MANAGEMENT METHODS OF COMMERCIAL CATFISH FARMERS IN OKLAHOMA

By

MARK ANTHONY KLIMKOWSKI

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Oklahoma State University

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MANAGEMENT PRACTICES OF COMMERCIAL

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Thesis Approved:

James P Key
Thesis Advisor

Robert Terry

Eddy Finley

Thomas C. Collins
Dean of the Graduate College

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Introduction

Oklahoma's past agricultural history was dominated by cattle and wheat production. A decline in cattle and wheat prices, with increased costs of living, has caused producers to look at other crops for increased income. Aquaculture is one of these alternatives, because any crop or livestock operation usually has a water source. Water is the main ingredient for aquaculture.

Overfishing our oceans has also caused a decline in aquatic populations. The High Plains Journal (Nov. 2, 1992) indicated that world population gains and limits on the wild fish catch from the oceans should increase the demand for aquacultural products.

Channel catfish production is the largest sector of United States aquaculture. Channel catfish culture is the most successful aquaculture endeavor in the United States as well as the fastest growing food production industry (Tucker and Robinson, 1990). In 1989, annual production exceeded 300 million pounds. Mississippi produces 75% of the commercially grown catfish in the United States. Although Mississippi is the leading state in catfish production, most of the research for large-scale production came from other states such as Alabama, Louisiana, Arkansas, and Oklahoma.

National Agricultural Statistics (1992) showed that as of July 30, 1992, Oklahoma had eighty catfish producers in the state. Oklahoma has two processing plants, one in Holdenville and a small operation in Morris.

Channel catfish production requires intensive management. Like any business, good management leads to good production. Oklahoma catfish production is still growing. Though the number of producers is small as compared to other states, most of them are managing to stay in business.

Channel catfish production offers some Oklahoma agriculturalists a chance to increase income on their farm or ranch if proper management skills are maintained. With proper management skills it is possible to see catfish production as a viable source of agricultural income in Oklahoma.

Statement of the Problem

Profitability in catfish production is directly related to managerial practices. Management of production, economics, and disease control is vital to any animal operation.

Oklahoma has had some decline in the number of catfish farmers due to improper management skills. People have gone into the catfish business with the idea that the operation is easy to manage. Many people think that all they have to do is throw catfish in a pond, feed and harvest them, and then make money. However, catfish production requires intensive management.

Oklahoma has a small number of catfish farmers compared to other states, but these farmers manage to stay in business. Little is known about their actual management procedures. Knowledge of catfish farmers' management methods will allow the Extension Service to put emphasis on areas of management that need improvement and will also provide information for beginning catfish farmers.

Purpose of the Study

The purpose of this study was to determine the management methods of commercial catfish farmers in Oklahoma.

Objectives of the Study

In order to complete this study, the researcher had the following specific objectives:

1. Identify commonly applied catfish management methods, including those dealing with stocking, feeding, water quality, diseases, harvesting, record keeping, and marketing;

2. Identify problems experienced by Oklahoma catfish farmers;

3. Identify the number of farmers who are no longer in the catfish business; and

4. Identify farmers who are no longer in the catfish business but are raising other types of fish.

Assumptions of the Study

For the purpose of this study, the following assumptions were accepted:

1. Catfish acreage figures were estimated by farmers and ranchers;

2. The instrument (questionnaire) elicited accurate responses from the catfish farmers;

3. The catfish farmers of Oklahoma would be present for an interview or have access to a telephone; and

4. Some catfish farmers in the population may no longer be in business.

Scope of the Study

The scope of this study included 133 catfish farmers located in the State of Oklahoma who were identified by Southeast District Area Aquaculture Specialists who constructed a directory, through personal knowledge, which listed fish farmers by county, their addresses and phone numbers, and the type of fish they grew. Only those farmers in the directory who grew catfish were surveyed. A multiple survey was used to elicit responses from the catfish farmers, which consisted of: 1) a personal interview where the researcher surveyed catfish farmers at the 1993 Catfish Farmers of Oklahoma Annual Conference and Trade Show in Wetumka, Oklahoma, 2) a telephone survey for distant areas in the state, and 3) a mail survey for farmers who could not be reached by telephone.

Definition of Terms

Certain terminology presented in this study corresponds to the following definitions:

1) Aquaculture: The rearing of aquatic organisms under controlled or semi-controlled conditions.

2) Cage Culture: Rearing of aquatic organisms in floated or suspended enclosures, generally constructed of wire or netting around rigid frames, in large bodies of water.

3) Clean Cropping: Harvesting all fish at one time.

4) Crude Protein: The nitrogen content of a feedstuff multiplied by a factor, generally 6.25, and expressed as a percentage of the diet (e.g. 32 or 36% protein).

5) Demand Feeder: A feeder that dispenses feed when activated by the animals consuming the contained feed.

6) Feed Conversion Ratio: In aquaculture, the amount of dry feed fed divided by wet weight gain.

7) Fingerling: A fish. Juvenile fingerlings are capable of eating particulate food, but are subadult and not reproductively capable. Fish of about two to eight inches in length.

