PERFORMANCE EVALUATION OF INTENSIVE, POND-BASED CULTURE SYSTEMS FOR CATFISH PRODUCTION

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Participants	USDA-ARS	Les Torrans (Project Leader), Travis Brown, Craig Tucker
	Auburn University	Luke Roy, Jesse Chappell, Terry Hanson, Claude Boyd
	Mississippi State University	David Wise, Terry Greenway, Matt Griffin
	Univ. of Arkansas at Pine Bluff	Carole Engle, Yushun Chen, David Heikes, Matt Recsetar

PROJECT OBJECTIVES

1. Monitor the production performance of channel catfish and hybrid catfish grown in in-pond raceways and split-pond systems and monitor the production performance of hybrid catfish grown in intensive, small-acreage production systems on commercial-scale, catfish operations.

2. Estimate costs of production in these systems including total investment costs, annual fixed and variable costs, and cost per pound of production.

3. Identify the relative strengths, weaknesses, and trade-offs of these alternative production systems.

ANTICIPATED BENEFITS

Many farmers feel that intensifying fish production will reduce production costs. They are currently using three production systems to do this; smaller conventional earthen ponds with increased aeration rates, split-pond systems, and in-pond raceways. Intensified production systems will likely continue to draw the interest of catfish farmers in the future but without a thorough economic analysis there can be no definitive recommendations. As a first step, this study will evaluate the production efficiencies of these new production systems on commercial catfish farms. Based on these findings, a complete economic analysis will be performed and will provide the necessary guidance to make recommendations to farmers. In addition, detailed physical descriptions of each culture system will be thoroughly investigated and the most efficient and practical designs will be recommended to farmers.

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

Objective 1: *Monitor the production performance and efficiency of channel catfish and hybrid catfish grown in in-pond raceways and split-pond systems and monitor the production performance and*

efficiency of hybrid catfish grown in intensive, small-acreage production systems on commercial-scale, catfish operations (USDA-ARS; Auburn University; Mississippi State University; University of Arkansas at Pine Bluff).

USDA-ARS (Intensively-aerated conventional ponds and split-ponds).

The following farms (along with their system descriptions) have been recruited to participate in the intensively-aerated conventional ponds and split ponds portion of the project. Their system descriptions are listed below:

Four traditional earthen ponds with intensive, small-acreage (3.6 to 5.9 acres each with a 5.0 ft average water depth) hybrid catfish food fish production have been monitored at Need More Fisheries in Glen Allan, MS. Fingerlings were stocked in April 2013. The ponds utilize 5.1 to 8.3 hp/acre (mean of 6.5 hp/acre) of aeration using electric paddle-wheel aerators. The aerators are operated automatically with a monitoring system with oversight by the farm crew. Dissolved oxygen and temperature are also monitored and logged continuously. No fish have been harvested yet.

Two 25-acre split-pond aquaculture systems, located at Itta Bena, MS (America's Catch Catfish, Inc.) have been monitored since stocking hybrid catfish fingerlings in March 2013. Each split pond consists of three fish culture basins (4 acres each with a 7.0 ft average water depth) and a common waste treatment lagoon (12.5 acres with a 5.0 ft average water depth). The fish culture basins each utilize approximately 15.0 hp/ acre of aeration using electric paddle-wheel aerators. Water is circulated between each fish-culture basin and the waste-treatment lagoon using a 10-hp high-speed auger pump. The aerators and water circulators are operated automatically with a monitoring system. In addition to the two split ponds, two traditional ponds with intensive, small-acreage (one 2.6 acres and another 4 acres each with about 7.5 ft average water depth) hybrid catfish food fish production are being monitored. Fish have been stocked (March 2013) in one of the traditional ponds so far; the second pond is awaiting harvest of a previous crop before being enlisted in the study. Each of these traditional ponds has approximately 15.0 hp/acre of aeration using electric paddle-wheel aerators. The aerators are operated automatically with a monitoring system. Harvesting of the split-pond systems has begun but production data are not yet available.
Two commercial-size split-pond aquaculture systems (4.5-acre and 7.0-acre) located in Stoneville, MS (MSU Delta Research and Extension Center) have been monitored since stocking hybrid catfish fingerlings in April, 2013. Both systems utilize approximately 30 hp/acre of aeration in the culture basin using electric paddle-wheel aerators. The 4.5 acre split pond has a 1.0-acre fish culture basin (5.3 ft average water depth) and a 4.5-acre waste treatment lagoon (4.8 ft average water depth). Water is circulated between the fish-culture basin and waste-treatment lagoon with a 3.0 hp slow-rotating paddlewheel. The 7.0 acre split pond has a 1.3-acre fish culture basin (6.1 ft average water depth) and a 5.7-acre waste treatment lagoon (4.3 ft average water depth). Water is circulated between the fish-culture basin and waste-treatment lagoon with two 3.0 hp slow-rotating paddlewheels. The aerators and water circulators are operated automatically with a monitoring system. In addition to the two split ponds, three traditional ponds with intensive, small-acreage (two acres each with about a 5.0 ft average water depth) hybrid catfish food fish production stocked in April 2013 are being monitored and compared to three similar ponds stocked with channel catfish. These ponds utilize approximately 6.5 hp/acre of aeration using electric paddle-wheel aerators. Aerators in these intensive ponds are operated manually by the farm crew. Harvesting has begun on some of these ponds but production data are not yet available.

