EXTENSION NEWSLETTER

Managing Higher Catfish Feed Prices in 2022

Terry Hanson, SFAAS and Wendiam Sawadgo, Agricultural Economics and Rural Sociology

In the catfish industry, feeding fish is everything. Changes in corn and soybean prices lead to fluctuating catfish feed prices. Thirty-two percent crude protein catfish feed contains 30 to 44 percent soybean meal, 15 to 20 percent corn grain, and up to 20 percent corn gluten feed. As corn and soybean prices rise, catfish feed prices do as well.

2021 Markets

Catfish feed prices were high in the first half of 2021, at approximately $500 per ton (Fig 1). A decreased supply in corn and soybean production in the United States led to an increase in corn, soybean, and soybean meal prices (Fig. 2). This decrease in grain crop supplies was due to trade policies, drought, storm damage, and yield changes (decreases). By mid-year, the outlook for these commodities improved and there was a $40 per ton decrease in catfish feed prices during July through August. This lower feed price did not last and the industry saw increased feed prices by the end of the year when it increased back to near $500 per ton. Fortunately for catfish producers in 2021, the price they received for catfish sold to processors also increased, making the burden of higher feed prices less (Fig. 3). However, feed prices are still a concern as this expenditure makes up approximately 50 percent of all variable costs. Thus, it is important to try to understand which way catfish feed prices will head in the upcoming 2022 catfish production year.

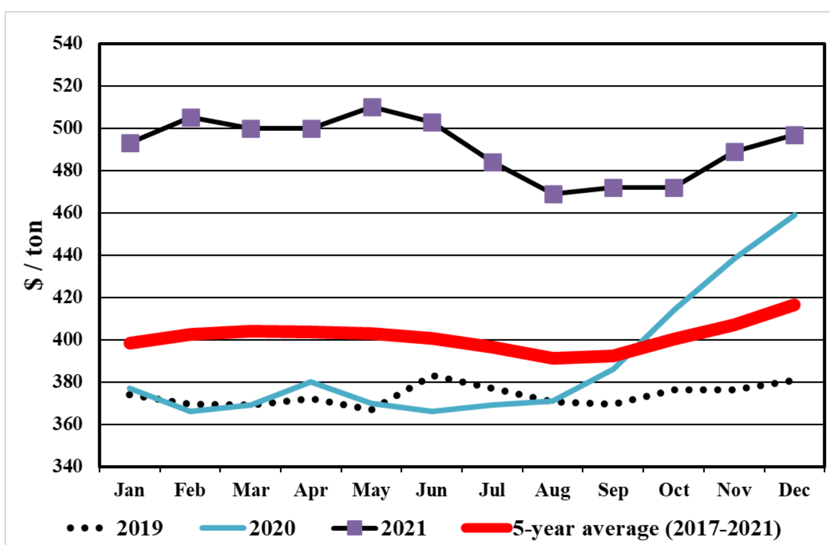


Fig .1. Catfish feed prices for 32 percent protein feed in 2019, 2020, and 2021 as well as the five-year average.

Fig. 2. Corn and Soybean Prices Since 2020. (Source: Macrotrends)

Overcoming High Feed Prices

Below are four approaches to understand catfish feed price movements and ways to adjust your operation to reduce expected high catfish feed costs in 2022.

1. Watch Futures Markets

Catfish producers should always keep an eye on the corn and soybean futures market prices. In addition to cash prices, which show the current price of the commodity, futures prices provide the markets' prediction of what prices will be at different points throughout the year.

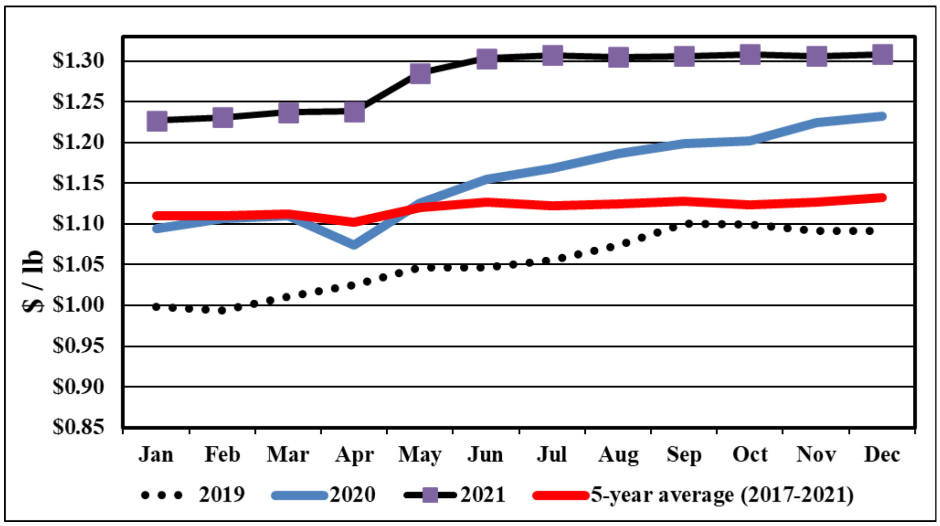


Fig. 3. Premium sized catfish (1 to 4 pounds) price to producer for 2019, 2020, 2021, and the five-year average.

The primary crop ingredients in catfish feed are soybean meal and corn, at about 50 and 37 percent, respectively. A producer can check futures markets through the Chicago Board of Trade. There, they can see futures contracts on corn and soybean derived from traders who are using all available information to determine future prices. To check on commodity future contract prices, visit the CME Group website and search for corn quotes, soybean quotes, or soybean meal quotes.