8) Floating Feed: Commercially prepared feed that floats on the water surface.

9) Fry: Newly hatched fish.

10) IFMAPS: The Intensive Financial Management And Planning Support program sponsored by the OSU Cooperative Extension Service. It is designed to educate and assist farm families with financial planning.

11) Olivaceous: Olive in color.

12) Spawning: To deposit eggs or sperm directly into the water, as fishes. Egg masses are called spawn.

13) Topping: Harvesting fish that have grown to marketable size, while leaving subharvestable fish in the pond or cage.

CHAPTER II

REVIEW OF LITERATURE

Introduction

This chapter provides information about commercial catfish production. This overview was divided into ten major areas: 1) History of Channel Catfish (*Ictalarus punctatus*); 2) Financing Channel Catfish Production in Oklahoma; 3) Stocking Procedures; 4) Feeding Procedures; 5) Water Quality Management; 6) Catfish Diseases; 7) Harvesting Techniques; 8) Record Keeping; 9) Marketing in Oklahoma; and, 10) Summary.

History of Channel Catfish (*Ictalarus punctatus*)

There are 39 species of catfish in North America but only six of those species have been cultured or have potential for commercial production. The channel catfish, *Ictalurus punctatus* (*Rafinesque*), is the most important commercially cultured species in the United States. The channel catfish was originally native to Mexico, the

Mississippi Valley, and states bordering the Gulf of Mexico (Wellborn, 1988). Channel catfish were not native west of the Rocky Mountains or in the Atlantic Coastal Plain. During the 1880's channel catfish were successfully introduced in Washington and Oregon by state and federal hatchery personnel (Iversen, 1992). Channel catfish have now been widely introduced throughout the United States and the world.

The channel catfish is cylindrical in cross-section and has no scales. The fins are soft-rayed except for sharp, hard spines at the anterior end of the dorsal and pectoral fins. There are four barbels on the lower jaw and one on each tip of the maxilla (upper jaw). Young channel catfish have an irregular pattern of spots on their side that tend to disappear as they become adults. Wellborn (1988) stated that the channel catfish is the only spotted North American catfish with a deeply forked tail. They are generally olivaceous to blue in color on the back and shade to an off-white on the belly. The water they inhabit dictates their color. In clear water channel catfish appear almost black while in muddy water they appear to be a light yellow or gray. Figure I shows the external part of the channel catfish.

Channel catfish usually reach sexual maturity at three years of age, at a size of two pounds or more. The optimal temperature for growth is about 85 degrees Fahrenheit.

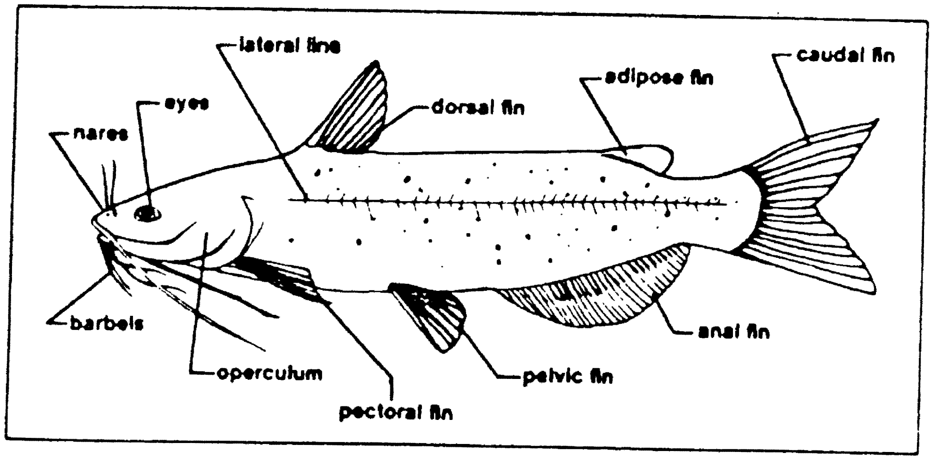


Figure I

External Parts of the Channel Catfish

Below 50 degrees Fahrenheit (10 degrees Celsius) feeding activity essentially stops, and so does growth. Growth in channel catfish is dependent on several factors. Two of the major factors are environmental temperature and food availability. Young channel catfish feed mainly on aquatic insects; adults feed on snails, insects, crawfish, algae, aquatic plants, and small fish. Tucker and Robinson (1990) stated that channel catfish have been reported to live for up to 40 years and reach 58 pounds (26.31 kg.).

Channel catfish are bottom dwellers. Their natural habitat is moderate- to swift-flowing streams. They prefer clear water, but are found in turbid water. Most feeding occurs at night, but some feeding does occur during the day.

Channel catfish are cavity spawners in undercut banks, holes, or hollow logs that are secluded and semi-dark. Spawning occurs when water temperatures are 75 to 85 degrees Fahrenheit (24 to 30 degrees Celsius). The male prepares the spawning site, fertilizes the eggs after the female lays them, and then cares for the eggs until they are free swimming. After the eggs hatch catfish fry absorb the nutrients in their yolk sac for two to five days until they are able to feed on their own.

