%20Report_0.pdf

7 U.S. Department of Agriculture, Co-ops 101: An Introduction to Cooperatives, 25.

8 U.S. Department of Agriculture, Co-ops 101: An Introduction to Cooperatives, 26-7.

9 U.S. Department of Agriculture, Co-ops 101: An Introduction to Cooperatives, 41-42.; Robert J. Sexton & Julie Iskow, "Factors Critical to the Success or Failure of Emerging Agricultural Cooperatives," Giannini Foundation Information Series 88 (1988): 2-3.

10 "Ohio Aquaculture Industry Analysis," 22-3.

11 "Southern States Heritage," Southern States ; Zueli & Cropp, "Cooperatives: Principles and Practices in the 21st Century," 77.

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