Future commodity prices are a good summary of factors likely to influence market prices. When comparing current commodity prices with future contract prices six to eight months later in the year, future prices provide an idea of which way traders currently expect the commodity's price will go. As shown in Table 1, the future prices for each commodity are slowly decreasing over the next two to eight months. This reflects the seasonal nature of row crops, as prices decrease when supplies are the highest after harvest. However, conditions change quickly, and as the latest information about crop production becomes available, these future prices adjust accordingly. For instance, acreage planted of each crop and crop conditions will affect prices throughout the growing season.

Another tool to predict prices is the USDA World Agricultural Supply and Demand Estimates (WASDE). This publication estimates and projects farm-level prices for the entire marketing year for commodities. Corn, soybean, and soybean meal prices are all expected to be higher than what we have seen in recent years, as shown in Table 1. For example, corn prices were estimated at $3.56 per bushel in the 2019/2020 marketing year, $4.53 in 2020/2021, and are expected to reach $5.45 this current marketing year. The WASDE along with the futures prices suggest feed prices could continue to increase in 2022.

	Corn ($/bu)		Soybean ($/bu)		Soybean Meal ($/ton)	
Cash Price		7.52		16.39		474.90
Futures Prices[1]	**May '22**	7.49	**May '22**	16.59	**May '22**	458.70
	Jul '22	7.51	**Jul '22**	16.34	**Jul '22**	451.40
	Sep '22	6.74	**Aug '22**	15.80	**Aug '22**	439.20
	Dec '22	6.43	**Sep '22**	15.00	**Sep '22**	428.30
			Nov '22	14.53	**Oct '22**	416.90
					Dec '22	414.30
Prior Year Prices[2]	**2021/2022 (Forecast)**	5.45		13.00		410.00
	2020/2021	4.53		10.80		392.31
	2019/2020	3.56		5.57		299.50

[1] Futures Prices obtained from Chicago Mercantile Exchange: closing prices on March 7th, 2022

[2] Marketing-year average farm prices received, USDA World Agricultural Supply and Demand Estimates February 2022; Note that the marketing year begins September 1st for corn and soybeans and October 1st for soybean meal.

Table 1. Feed Grain Cash Prices, Future Prices, and Marketing-Year Average Prices in Prior Years.

2. Booking Feed Prices

Booking catfish feed prices is not an all-or-nothing proposition. Given the potential for significant price increases in the future, producers might consider booking a portion of their feed needs. It may be good for producers to book some of their feed early and see how the prices are in one to two months. At that time, one can reconsider if additional feed should be booked or not. However, producers should check with their feed supplier to learn more about their booking requirements, such as minimum acceptable amounts, times for booking and delivery, payment method, and other criteria they may have.

Remember, it is not necessary and not advisable in most circumstances to book 100 percent of anticipated feed needs. However, lining up a portion of those needs may have advantages and can serve as a risk-management strategy. If feed prices go up significantly, at least a portion of that increased feed cost has been avoided. If feed prices decline, the producer can take advantage of that decline on the portion of feed purchases not made in advance. Also, having a portion of your feed needs booked may help a producer narrow down expected production expenditures and per-unit costs of production. This can help in developing financial plans for the coming year and, if pre-paid, may help reduce taxes.

3. Alternative Feeding Strategies

Producers can consider alternative feeding strategies for unfavorable economic conditions. One of these strategies is feeding every other day instead of every day. Feeding strategies on farms are sensitive to the levels of available capital, feed price, and fish price. Under higher feed prices or tighter credit, every other day feeding may become necessary. However, at current feed and fish prices, feeding should be every day. Every other day feeding is optimal only when feed prices are extremely high. Feeding every third day **is not an optimal feeding strategy**. Be aware that switching to feeding every other day will decrease total fish produced.

Producers can also try to reduce their cost of feeding by feeding a 28 percent protein diet, as the majority of producers in Mississippi do.

Ganesh Kumar, an aquaculture economist at the

National Warmwater Aquaculture Center in Stoneville, Mississippi offers the following additional tips for alternative feeding strategies:

- Monitor feed budgets and talk with lenders.
- Reduce the need for feeding by stocking less in the 2022-2023 growing seasons.
- Stocking larger fingerlings will provide a greater head start in production.
- Prioritize and feed ponds that have fish approaching market size.

Feeding every day is the best strategy for production. However, every other day feeding becomes optimal when feed prices are approaching $500 per ton, though the price received for live fish will need to be considered as well in making the feeding frequency decision.

4. Higher Prices Offsetting Costs

Currently, the bright spot for producers is that catfish prices are high now (Fig. 3). The question is whether the higher fish prices will offset the higher feed costs. Producers can do a quick estimate to see whether they are making or losing money this year.

a. Estimate feed costs by multiplying the expected feed quantity to be used by the expected higher feed price.
b. Multiply the estimated feed costs by two, as feed is approximately 50 percent of total operating costs.
c. Subtract the feed costs, and any other costs, from the expected sales revenue to calculate cash profit. Sales revenue is calculated by multiplying the quantity of live fish one expects to sell by the expected fish price.

The future is full of unknowns but substituting fish/feed quantity combinations with fish/feed price combinations will give producers a range of returns that can inform them about their chances for operational success.

Summary

The decision of whether or not to contract either input purchases or output sales can be a difficult one because there are seldom any right or wrong answers (without the benefit of hindsight, that is). Each producer must make an individual decision based on their set of experiences and facts. The most important thing to consider is an individual's willingness and ability to withstand the existing price risks. In this decision, it is important for the producer to determine whether or not the potential exists for a loss that would jeopardize the financial stability or survivability of the operation. If so, contracting, or forward purchases or sale could be an effective means of reducing that risk to an acceptable level.