Several different types of culture systems are used to raise channel catfish, such as the use of levee ponds, cages, raceways, and recirculating systems. These systems vary in economics.

Levee ponds are impoundments built by excavating an area to a shallow depth. The soil is used to build a perimeter of levees or dikes. Keating (1992) stated levee ponds are the state-of-the-art systems as far as reliable, economical production facilities for catfish and most other warm-water finfish. Cages and raceways can raise more catfish when comparing amount raised per area but, economics plays a major factor since confinement of a large number of catfish in a small area can lead to disease problems and the large quantity and quality of water needed for raceways must also be considered.

Cage culture consists of raising catfish in floating cages. Collins (1988) reported that although cage culture of catfish has been used in several states, most of the production (500,000 pounds annually) is in western Arkansas.

Raceways and recirculating systems are linear or circular containers with a continuous flow of water. In raceways the water enters at one end and exits the other end. Recirculating systems have basically the same procedure but when the water exits it is recycled through filters and re-used.

Oklahoma's catfish industry is growing. There are 148 fish producers in the state (as of June 26, 1991) and 133 raise catfish. Catfish producers are located in 51 of 77 counties in the state. As of January 1, 1992, Oklahoma had 1,100 water surface acres in catfish production. One hundred fifty acres were being renovated, sixty acres were under construction, and fifty acres were out of production.

There are two fish processors in Oklahoma. Aquafarms Catfish is located in Holdenville, in Hughes County. Aquafarms was established in August of 1987. Two million pounds of catfish are processed each year at Aquafarms. They employ around 45 people. The other processing plant is expected to open for business in December 1992. It will be located in Morris, in Okmulgee County, and operated by Mr. Bill Williams. In a telephone interview with Mr. Williams, the researcher found that he expects to process 15,000 pounds of catfish per week. Mr. Williams predicted employment of one person per 1,000 pounds of catfish processed.

Total catfish sales were down in 1991 ($1,954,000.00) from 1990 ($2,235,000.00). The annual average price per pound in 1991 was 63.1 cents. The average price per pound has dropped 15 cents since 1988.

Aquaculture is even starting to be taught in Oklahoma's high school Agriculture programs. So far, Cushing, Perkins and Red Rock, Oklahoma are the only three schools that have an aquaculture program. The programs allow the students and teacher to learn by experience. Aquaculture has taught students basic science concepts. An agriculture teacher in Illinois (Walsh, 1992) stated, "It has made me an Agriscience teacher. I am finding myself relearning even the most basic science concepts."

Aquaculture provides new jobs for the next generation. In Visalia, California, one young man created his own business. It started as a small Supervised Agricultural Experience (SAE) program. Keith Jones raises colored Koi fish. Hamilton (1992) stated,

> Jones believes more FFA members could develop their SAE programs into a small business. You've just got to have the initiative to do it (p. 7).

Financing Channel Catfish Production in Oklahoma

Financing is very important in any business. All aspects must be studied carefully before getting into catfish production. These include type of facilities, construction costs, and marketing. A producer should ask himself, "Do I have the capital to invest, and how long will it take to get my investment back?" Altman (1990) explained that although fish farming can provide high income, the risks are great and losses can be tremendous. It is best for beginners in the catfish business to start with a small operation. This allows the farmer to actually see if this is the business they want and gives them experience with a smaller risk. If possible, it is best for producers to use their own capital.

When financing an operation it is important to reduce costs as much as possible. Enterprise budgets should be estimated before committing any money. Most often, if the budget doesn't work on paper it won't work in reality. Several programs can help producers fund a catfish enterprise. The best place to get started is the Oklahoma Cooperative Extension Service. They can't provide money, but they can answer questions, help plan procedures, and get producers started in the right direction. A few programs in Oklahoma offer reduced interest rates on loans. They are:

- Farmer's Home Administration
- Oklahoma State Treasurer's Office Link Deposit Program
- Oklahoma Development Finance Authority
- Small Business Innovation Research Program (SBIR)

- Small Business Administration (Oklahoma Channel Catfish Directory, OK Department of Agriculture).

The Farmers Home Administration (FmHA) provides loans for family farms that cannot obtain a loan elsewhere. The FmHA also provides loans for partnerships, cooperatives, corporations, and public bodies.

Eligibility requirements for loans are stated here briefly:

- Must not have been convicted of producing a controlled substance.
- Be a citizen of the United States, or an alien lawfully admitted to the United States for permanent residence.
- Possess the legal capacity to incur the obligations of the loan.
- Have sufficient applicable educational and/or on-the-job training or farming experience in managing and operating a farm or ranch.
- Have the character (emphasizing credit history, past record of debt payment and reliability) and industry required to carry out the proposed operation.
- Honestly endeavor to carry out the applicant's/borrower's undertakings and obligations.

- Be unable to obtain sufficient credit elsewhere to finance actual needs at reasonable rates and terms.
- Be the owner-operator or tenant-operator of not larger than a family farm after the loan is closed (FmHA Brochure).