Electronic data loggers were installed on all electrical equipment (aerators and circulators) on the production systems listed above. Monitoring of water quality and fish production performance in these systems was initiated in March and April of 2013 and bi-weekly data collection has been performed since then.

Mississippi State University (Intensively-aerated conventional ponds and split-ponds).

Water samples have been collected from split pond and intensively aerated conventional production systems used in the culture of channel and hybrid catfish. Samples were collected bimonthly and monthly from Scottland Fish Farms (nine split pond production systems and two conventional ponds stocked with hybrid catfish), Tackett Farms (12 split pond production systems stocked with channel catfish), Need-More-Fisheries (four conventional production systems stocked with hybrid catfish) and production ponds located at the National Warmwater Aquaculture Center (3 split pond production systems stocked with hybrid catfish, 3 conventional production systems stocked with hybrid catfish and three conventional production systems stocked with channel catfish). DNA has been isolated from collected water samples and will be analyzed before the start of the 2014 production season.

Auburn University (In-pond raceways and intensively-aerated conventional ponds).

Description of Systems in Study: In Alabama two farms are participating in the intensive raceway system and intensively aerated ponds portion of the project. Their system descriptions are listed below:

Six raceways within one larger In-Pond Raceway System (IPRS) located in a 6 acre pond have been monitored at Browns, AL. Each raceway is 35’ x 16’ x 3.9’ in size. The fish culture area of each raceway in the IPRS is 25’ x 16’ x 3.9’ with a waste collection area at the tail end of each raceway. Each raceway holds approximately 11,350 gallons of water and consists of three separate components: a slow rotating paddlewheel (SRP) area; a fish culture area; and a waste settling area. The walls are constructed of standard cinder blocks filled with concrete and supported with 1.3 cm reinforcing bar. An end partition barrier spanning the width of each raceway unit confines the fish. Each partition is constructed of a 3.8 cm^2 aluminum tubing frame. Attached to the frame is PVC-coated, steel mesh wire (0.15 cm diameter). Walkways are utilized to access system components and the individual raceways. One walkway is located directly above the water inflow to the fish culture unit and the other is located downstream. There is a SRP mounted outside each raceway to provide constant water flow through the unit. Powered by a 0.37 kW motor, each SRP has a rotation rate of 1.2 rpm and pushes an even distribution of water through the fish culture unit to flush out waste material and continually supply freshly oxygenated water. The IPRS is equipped with an In-Situ water monitoring system that measures and records dissolved oxygen (DO) and temperature in each raceway and feeds vital information to a computer where management can continuously monitor levels and make adjustments as needed. Five of the six raceways were stocked with hybrid catfish fingerlings in June and July of 2012. Four of the five raceways have been completely harvested, and as of October 2013, one raceway still remains in production.

There is one farmer participant that is using traditional earthen pond and high rates of aeration, averaging 10.3 hp/acre in the three study ponds. The three study ponds are 7.9, 6.5, and 8.0 acres in size with 8.9, 10.8, and 10.6 Hp/acre, respectively. The ponds were not stocked until April of 2013 and only one harvest has occurred thus far in August 2013. Production parameters from stocking to harvest will be followed in these ponds.

Data Monitoring

Farm cooperators for both the IPRS and the intensive aeration study are keeping detailed records of expenditures and production data. These data include size and quantities of fish stocked and harvested, feeding, mortality estimates, oxygen records, water quality, pond treatments and medications, flavor checks, repair incidences and maintenance, and PTO aeration hours. Disease incidences were documented by date and causative agent. Collaborating researchers assisted farmers in data collection and analysis.

Research personnel verified stocking and harvest data (numbers and weight) by being present to sample fish at stocking and harvest. Fish in the IPRS were sampled monthly to track growth and FCR. Both farms are utilizing a 32% protein feed.