New Addition to AU Faculty

Dr. Andrea Tarnecki joined the Auburn University Shellfish Laboratory as Assistant Extension Professor and Director in December 2021. Prior to her current position, she was a Staff Scientist and Microbiology Division Lead at Mote Marine Laboratory in Sarasota, Florida. Andrea received her Ph.D. (2014) from Auburn's School of Fisheries, Aquaculture, and Aquatic Sciences, with a focus on marine microbiology. Her dissertation research, which she continued to expand upon at Mote, centered around interactions between aquatic organisms and bacteria, particularly relating to the use of bacterial communities to improve production of cultured fish and shellfish.

Dr. Tarnecki's research and extension efforts will address issues identified by the Gulf of Mexico's off-bottom oyster farming industry and its stakeholders. Specific research topics include improving shellfish aquaculture production, describing shellfish-microbe interactions that play a role in health and disease, increasing data availability to generate early warning forecasts for harmful algal blooms and human food-borne pathogens, and generating data to inform regulations regarding shellfish harvesting closures.

US Farm-Raised Catfish Industry 2021 Review and 2022 Outlook

Terry Hanson, SFAAS

Fish and seafood consumption in the U.S. has been on the rise during the last decade, from 16.8 lb/person/year in 2012 to 19.2 in 2019. Of this amount, one-half pound of U.S. farm-raised catfish was consumed by each American annually.

2021 Review

In 2021, there were 307 million pounds of live catfish produced in 58,130 acres of water located primarily in Alabama, Arkansas, Mississippi, and Texas. In 2021, the U.S. farm-raised catfish industry had major issues with rising catfish feed prices, scarcity of premium-sized (1-4 lb) live fish, and lack of available labor in processing plants and on farms.

Catfish feed delivered for the production of foodsize fish was 431,472 tons in 2021, a 7 percent increase from 2020 levels. Lower foodsize inventory pounds coming into 2021 resulted in an overall 3 percent decline in catfish pounds processed by years end. The lack of available processing labor also reduced processing capacity, live fish purchases, and processed final products.

Catfish feed delivered for the maintenance of broodstock and for fry and fingerling production was 43,468 tons in 2021, down 11 percent from 2020. The 2021 beginning fingerling inventory grew into stocker sized fish and small foodsize fish by the end of 2021. Because the foodfish inventory for early 2021 was 7 percent lower than in early 2020, the total foodsize fish production was less in each month of 2021 compared to 2020, resulting in an overall 3% decline in catfish processing in 2021.

Catfish feed prices increased in 2021 over 2020 prices to highs not seen since 2014. There was a $90/ton increase in 32% crude protein (CP) feed price between the 5-year average price and the 2021 price, and a $120/ton increase in 32% CP feed price between 2020 and 2021. Similar large price increases occurred for 28% CP and 35% CP catfish feeds. Twenty-eight percent and 32% CP catfish feed was used for foodsize fish production and added substantially to production costs, as feed costs are more than 50% of all variable costs. In the hatchery sector, 35% or higher CP feed is used for fry and fingerling production at increased cost. Prices rose so swiftly during the February to June period that feed purchases were reduced to a point that it disrupted the fry/fingerling production cycle enough that the annual fry/fingerling feed delivery for 2021 was 11% less than in 2020.

Catfish feed is grain based, with soybean meal making up approximately 20% of the ration, corn grain 15%, corn gluten feed 20%, wheat midlings 5%, and cottonseed meal 20%, plus smaller amounts of distillers' dried grains with solubles, fat/oil, lysine HCl, phytase enzymes, vitamin premix and trace mineral premix. Predicting catfish feed price direction and magnitude can be approximated by watching USDA's crop plantings report, weather issues throughout the crop season, and keeping track of these commodity futures fall price contracts.

For instance, the projected September 2022 corn contract was $5.83 per bushel, an increase of $1.20 per bushel from the 2020/21 estimated ending price. The soybean November 2022 futures contract was $13.86 per bushel, an increase of $3.06 per bushel from the 2020/2021 estimate. Likewise for the soybean meal's September 2022 contract that showed an increase of $2.50 per bushel from the 2020/2021 estimated price. A $2.00+ margin for wheat occurred between the July 2022 contract and the 2020/2021 estimated price. Thus, at present, all indications are that catfish feed prices will be higher for early 2022 compared to their high 2021 price levels. This will make it more costly for catfish farmers to produce fish in 2022 than in 2021.

On the positive side, catfish producers received higher prices for their live fish from processing plants in 2021. The average weighted price for all catfish size categories was $1.28/lb in 2021. This was $0.12/lb more than the weighted average 2020 price paid, and it was $0.29/lb higher than the 2018 price level. These higher prices have definitely helped producers offset the higher feed prices they encountered in 2021. Prices for live foodfish were higher in 2021 due to a live fish shortage, aggravated by lack of personnel at the processing plants, and strong demand by processors for live fish of any size category (except 8+lb fish).

2022 Outlook

With the Ukraine-Russia war, commodity feed ingredient prices may become volatile, as Ukraine is a large supplier of grains to the world. This disruption will have unknown effects on domestic crop supply as they may be sold overseas at a higher rate, causing domestic prices to rise. But, we just do not know at this moment. Even before this event, catfish feed costs were expected to be as high or higher in 2022 than in 2021 due to increases in freight costs, lack of trucking, higher fuel prices, higher feed ingredient prices, and lack of available labor. So now it is even more important to pay attention to the number of soybean and corn acres being planted this spring, favorable and/or unfavorable weather conditions, and future contracts for these catfish feed ingredient commodities. Collectively, these will provide clues to the direction and magnitude of catfish feed prices in 2022.