A producer would first go to their FmHA county office, and complete a loan application. A committee of three people from the county would determine whether the producer is eligible for the loan. FmHA offers low interest rates and are a temporary source of credit. FmHA's purpose is to provide credit to a producer until they are able to obtain credit from another source.

FmHA has several programs that can be used for Aquaculture loans. A few are listed:

- Farmers Ownership Loans: used for real estate. Current rate 7%, 40 year term.
- Operating Loans: used for equipment and other operating expenses. Current rate 6%, seven year term.
- Emergency Loans: used for disasters. Current rate 4.5%. Production losses, 20 year term; Buildings, facilities, etc., 40 year term; and Real Estate, 40 year term.
- Soil and Water Loans: used for land and water development. Current rate 6.50%; 40 year term.

- Recreational Loans: used in converting farm or ranch land into an outdoor income-producing recreation enterprise (FmHA Brochure, 1979).

Another program from which producers can obtain loans is the Oklahoma State Treasurer's Office's Link Deposit Program. The State Treasurer continually invests state funds to earn interest until the funds are required to pay the state's bills. Much of the time the treasurer deposits these funds in state depositories such as commercial banks and savings and loans. These institutions then use the funds and pay interest to the state.

In the case of a linked deposit, the State Treasurer is allowed to deposit funds with approved lenders that are willing to make specific loans. Thus, the deposits are "linked" to a specific use. The lenders can apply for linked deposits for loans to borrowers that meet the specifications of the legislation. The lenders will be able to pay reduced interest rates on the deposits, and must then charge reduced rates to the applicable borrowers.

The Oklahoma Agricultual Linked Deposit Program was designed to target two segments of the agricultural sector. They are:

1) Any "at-risk" farm or ranch businesses in operation which meet the eligibility criteria outlined in the legislation; and

2) Any individuals or businesses initiating or expanding production, processing, or marketing of approved alternative agricultural products within Oklahoma.

Aquaculture falls under segment number two as an alternative agriculture product, which means those enterprises which are non-traditional crops or enterprises in Oklahoma and which the State Board of Agriculture determines will broaden Oklahoma's overall agricultural base.

The eligibility criteria for acquiring a linked deposit loan under the alternative products portion are:

1) Must be Oklahoma residents doing business in Oklahoma;

2) Must certify and document that they use the linked deposit portion of the loan for expanding or starting the production, processing, or marketing of eligible alternative agricultural products;

3) Must find an approved lender willing to make the loan; and

4) Must develop a financial management plan with the assistance of the IFMAPS program of the Oklahoma Cooperative Extension Service.

The size of the total loan is up to the individual lender. The maximum linked deposit that the Treasurer can make for each individual alternative product loan is $1,000,000. The interest rate a farmer would pay depends on the lender, who will pay the current two-year treasury note rate minus three percentage points. However, if the two-year T-note rate equals or goes above nine percent, the deposit rate would change to a sliding scale based on 60% of the T-note rate (e.g., if the T-note rate was 7% the cost of the linked deposit to the lender would be 4%. However, if the T-note rate was 10%, the cost to the lender would be 6%).

Once the rate the lender pays on the linked deposit is established, the lender can then add his standard operating margin, not to exceed 5.5 percentage points. Thus, the maximum interest rates on loans in the two examples would be 9.5% (7% - 3% + 5.5%) and 11.5% (10% - 4% + 5.5%). The lender could charge a margin less than 5.5%, which would reduce the interest rate (Love and Hildebrand, 1992).

The Oklahoma Development Finance Authority is a state lending agency. They will loan money on hard assets such as land, buildings, and equipment. They will loan up to two-thirds the cost of such hard assets. The loan is made through a local industrial authority. The person acquiring the loan must fill out a business plan and provide an employment plan and history information. The interest rate is based on 425 base points above the cost of funds and rates paid on bonds (Blake, telephone interview, 1993).

The Small Business Innovation Research (SBIR) program provides grants that are seed capital directly from twelve federal agencies to stimulate technological innovation based on research (Sherrer, no date available). The SBIR is a highly competitive three-phase award system that provides qualified small business concerns with opportunities to propose innovative ideas that meet the needs of the federal government.

Phase I is to evaluate the scientific technical merit and feasibility of an idea. Awards of up to $50,000 with a period of performance of up to six months are involved in this phase.

Phase II is to expand on the results of and further pursue the development of Phase I. Awards of up to $500,000 with a period of performance normally not to exceed two years are involved in this phase.

Phase III is for the commercialization of the results of Phase II and requires the use of private or non-SBIR federal funding. No SBIR funds are expended in this phase.

The only way a small business concern can obtain SBIR funding is to successfully compete for ann SBIR award (Small Business Innovation Research Brochure).

The Small Business Administration (SBA) is an agency of the U.S. government with authority to make loans to farmers who cannot meet FmHA eligibility requirements or obtain regular commercial financing. Farmers, farm corporations and partnerships qualify if maximum gross income does not exceed $1,000,000.

The types of loans offered are long-term real estate loans, short-term operating loans and intermediate loans for the purchase of machinery and livestock. The SBA also has some emergency lending authority.