Water samples are being collected from the fish culture area at a biweekly rate from each system and are transported on ice for laboratory analysis. Standard methods are followed for analyzing the concentrations of total ammonia nitrogen (TAN) and nitrite (NO_2, mg/L; APHA, 2005). Water samples are being collected from the fish culture zone to analyze chloride (mg/L), total alkalinity (mg/L as $CaCO_3$), and total hardness (mg/L as $CaCO_3$ equivalence) at stocking, harvest, mid-summer, and after heavy rain events. Chloride levels are being maintained at a minimum 100 ppm level. All water quality variables are being measured when a disease outbreak occurs. During the first year of data collection in this study, no real problems with water quality were documented in the IPRS.

Both producers are utilizing water quality monitoring equipment for measuring dissolved oxygen and temperature. This equipment is also capable of controlling the operation of circulators and paddlewheel aerators.

UAPB (Split-ponds and intensively-aerated conventional ponds).

Six traditional earthen ponds with intensive, small-acreage (4.1 to 5.5 acres with water depths ranging from 3.8 to 5.2 ft) hybrid catfish food fish production have been monitored at a farm in Montrose, AR. Fingerlings were stocked in February 2013. The ponds utilize 6.4 to 8.5 hp/acre (mean of 7.9 hp/acre) of aeration using electric paddle-wheel aerators. The aerators are operated automatically with a monitoring system with oversight by the farm crew. Dissolved oxygen and temperature are also monitored and logged continuously. No fish have been harvested yet.

Two split-pond aquaculture systems, located in Portland, AR have been monitored since stocking hybrid catfish fingerlings in March 2013. A third split pond was stocked with triploid hybrid catfish in late August. The first split pond was 6.6 acres with a fish culture area (2.2 acres with an 11.0 ft average water depth) and a waste treatment area (4.4 acres with a 7.0 ft average water depth). The second split pond was 7.2 acres with a fish culture area (1.95 acres an estimated depth of 7.0 ft) and waste treatment area (5.25 acres with an estimated depth of 5.0 ft). The fish culture areas each utilize approximately 15.0 hp/ acre of aeration using electric paddle-wheel aerators. Water is circulated between each fish-culture area and the waste-treatment area using a 10-hp high-speed auger pump. The aerators and water circulators are operated automatically with a monitoring system. Fish in the second pond (7.2 acres) were previously stocked in another split pond and then moved to the current split pond in August when they had an average weight of 0.68 lbs and 81% survival after the initial march stocking. The current pond had an estimated 5,000 lbs of hybrid catfish (1.0 lb average) in it at the time. In addition to the two split ponds with auger pumps, the third split pond is 17.7 acres and has a fish culture area (3.7 acres with a 5.0 ft estimated average water depth) and waste treatment area (14.0 acres with a 4.5 ft estimated average water depth). Water is circulated in this system via a culvert-based 5.0 hp slow-moving waterwheel (UAPB waterwheel). The fish culture area in this system has approximately 10.8 hp/acre of aeration using electric paddle-wheel aerators. Harvesting of the split-pond systems on this farm has not yet begun so production data are not yet available.

10 split-pond aquaculture systems located near Amagon, AR have been monitored since stocking hybrid catfish fingerlings in April, 2013. All systems utilize between 10 – 15 hp/acre of aeration in the culture basin using electric paddle-wheel aerators and supplemental PTO aerators when needed. The split ponds ranged from 4.5 – 7.5 acres with fish culture areas ranging from 18.9 – 25.0% of total pond acreage. Water is circulated between the fish-culture and waste-treatment areas with either a culvert-based 5.0 hp or 7.5 hp slow-rotating UAPB waterwheel. The aerators and water circulators are operated automatically

with a monitoring system. Harvesting has begun on some of these ponds but production data are not yet available.

Objective 2: *Estimate costs of production in these systems including total investment costs, annual fixed and variable costs, and cost per pound of production (USDA-ARS; Auburn University; Mississippi State University; University of Arkansas at Pine Bluff).*

USDA-ARS (Intensively-aerated conventional ponds and split-ponds).

Data collection has included (but has not been limited to) all stocking data (fish numbers and weight), feed fed (weight), energy used (electrical and chemical), and all other expenses incurred. Water samples were collected bi-weekly and analyzed for total ammonia nitrogen, nitrite nitrogen, total alkalinity, pH, total hardness, and chloride. In addition, water samples have been collected for pathogen analysis at the MSU facility.

Mississippi State University (Intensively-aerated conventional ponds and split-ponds).

No involvement with Objective 2.

Auburn University (In-pond raceways and intensively-aerated conventional ponds).

Detailed records of investment and operating costs have been collected for each production unit at each cooperating farm. Records include a description of each input line item, quantities purchased, unit costs, and total costs for each item.

Data collection for the first production cycles for the five raceways in the IPRS system is almost complete. One of the five raceways is still in production (see Table 1) for preliminary results) and the economic analysis is in progress.

Table 1. Production results for one IPRS utilizing five raceways in Browns, Alabama.