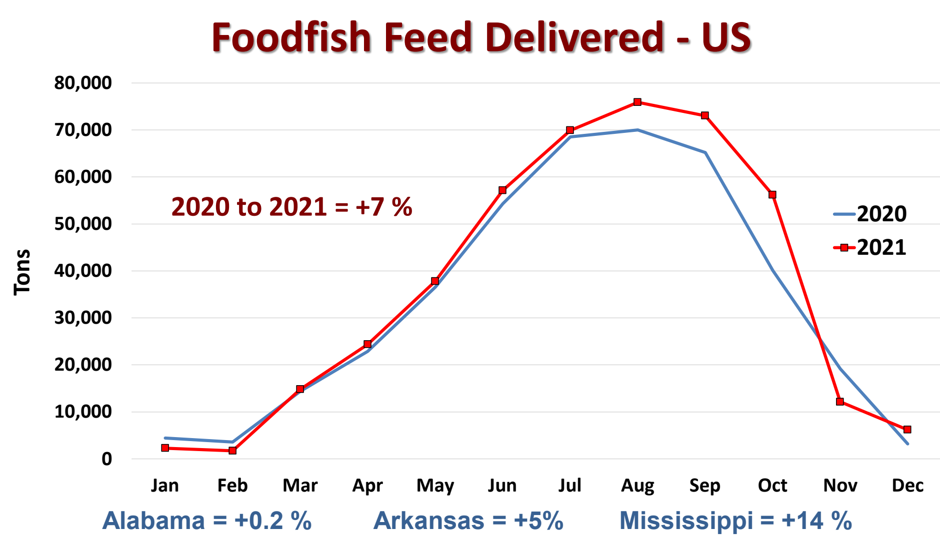
However, consumers seem to have adapted to higher prices, and it is expected they will continue buying products at the higher prices. Other protein source's prices are going up as well, so it expected that catfish demand will not be dampened and remain strong in 2022.

Round weight (live fish) processing is expected to either remain steady from last year or perhaps decline slightly. This is due to stocker and foodsize catfish inventories being down in January 2022 compared to January 2021. Secondly, the quantity of saleable sized product coming into 2022 is less than the amount at the beginning of 2021.

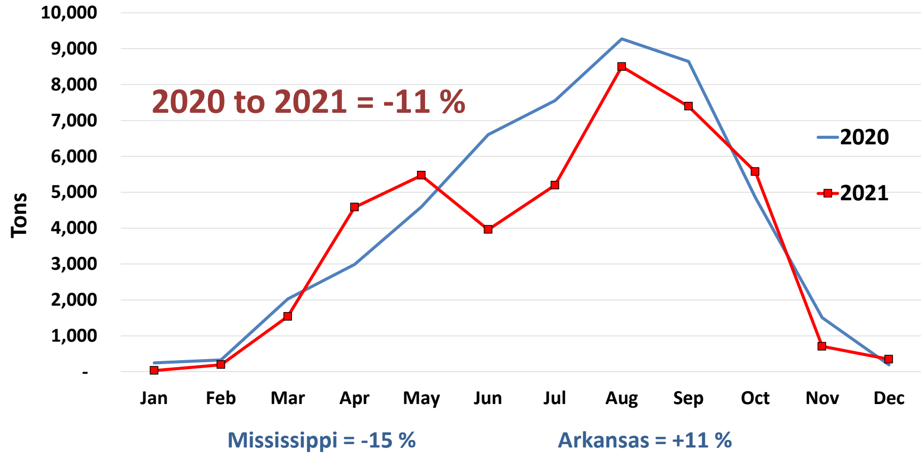
Prices to producers (from processors) are expected to remain steady or perhaps increase some in 2022. This is because producers will face higher feed costs and without higher live fish prices, farmers will not be able to meet processor's demand for live fish. Thus, for processors to obtain the same quantity of live fish as they did in 2021, they will likely need to pay higher prices for live fish in 2022.

However, due to the higher feed costs combined with labor shortages at processing plants, processors may not be able to process increased live fish volumes. In that case, catfish producers may have less live fish for processors and end up purchasing less feed in 2022 than in 2021.

Finally, imports of catfish products were high in 2021 (256 million pounds of fillets) and will likely continue strong in 2022, whereas exports of U.S. produced catfish was low in 2021 (2.2 million pounds) and will likely remain low in 2022.



Fingerling / Broodfish Feed Delivered - US

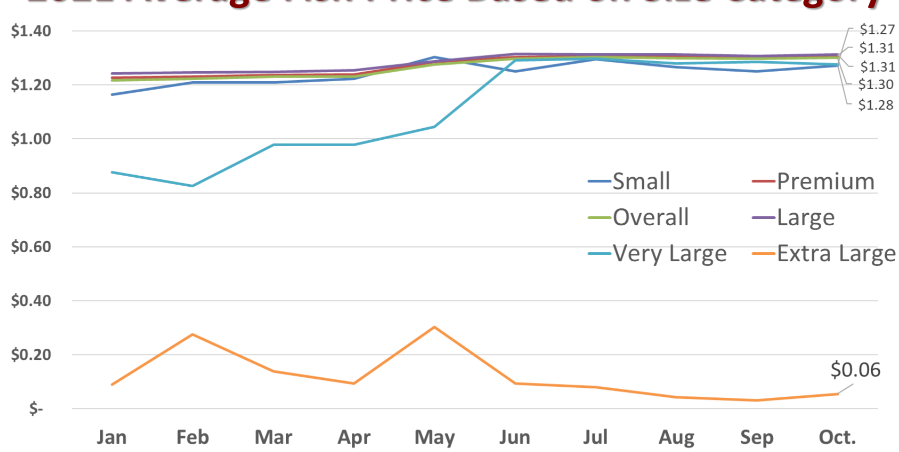


Change in Price of 32% and 28% Catfish Feed

	32%	28%
5-yr Average	$ 401	$ 375
2020	$ 389	$ 363
2021	$ 491	$ 457
Change from 5-yr Average	+ $ 90	+ $ 82
Change from 2020	+ $ 102	+ $ 94