Loan maturities are up to 20 years on real estate loans, one year on operating loans, and up to ten years on intermediate loans for machinery and livestock purchases. The SBA can guarantee up to 90 percent of the loan up to $500,000. Direct SBA loans cannot exceed $150,000. Almost all farm loans are made through banks with SBA guarantees (Mapp, 1992).

Interest rates on the guaranteed loan program are negotiated between the borrower and the lender, subject to SBA maximums. Generally, interest rates for lonas cannot exceed 2.75 percent over the New York prime rate. Interest rates on direct loans are based on the cost of money to the federal government and are calculated quarterly (Business Loans & The SBA brochure).

Besides loan agencies, other agencies provide counseling to help farmers get started. Some agencies may help cut costs, like the Oklahoma Association of Electric Cooperatives who provide reduced rates for electricity during non-peak hours.

One objective of this study is to find which agencies are most often used by Oklahoma catfish producers to obtain capital. Farmers must do their homework before obtaining a loan. Since the catfish industry is still growing in Oklahoma, the farmers may be required to educate the banker.

Stocking Procedures

Stocking procedures are an important management tool for channel catfish producers. Stocking rates are linked with other management prodecures such as feeding, disease prevention or treatment, water quality management and marketing. When stocking ponds to produce food fish, many factors must be considered: market demand, production method, feeding, experience, and management skill are some of the most important. Walker (1990) stated,

> As a rule of thumb, new producers should not stock more than 3,000 to 4,000 fish per surface acre of water if the desired market size is one and a quarter pounds or more. This allows the new producer to gain experience while reducing potential problems (p. 524).

Stocking rates for extensive production vary from 500 to 2,000 catfish fingerlings per surface acre of water. Intensive commercial ponds vary from 2,500 to 6,000 or more catfish fingerlings per surface acre of water.

Cage cultured channel catfish fingerlings usually are 4-8 inches long. They are stocked at a density of eight to twelve per cubic foot. Cages are usually used for small-scale culture in bodies of water that cannot be seined, drained, or harvested. Examples for cage use are strip mines, gravel pits, lakes, large reservoirs, and irregular farm ponds. A producer should not expect to produce more than 1,500 pounds of catfish per acre per year in cages without supplemental aeration or a significant inflow of fresh water.

Fingerlings are usually stocked to grow to fish-food sizes within 120 to 150 days. Stocking rates depend on the desired size at harvest and maximum feeding rate. The more intense the stocking rate, the smaller the catfish at harvest time.

Walker (1990) stated clean-crop Fall harvesting of food-sized catfish requires the Spring purchase of five- to six-inch fingerlings in the Southern states, six- to eight-inch fingerlings in the more northern states, and eight- to ten-inch fingerlings in Iowa and states even further north (p. 523). In Oklahoma the desired stocking size of fingerlings is six to eight inches in length. Studies at Langston University, Langston, Oklahoma, have shown that the larger fingerlings (8 inches) produce the greatest net returns when compared to smaller fingerlings.

Fingerlings are stocked in late March and harvested in October and November. When buying fingerlings, the farmer must decide of the size to meet their market needs, and which size will be cost effective to feed. Studies have shown that larger fingerlings can gain more weight in a given time period than smaller fish. In the Southern states, when the temperatures are 75 to 85 degrees Fahrenheit, six to eight inch fingerlings grow to about one pound in 20 to 21 weeks, 8 to 10 inch fingerlings grow to about one pound in 15 weeks, and 10 to 12 inch stockers grow

Length-Weight Relationship for Channel Catfish Fingerlings and Food Fish

Total Length (Inches)	Average Weight per 1000 Fish (Pounds)	Number of Fish per Pound	Average Weight per Fish (Pounds)
1	1.3	767.7	.0013
2	3.5	285.7	.0100
3	10.0	100.0	.0100
4	20.0	50.0	.0200
5	32.0	31.1	.0321
6	60.0	17.0	.0588
7	93.0	10.8	.0926
8	112.0	9.0	.1111
9	180.0	5.5	.1818
10	328.0	3.1	.3280
11	395.0	2.5	.3950
12	509.0	1.9	.5090
13	656.0	1.5	.6560
14	850.0	1.1	.8500
15	1090.0	0.92	1.0900
16	1290.0	0.82	1.2900
17	1432.0	0.69	1.4320
18	1750.0	0.57	1.7500
19	2200.0	0.45	2.2000
20	2890.0	0.35	2.8900
21	3290.0	0.30	3.2900
22	3470.0	0.29	3.4700
23	3600.0	0.28	3.6000

Tables from *Handbook for Common Calculations in Finfish Aquaculture* by Gary L. Jensen, Louisiana Cooperative Extension Service, with permission.

Figure II

Table for Calculating Stocking Numbers and Sizes

to about one pound in nine weeks.