	Raceways					
Production Cycle 1	1	2	3	4	5	Average
Production period (yr)	1.00	.90	.90	.90	*	0.93*
Pounds stocked	4,852	4,932	1,390	4,502	4,502	4,036
Head stocked	12,570	12,778	12,451	11,664	11,664	12,225
Weight at stocking, (lb)	0.386	0.386	0.109	0.386	0.123	0.278
Weight harvested (lb)	12,677	14,583	13,070	10,727	*	12,764*
Survival (%)	75.29	86.46	94.90	91.97	*	87.16*
Total feed fed (lb)	19,471	20,717	12,085	19,904	*	18,044*
Net FCR[1]	2.49	2.15	1.26	2.06	*	1.99*

*Production in Raceway 5 incomplete.

[1] FCR = Quantity of feed (total lbs) / [Ending harvest weight (total lbs) – Beginning fish stock weight (total lbs)]

UAPB (Split-ponds and intensively-aerated conventional ponds).

Data collection has included (but has not been limited to) all stocking data (fish numbers and weight), feed fed (weight), estimated energy usage and all expenses incurred. Water samples were collected weekly or bi-weekly and analyzed for total ammonia nitrogen, total alkalinity, and pH. Total hardness, nitrite nitrogen and chlorides were measured at the beginning middle and end of the growing season and nitrite was measured weekly in the fall if ammonia nitrogen was present. In addition, water flow rates and exchange rates in the split pond systems were measured where possible.

Detailed data have been collected on investment costs, and annual variable and fixed costs on split-pond and intensively-aerated ponds on the cooperating farms. The framework for the economic analysis has been developed and preliminary analyses are underway.

Objective 3*: Identify the relative strengths, weaknesses, and trade-offs of these alternative production systems (USDA-ARS; Auburn University; Mississippi State University; University of Arkansas at Pine Bluff).*

USDA-ARS (Intensively-aerated conventional ponds and split-ponds).

Physical measurements of all production systems in Mississippi (surface area and mean depth) have been completed.

Mississippi State University (Intensively-aerated conventional ponds and split-ponds).

Differences in pathogen loading rates among production systems will be evaluated at the end of the study to identify strengths and weaknesses of each production system as it relates to fish health.

Auburn University (In-pond raceways and intensively-aerated conventional ponds).

Physical measurements of all production systems in Alabama have been completed. In the IPRS unit, there have been four raceways completely harvested thus far and one raceway cell that is still in production. To date FCRs from the IPRS cells have varied but compare favorably to traditional pond production of catfish using the multiple batch system. The intensively aerated pond production system is in progress and it is too early to discuss strengths and weaknesses.

UAPB (Split-ponds and intensively-aerated conventional ponds.)

Physical measurements of all production systems in Arkansas (surface area and mean depth) have been completed. However, it was found that depths in the split ponds changed over the course of the growing season. It appears that solid waste and loose sediment was transferred from fish-culture area to waste-treatment area making the fish-culture area deeper and the waste-treatment area shallower. New depth estimates in split ponds will be calculated at the beginning of the 2014 growing season when water levels are back to normal.

IMPACTS

USDA-ARS (Intensively-aerated conventional ponds and split-ponds).

Two commercial catfish farms in Mississippi have been enlisted as cooperators on this project. Additionally, six-commercial-sized ponds at the MSU Delta Research and Extension Center are being used in this study. Electric monitors have been installed on all equipment, production facilities have been

stocked with either hybrid or channel catfish, and management inputs are being monitored. Harvesting of the first year production has begun.

Mississippi State University (Intensively-aerated conventional ponds and split-ponds).

Data will be used to identify fish health related risk factors associated with each type of production system. Information will be used to develop disease management programs to complement specific production parameters.

Auburn University (In-pond raceways and intensively-aerated conventional ponds).

The impact of this project cannot be measured at this point as the data is incomplete. However, it can be said that the early crops of hybrid catfish produced in the IPRS system compare favorably or better to traditional multiple batch pond production systems. The economic analyses of these first crops from the IPRS have not been conducted yet but when the analysis is complete will provide a good insight into the viability of this system. Monitoring of the intensively aerated pond system continues with no harvests having occurred during the first year so no impact can be reported at this time.

UAPB (Split-ponds and intensively-aerated conventional ponds.)

Three commercial catfish farms in Arkansas have been enlisted as cooperators on this project. Production facilities have been stocked with either hybrid or triploid (on three occasions) hybrid catfish, and management inputs are being monitored. Harvesting of the first year production has begun. The framework for the economic analysis of split pond and intensively-aerated ponds has been developed and preliminary analyses are underway.

PUBLICATIONS, MANUSCRIPTS OR PAPERS PRESENTED

None to date

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