Source: The Catfish Institute

2021 Average Fish Price Based on Size Category



U.S. Farm Price Projections

	2019/20	2020/21 Estimated	2021/22 Projected	Feb 2, 2021 Closing Price
Corn	$3.56	$4.53	$5.45	$5.83 Sep 22
Soybeans	$8.57	$10.80	$12.60	$13.86 Nov 22
SBM	$299.50	$392.31	$375.00	$404.60 Sep 22
Wheat	$4.58	$5.05	$7.15	$7.55 Jul 22

Expect catfish feed price to go up as well!

Source: USDA-WASDE; Updated January 2022

Aquatic Vegetation Control: Water Primrose, *Ludwigia uruguayensis*

Jesse James, AFFC

Water primrose is an invasive aquatic plant native to South and Central America that has become a frequent problem in commercial and recreational ponds in the southeastern United States. This plant

Fig. 1: Vegetative State March - May.

can be identified by its small bright yellow flowers that appear from May to September. Primrose is typically rooted along the shoreline growing outward horizontally producing floating mats that can cover large areas of the pond surface. The leaves are arranged in an alternating pattern around hollow stems that are often green to maroon in color. The vegetative growth or horizontal branches that grow out across the water surface produce oval or club shaped leaves while the vertical flowering stems produce elongated willow-like leaves.

To control this aggressive plant, it is best to begin treating during the vegetative state while the bulk of the plant is still close to the shoreline. The practice of stocking grass carp as a means of passive weed control is ineffective against water primrose, therefore topical chemical applications will be needed. Fortunately, most commonly available herbicides that contain 2,4-D or Glyphosate are effective against this weed. All chemical mixing instructions should be followed to ensure a proper dosage is applied. The use of a surfactant is recommended to help the herbicide adhere to the waxy surface of the plant leaves to allow for a more even kill. For best results, a second follow up treatment, in situations where the plant has become overgrown, may be required. Due to the nature of this plant's growth, it is also possible to remove it manually with a heavy rake or grapple.

For more information on aquatic weed identification and control please contact the Alabama Fish Farming Center at (334) 624-4016.

Fig. 2. Vegetative State, horizontal growth with immature vertical stems.

Fig. 3. Flowering state, mature vertical stems with elongated leaves and yellow flowers. Photo credit: https://www.outdooralabama.com/emerge nt-aquatic-plants/water-primrose

Monitoring Historically Problematic Blue-green Algae Ponds in the Spring can be Beneficial for Commercial Catfish Producers

Luke A. Roy, Julia Palmer, Anita M. Kelly, AFFC

Each year, the Fish Center documents several fish kills in commercial catfish ponds in which toxic releases of blue-green algae are the prime suspect. For the most part, problematic blue-green algae appear in the warmer months, particularly in the summer and early fall when farmers offer the highest amounts of feed to catfish in commercial ponds. (Fig. 1) Excess nutrients from uneaten feed and excreted nutrients in the form of fish waste can contribute to blue-green algae issues in the pond. Fish kills due to disease can also add nitrogenous waste to the pond system as fish decompose in the pond water. Other sources of nitrogenous wastes in ponds include large numbers of waterbirds and cattle (on operations that have both catfish and cattle). It is very difficult to know when a toxic algae release will occur in a commercial catfish pond; however, being

Fig. 1. Signs of blue-green algae are often evident in the water color.

proactive in managing water quality in your ponds can often help avoid catastrophic fish kills and issues with off-flavor.

In discussing algae issues with Alabama catfish farmers, they often note that certain ponds on their farms appear to have a history of blue-green algae related problems while other ponds seemingly are blue-green algae free year after year or rarely become a problem. Therefore, closely monitoring these historically problematic catfish ponds throughout the production cycle, starting in the spring, can be a valuable exercise for commercial producers.

The color of the pond water of these problematic ponds can be a valuable indicator of blue-green algae problems. If the characteristic blue-green color appears in the pond, it would be a good idea to take a water sample and look at it under the microscope

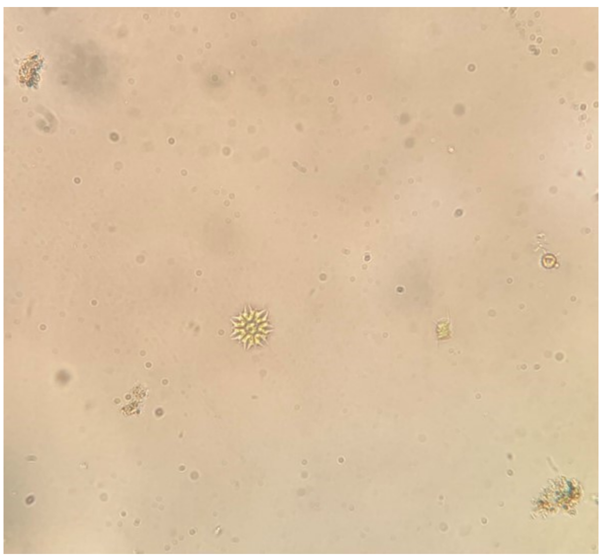


Fig. 2 Microscopic view of blue-green algae.