There are many equations for calculating fish stocking rates. To stock six-inch channel catfish fingerlings at 3,000 per acre in a two acre pond, first find the total number of fish in the pond. Multiply the number of fish desired per acre times the number of acres. Walker (1990, p. 537) gave this example:

Total Number of Fish to Stock = No. of Fish/Acre x No. Acres

= 3,000 Fish/Acre x 2 Acres

= 6,000 Fish

Next, calculate the number of pounds of fingerlings to purchase. Use the chart in Figure II to find the estimated number of pounds per 1,000 six-inch fish.

6-inch length fingerlings = 60 pounds per 1,000 fish

To find the total pounds of fingerlings to purchase, divide the total number by 1,000 and multiply by the pounds per 1,000 fish.

$$\text{Total No. of Pounds Needed} = \frac{\text{Total No. To Stock}}{1000} \times \text{lb}/1{,}000$$

$$= \frac{6{,}000}{1{,}000} \times 60$$

$$= 6 \times 60$$

$$= 360 \text{ pounds of fish}$$

When buying fingerlings, the producer must also consider fish health. Williams (1991) stated:

> Regardless of the size or quantity of fingerlings purchased, make sure they are healthy. Avoid fingerlings with red sores on their bodies, sunken bellies, or bulging eyeballs (p. 2).

Feeding Procedures

This is one of the most important management procedures involved in catfish production. When catfish are stocked at high densities it is important that they receive the proper nutrition. Catfish feed that lacks the essential nutrients in proper amounts end up just being a supplemental feed which has no place in a production system where stocking rates exceed 1,200 fish per surface acre. Use of a supplemental feed at high stocking rates will lead to poor growth and death of fish due to a nutritionally-induced disease. It is important that the producer know what the feed consists of. Most feed manufacturers use "least cost" instead of "fixed feed" method of feed formulation, where the formula varies, within limits, as ingredient prices change. Since the kind and amount of ingredients needed for catfish is not a secret, the feed manufacturer should be willing to reveal the type and amount of ingredients in their feed. Wellborn (1987) stated:

> If feed company officials are not willing to do this, consider buying feed from another company to get what you pay for (p. 1).

Palatability, size and form of feeds are important to achieve maximum growth rate. There are four types of form and size of feeds available, according to Wellborn (1990):

* Meal
* Crumbles
* Floating (expanded or extruded) Pellets
* Sinking (hard or compacted) Pellets.

Feed size and form depend on the type of management, water temperature, and fish size. Meal and crumbles are used for fry and small fingerlings. The floating pellets are used when temperatures are above 65 degrees Fahrenheit.

This makes the fish come to the top of the water when feeding and allows the producer to observe the fish eating. This can help the producer monitor feeding habits and catch potential problems. Sinking pellets are used when temperatures fall below 65 degrees, because catfish reduce feeding activity at colder temperatures and seldom come to the surface. It is best to convert feeding floating pellets to sinking pellets while catfish are still feeding actively at 65 degrees Fahrenheit. Wellborn (1987) commented:

> If you wait until they completely quit feeding at the surface, usually about 60 to 63 degrees Fahrenheit, it may be difficult to get them to accept sinking feed (pp. 1-2).

A three-sixteenth to three-eighth inch pellet has seemed to be the best size of pellet to feed in intensive pond production. This is where multiple or topping harvest is done. Fish will vary in size. this size of pellet is too large for small fish to consume whole and is rather small for large fish, but it keeps the producer from feeding two sizes of pellets each day.

Usually a 32% protein feed is used when feeding large fingerlings to harvest. A nutritionally complete 32% protein catfish feed would consist of the indgredients in the following example (Wellborn, 1987):

Ingredient	lbs/ton	Percent
Menhaden Fish Meal	160.00	8.00
Soybean Meal,48% Protein	965.00	48.25
Corn	582.00	29.10
Rice Bran or Wheat Shorts	200.00	10.00
Dicalcium Phosphate	20.00	1.00
Pellet Binder	40.00	2.00
Fat (sprayed on)	30.00	1.50
Trace Mineral Mix	1.00	0.05
Vitamin Mix	2.50	0.125
Coated Ascorbic Acid	0.75	0.038

The menhaden fish meal seems to be an important factor in the ration. Studies have been done to substitute the fish meal with soybean meal with little success. Andrews and Page (1974) showed that when soybean meal was substituted on an isonitrogenous basis for menhaden meal, growth and feed efficiency were substantially reduced (p. 1091).

Feeding catfish can be done by hand or by mechanical feeders, and these methods can depend on the size of the operation. It is best to feed catfish over a wide area to allow all fish a chance to eat. Just feeding in one spot will usually cause the more aggressive catfish to consume most of the feed and become bigger at the expense of the smaller catfish. This problem is also caused by underfeeding. As Wellborn (1987) stated,

> To produce catfish uniform in size, and to maximize profits, it is equally important that catfish be fed the proper amount of feed daily and the food be distributed as evenly over the pond as possible. Feed catfish once or twice a day between 9:00 a.m. and 5:00 p.m.,

> when dissolved oxygen levels are high (p.4).

It is important that the producer doesn't overfeed or underfeed. A good rule of thumb is not to feed more than can be eaten in five to fifteen minutes. Overfeeding can result in the uneaten feed sinking to the bottom, causing water quality problems. The uneaten feed adds to the organic matter at the bottom of the pond that burns up the oxygen in the water. This can lead the producer to increased expenses for aeration, stress on fish, low growth rates, and death loss. If feeding rates are maintained at or below 35 pounds per acre per day, dissolved oxygen concentrations rarely fall to critical levels. Tucker and Robinson (1990) showed that a maximum feeding rate of 35 pounds per acre per day is sufficient to grow about 2,000 fish per acre to harvestable size in one growing season in a single-batch cropping system (p. 231). This is why producers just starting should start small, to cut the cost of aeration, feeding, and stress related problems. Increase in stocking rate will cause an increase in feeding and management for the producer.

Feeding allowances can be based on the percentage of body weight. The amount of feed that should be fed may change daily. Fish size and water temperature are used because these two situations affect feeding the most. A good assumption is two pounds of feed per one pound of gain. To formulate feeding allowances simply divide the total weight at stocking by the total number of fish stocked.

This will give the producer the average fish weight. Then, by using the table in Figure III, find the percentage body weight recommended for feeding fish that size. Multiply the percentage body weight by the total weight of fish stocked to determine the amount that should be fed on that day. Though feeding this way can be done, it is very inconvenient (Tucker and Robinson, 1990, p. 309). Note that as the fish size increases in Figure III the feed allowance decreases. This is why most catfish are harvested at 1.5 pounds per fish, because the feed conversion ratio is no longer cost effective when selling the product straight to a processing plant.

It is important to feed catfish seven days a week in order to maximize growth. Wellborn (1987) stated that by doing so production time can be decreased by four weeks, when compared to feeding only six days a week.

Catfish feed consumption decreases in the winter months (November 15 to March 15), but research has shown that catfish can lose about 9% of their body weight if not fed, although when put on a winter feeding program catfish can gain as much as 20% of their body weight. During the winter months, sinking feed should be fed at 0.5 to 1% of the body weight, on alternate days when temperatures are above 49 degrees Fahrenheit. This same method can be used when water temperature at a depth of three feet is 54 degrees Fahrenheit or higher.

Feeding procedures for catfish are very important in management of the operation. As we have stated, improper feeding procedures can lead to stress, poor water quality, reduced growth rates, and death loss, all of which mean less money in the producer's pocket.

Water Temp. (°F)	Fish Size (pounds)	Feed Allowance/Day: % of Fish Weight
68	0.04	2.00
72	0.07	2.50
77	0.11	2.80
80	0.15	3.00
82	0.22	3.00
84	0.92	3.00
85	0.35	2.80
85	0.42	2.50
86	0.59	2.20
86	0.75	1.80
82	0.90	1.60
79	1.00	1.40
73	1.10	1.10

Figure III

(Tucker and Robinson, 1990, p. 310)

Water Quality Management

Water is the key to successful commercial fish farming (Altman, 1990). Good quality water can be a life saver in reducing instances of an emergency, such as periods of low oxygen and outbreaks of diseases. The key to successful catfish farming in ponds is to stock and feed fish at the highest rate possible without degrading the environment of the fish to a point where net economic returns decrease due to excessive management costs. Poor water quality management can lead to aeration and water pumping costs, poor growth rates, increase in death loss, or infectious diseases.

Mechanical aerators are used to put oxygen into the water. The amount of dissolved oxygen in water is influenced by temperature. During cold temperatures ponds are able to hold more dissolved oxygen. It is during warm temperatures that a decrease in dissolved oxygen can be a problem. In respiration the energy stored in organic compounds is liberated and oxygen is consumed. All aerobic organisms in the water constantly consume oxygen in respiration. Tucker and Robinson (1990) stated:

> Rates of respiration increase as biomass and water temperature increase. This is why overfeeding can be a problem. The unused feed adds to the organic matter in the pond, causing an increase in respiration rates (p. 221).

The producer must understand the dissolved oxygen budget (Tucker and Robinson, 1990, p. 218). This budget is rather simple and consists of photosynthesis and diffusion, which produce oxygen in water, and respiration and diffusion, which use up oxygen in the water. Diffusion is the transfer of oxygen across the air-water interface. Diffusion can result in either a gain or loss of oxygen, depending on the percentage saturation. As saturation deficit or saturation surplus increase, so does the rate of diffusion increase. Highly undersaturated or supersaturated waters gain or lose oxygen faster than those waters that are at equilibrium. This is important because aeration becomes less efficient at adding oxygen to the water if the dissolved oxygen is near saturation or a low saturation deficit.

Photosynthesis is the conversion of carbon dioxide to organic compounds (Stickney, 1979). Oxygen is released in the process. The plants use light energy to produce sugars from carbon dioxide and water with a release of oxygen. Photosynthesis rates in catfish ponds are controlled primarily by the biomass of plant material and light intensity. The main plant form in catfish ponds is phytoplankton. Dissolved oxygen levels are often low during the late evening, night time, or cloudy days if oxygen production is reduced or stopped. Good management must be used to provide aeration during these times to make aeration cost effective.