or bring it to the Fish Center so we can examine it. We have several tools available at the Fish Center to assess a problematic pond. Typically, we will examine a sample of water under the microscope to identify whether blue-green algae is an issue. In some cases, upon examination, we may identify only green algae, which are not a problem. (Fig. 2) The Fish Center also has available a Turner Tool (provided to us by the SFAAS algae expert, Dr. Alan Wilson) that can help us quantify the extent of a blue-green algae problem. It may also be valuable for producers to monitor other water quality variables in these problematic ponds, particularly dissolved oxygen, ammonia, and nitrite. In cases where harmful blue-green algae species are identified in sufficient numbers, it could be necessary to begin treating the pond. (Fig. 3)

Fig. 3 The Turner Tool is used to measure the extent of the blue-green algae problem.

Weekly low dosages of copper are efficient in controlling blue-green algae populations in catfish ponds. Copper sulfate treatments should begin in late spring or early summer and continue weekly until the water temperature is below 68 degrees F. Copper sulfate pentahydrate is applied at 0.5 ppm or 5 lbs per surface acre. The copper sulfate pentahydrate crystals can be placed in burlap bags and hung either in front of or behind the aerator. The aerators should be run until all the crystals have dissolved. The aerators enabled a more even distribution of the copper around the pond. Alternatively, liquid copper can be used if evenly sprayed across the pond surface. This can be done using a boat. Using copper every week has been shown to lower the amount and cost of copper sulfate used on farms. An additional benefit to using low dosages of copper is that it also controls snail populations in the pond.

Controlling algal populations in an aquaculture pond can reduce the number of blue-green algae present, improve water quality, reduce the incidence of off-flavor in fish, and control snail populations. These benefits are seen when using low dosages of copper weekly. Weekly treatments of copper also result in lower amounts of copper being used overall.

Contact the Alabama Fish Farming Center if you have any questions or concerns about the management of blue-green algae or other water quality issues in your ponds.

Mobile Fish Lab's Mobility Issues

Since 2006, the Mobile Fish Lab has allowed AFFC personnel to come to farms to diagnose diseases. The West Alabama Catfish Producers purchased the converted RV with money from grants and donations. After 16 years of use, the Mobile Lab is experiencing more and more mechanical trouble. Unfortunately, we have not secured funding to replace this valuable tool. As a result, we will use the Mobile Lab until it no longer runs. We will make trips to farms if the RV is running but may ask that you bring fish to the Alabama Fish Farming Center when it is not. We apologize for the inconvenience this will cause in the future.

Featured Recipe

Catfish Piccata

Adapted from Blue Apron

4 catfish fillets
¾ lb. linguine pasta
4 cloves garlic
2 lemons
½ lb. fresh spinach
4 Tbsp butter
2 Tbsp capers
1/3 cup all-purpose flour
¼ cup grated Parmesan cheese

Wash and dry fresh produce. Heat a large pot of salted water to boiling. Quarter and deseed one of the lemons. Cut off and discard the rind and white pith of the remaining lemon; small dice the lemon, discarding the seeds. Roughly chop the capers. Peel and finely chop the garlic. Roughly chop the spinach.

Add the pasta to the pot of boiling water. Cook 9-11 minutes or until al dente. Reserving 1 cup of the pasta cooking water, thoroughly drain the cooked pasta. Rinse under warm water to prevent sticking. Rinse and wipe out the pot.

While the pasta cooks, place the flour on a plate. Pat the catfish fillets dry with paper towels, season with salt and pepper on both sides. Coat one side of each seasoned fillet in the flour (tapping off any excess) In a large pan, melt ¾ of the butter on medium-high until hot. Add the fillets, coated sides down. Cook 4-6 minutes on the first side or until golden brown. Flip and add the capers and diced lemon. Cook, occasionally spooning the sauce over the fillets, 2-3 minutes.

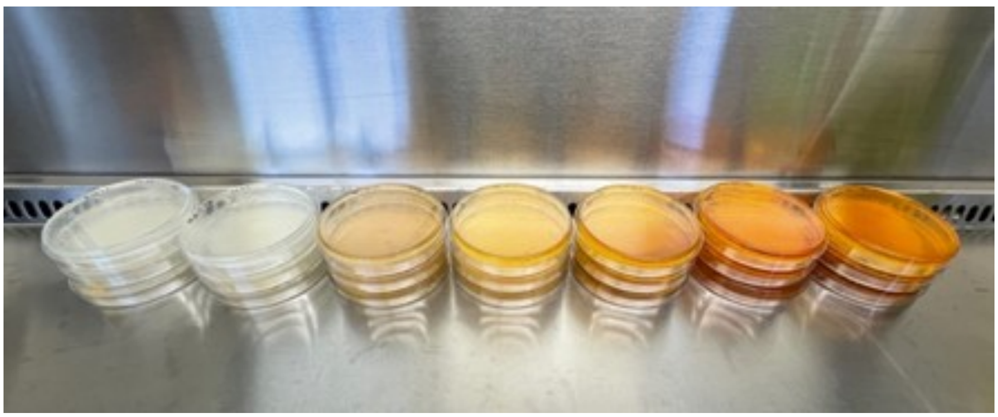
In the pot used to cook the pasta, heat 2 teaspoons of olive oil on medium-high until hot. Add the garlic and season with salt and pepper. Cook, stirring frequently, 30 seconds to 1 minute, or until fragrant. Add the spinach; season with salt and pepper.

Add the cooked pasta, remaining butter and half the reserved pasta cooking water to the pot of spinach; season with salt and pepper. Cook, stirring frequently, 2-3 minutes or until thoroughly combined. Remove from heat and place catfish fillets over pasta with sauce and sprinkle with Parmesan cheese. Serve with lemon wedges.

RESEARCH ROUNDUP

Development of an Attenuated Columnaris Vaccine for Catfish and Other Fish Species in the Southern Region

Courtney Harrison[1], Benjamin R. LaFrentz[2], and Timothy J. Bruce[1]
Auburn University, School of Fisheries, Aquaculture and Aquatic Sciences
USDA-ARS, Aquatic Animal Health Research Unit, Auburn AL



Flavobacterium columnare, the bacteria that causes columnaris disease in many cultured and wild fish species, is a devastating pathogen that generates significant mortality and economic losses. This disease is found throughout the catfish industry and treatment means can be both difficult and expensive for producers. This pathogen causes acute, mucosal and systemic infections that can be facilitated through abrasions to the skin and mucus. Pond transmission of the bacteria can occur through direct contact with an *F. columnare*-infected fish or exposure to the bacterium in a water source, where the bacteria can be rapidly shed by an infected fish. As such, the swift removal of mortalities in fish culture systems is essential to reducing pathogen levels. Outbreaks of columnaris disease typically occur when water temperature changes, or when fish are stressed due to overcrowding or unfavorable environmental conditions (i.e., low dissolved oxygen, swings in pond temperatures, etc.).

The mitigation strategy for *F. columnare* infections in production aquaculture is extremely important, given that outbreaks can lead to high mortality and expenses. In the past, a commercially available attenuated vaccine for columnaris disease, AQUAVAC-COL, was licensed for use in channel catfish and largemouth bass. However, the vaccine efficacy was found to be inconsistent and the product is no longer being produced and sold. A possible rationale for the lack of protection is that

there was an incomplete understanding of the genetic diversity of *F. columnare*. Recently, Dr. Ben LaFrentz (USDA-ARS, Auburn) published research comparing the previously established genetic groups of *F. columnare* using phylogenomic, biochemical, and physiological characteristics and revealed biological associations between genetic groups and different host species. *Flavobacterium columnare* now represents four distinct species: *F. columnare*, *F. covae*, *F. davisii*, and *F. oreochromis.* For example, genetic group 2 (now *F. covae*), is associated with channel catfish aquaculture and genetic group 4 (now *F. oreochromis*) is associated with the disease in Nile tilapia. Therefore, a live-attenuated vaccine that targets the appropriate columnaris-disease causing pathogen for production fish species in the Southern U.S. is what a new Southern Regional Aquaculture Center (SRAC; USDA-NIFA) project aims to develop.

This recently funded project involves investigators from Auburn University (Courtney Harrison, Dr. Tim Bruce), Mississippi State University (Dr. Matt Griffin), Michigan State University (Dr. Tom Loch), UC-Davis (Dr. Esteban Soto), and the USDA-ARS Aquatic Animal Health Research Unit in Auburn (Dr. Ben LaFrentz). At Auburn, the project objectives are to develop and identify live-attenuated vaccine candidates to prevent and control columnaris disease in farm-raised catfish and tilapia, and to perform efficacy and safety testing to identify optimal delivery of the vaccine. Currently, multiple isolates of *F. covae* and *F. oreochromis* are being attenuated in Dr. Timothy Bruce's laboratory at Auburn University. Once the successful attenuation of isolates from each bacterial species has been confirmed, *in vivo* studies in channel catfish will be conducted to test the lack of virulence and ability of the attenuated strain to protect against their parent strains. Although catfish is the primary fish species for the project, the collaborative project will also look at potential vaccine candidates for Nile tilapia (Auburn University), baitfish species (Michigan State University), and rainbow trout (UC-Davis), all of which are also cultured in the Southern U.S. In addition to assessing the efficacy of the live-attenuated vaccine, the project team also plans to conduct safety trials to ensure that the product will be a viable option in fish culture systems. In the third year of the project, large-scale pond trials will be incorporated to better translate the technology to the farm. The project team is excited about this revised approach to columnaris disease management and look forward to working with catfish producers as this SRAC project develops.

The Complexities of Bacterial Co-infections in Catfish Aquaculture

Timothy J. Bruce, SFAAS

As the season changes and warmer weather moves into Alabama, many fish producers are keeping a close watch on the health of their catfish stocks. The onset of bacterial infections in catfish is often tied closely to water quality or temperature fluctuations, as well as rearing stressors with the upcoming spawning season and return to feeding. The main bacterial pathogens encountered are *Flavobacterium columnare* (columnaris disease), *Aeromonas hydrophila* (motile Aeromonad septicemia), and *Edwardsiella ictaluri* (hole-in-the-head disease). Clinical signs of these diseases can manifest quickly, and efficiently-conducted diagnostics are essential to choosing the best course of treatment. Although the focus is often on a single diagnosis or commonly-identifiable pathogen, there are times where other secondary pathogens may partially contribute to the "disease" as a whole. These cases may be classified as instances of "co-infection" and involve interactions with combinations of bacterial, viral, or parasitic agents. These cases require additional considerations from the fish health diagnostician prior to recommending therapeutants, as final assessments may be complex in nature. For instance, there may cases where one bacterial pathogen enters the fish, initiates a stress or immune response, and this depressed immune system allows for a ubiquitous pathogen to take hold in the host. Additionally, if there are multiple pathogens present in bacterial cultures taken at the time of necropsy, it may be difficult to discern the more predominant bacterial species if both are present on culture plates. With the three pathogens mentioned above, these bacteria require or favor different media types for routine culture, so if a wide enough net is not cast at the time of necropsy, the diagnostician may not be able to culture all present bacteria. At times there can be lesions, ulcerations, or other clinical signs that appear similar to those shared by several types of bacteria. Additionally, if more than one bacterial pathogen is involved in an infection, there may be a gradient of clinical signs, and a diagnosis based on visual inspection may be quite difficult to perform. This masked conundrum can then make antibiotic treatment recommendations difficult for fish health specialists, as one drug may not be approved to treat both pathogens or the wrong bacterial target may be selected. Over time, the improper choice of antibiotic therapy may contribute to more problems in the pond and may potentially contribute to issues associated with antimicrobial resistance. To reduce this risk and ensure the selection of appropriate treatment strategies, it is important to work closely with fish health diagnosticians and turn over every stone when identifying pathogens at the catfish pond.

Allison Wise, a graduate student (M.S.) in the School of Fisheries, Aquaculture, and Aquatic Sciences at Auburn University, recently spearheaded a review paper on bacterial co-infections in catfish production. Researchers at Auburn University, Mississippi State University, and the USDA-ARS Aquatic Animal Health Research Unit contributed sections to the article. Summaries of bacterial co-infection diagnostics cases from both the MSU Aquatic Research Diagnostic Laboratory and the AU Alabama Fish Farming Center (2016-2020) are also included in the review.

Wise AL, LaFrentz BR, Kelly AM, Khoo LH, Xu T, Liles MR, Bruce TJ. A Review of Bacterial Co-Infections in Farmed Catfish: Components, Diagnostics, and Treatment Directions. *Animals*. 2021; 11(11):3240. https://doi.org/10.3390/ani11113240

Effect of Antibiotics on Gut Bacteria and Antibiotic-Resistant Genes in Channel Catfish

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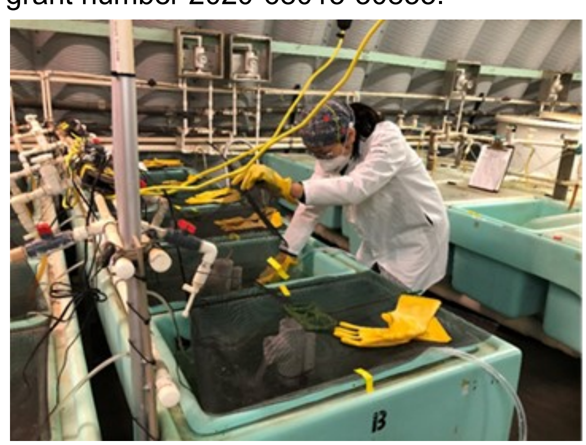
There has been considerable discussion lately about antibiotic resistance and antimicrobial resistance. The two terms are related but do differ in meaning. Antibiotics are medicines used to prevent and treat bacterial infections (like Aeromonas). Antibiotic resistance occurs when bacteria change in response to the use of these medicines. Bacteria, not fish, become antibiotic-resistant. These bacteria may then infect fish and are more challenging to treat than non-resistant bacteria. Antimicrobial resistance is a broader term, encompassing resistance to drugs to treat infections caused by other microbes as well, such as parasites (e.g., Asian tapeworm), viruses (e.g., channel catfish virus) and fungi (e.g., Saprolegnia).

Aquaculture has three antibiotics available for use in fish. These include Aquaflor®, Romet®, and Terramycin 200®. Antibiotic resistance will eventually happen, even if the medications are applied as prescribed. Unfortunately, limited information is available about antibiotic resistance in aquaculture. In the United States, catfish is the leading aquaculture finfish species. One of the major challenges for catfish production is losses due to bacterial diseases. Antibiotic-medicated feed has been used in catfish to treat bacterial infections and reduce economic losses. As one of the broad-spectrum antibiotics approved by the Food and Drug Administration (FDA), florfenicol (Aquaflor®) has been approved to control mortality due to enteric septicemia of catfish (ESC) caused by *Edwardsiella ictaluri*. Antibiotics are typically incorporated into commercial feed. Aquaflor® should be fed for 10 consecutive days with a 15-day withdrawal period. While our study showed that Aquaflor® could impact the bacterial composition (microbiome) of the catfish gut, limited information exists on how the consumption of antibiotic feed will affect the gut bacteria and the genes that allow antimicrobial resistance (resistome) in catfish during treatment and after the withdrawal period.

Since bacterial composition and abundance can influence catfish health, growth, and immune response, researchers at the University of California-Davis (UC Davis) and the Alabama Fish Farming Center (AFFC) have teamed up to determine how the three available and approved drugs for aquaculture affect the gut bacteria and to determine if antibacterial genes are present. We will be testing this in well water at UC Davis and in pond water at the AFFC. A trial conducted at UC Davis in well water found that the impact of florfenicol (Aquaflor®) treatment on fish gut bacteria and antibiotic-resistant genes were different from those of fish fed feed without florfenicol added. This study provides valuable information on the impact of florfenicol treatment in catfish production. Further studies will be conducted at both sites this year and will include all three antibiotics used by the U.S. catfish industry. These studies are funded by USDA grant number 2020-68015-30855.



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