Smaller fish consume more oxygen per unit body weight than larger fish. Oxygen consumption rates can be calculated from the fish weight and temperature. As temperatures increase, oxygen consumption increases. Healthy channel catfish can survive when dissolved oxygen concentrations are above two parts per million (ppm) but growth rate is slowed down because fish feed poorly. Catfish are more susceptible to infectious diseases if oxygen concentrations are below 5 ppm. Extremely high dissolved oxygen concentrations can be harmful. Tucker and Robinson (1990) stated that when dissolved oxygen concentrations exceed about 300 percent saturation (25 ppm to 40 ppm, depending on water temperature), fish may develop gas bubble trauma. This happens in water that is supersaturated with dissolved gases (p. 47). The gases form bubbles in the fish's blood, stopping flow and possibly resulting in death.

There are two methods for measuring dissolved oxygen. Chemical test kits can be used but are time-consuming and subject to sampling errors. Chemical test kits can effectively be used if only a few ponds need to be monitored (Tucker and Robinson, 1990, pp. 227-32). The second method is the polarographic oxygen meter. The meter is fast and reliable. The meter consists of an electrode that produces an electrical current proportional to the concentration of oxygen in the water and a meter that translates this current into oxygen concentration units that can then be read on a scale. When using the meter it is important to remember that water must move across the membrane surface to get a good reading. Move the probe back and forth or up and down at about one foot per second. The meter usually takes about 10 to 20 seconds to get a reading within about 10% of the actual dissolved oxygen concentration. During cold weather this takes even longer.

In a pond, measurements of dissolved oxygen should be taken at two sites on opposite ends of a pond larger than one acre. Do not take measurements near inflowing water, in scums of algae, beside the bank, the very surface, or the bottom of the pond.

During warm months, dissolved oxygen concentrations should be measured at least three times per day. Take measurements at dusk, four hours after dusk, and at dawn. Also, measure during hot, cloudy weather, and after ponds have been treated with herbicides or disease therapeutics. Any time fish are in distress is a good time to take dissolved oxygen concentration measurements.

Aerators are used to add oxygen to water by increasing the rate of oxygen diffusion from the atmosphere into water. Tucker and Robinson (1990, pp. 233-39) listed the following types of aerators:

* Diffused Air Aerators: Use blowers or compressors to supply air and diffusers or porous pipe to release air bubbles on the pond bottom. This type of aerator is not efficient in shallow ponds and interferes with seining.
* Vertical Pump Aerators: Has a submersible motor with an impeller attached to the output shaft. The impeller and motor are beneath a float and water is sprayed into the air through an opening in the center of the float. Most of these type aerators don't produce a large area of oxygenated water so this limits

their use to small ponds of one tenth to two acres in size.

* Propeller-Aspirator-Pump Aerator: Has a motor, shaft, propeller, and flotation. The propeller, which is mounted on the end of a hollow drive shaft, accelerates the water to a velocity high enough to create a partial vacuum at the end of the shaft. The air is pulled down the shaft and dispersed into the water as a stream of fine bubbles. This type of aerator is relatively efficient and most commonly used in shrimp aquaculture, but seldom used in catfish culture.

* Pump-Sprayer Aerator: A pump that discharges water at a high velocity through a pipe or manifold. Pumps are powered by an electric motor or power take-off (PTO) of a tractor. The manifold directs oxygenated water along the shoreline where distressed fish congregate. This type of aerator is commonly used in catfish culture.

* Paddlewheel Aerator: Has a hub with paddles attached in a staggered arrangement. The aerator can be powered by a tractor PTO, electric motor, self-contained diesel or gas engine. The paddles are two to ten inches wide and can be rectangular, triangular, or semi-circular in cross-section. The most efficient are the aerators run by an electric motor. Too much power

is lost with the PTO-driven type. This is the most popular type of aerator for catfish ponds.

Aerators should be placed at the convenience of the producer because fish tend to move in the area near the aerator when dissolved oxygen concentrations are low (Tucker and Robinson, 1990, p. 242). Mobile aerators should be placed in the same location each time. Fish may not be able to swim long distances through oxygen-deficient water to locate the aerator site. Though dissolved oxygen concentration is the main factor in water quality management, there are other factors that should be checked. Alkalinity, hardness, pH, ammonia, nitrates, and chlorides should be checked for water quality management.

Off-flavor can be a problem in production and an economic burden. Off-flavor can be caused by feeds high in marine fish oil or it can result when fish absorb odorous chemicals from the water. Earthy-musty off-flavors are the most common in pond-raised channel catfish. It is caused by fat-soluble alcohols, geosmin and 2-methylisoborneol produced by actinomycetes and blue-green algae. The fish absorb the fat-soluble alcohols through the water and deposit them in fat-rich tissues. The off-flavor is associated with that of old books, damp cellars, or freshly turned soil. The off-flavor disappears after two to seven days in clean water (Tucker and Robinson, 1990, pp. 260-64).

Other off-flavors can be petroleum off-flavors caused by diesel oil, gasoline or kerosene. Sewage off-flavors are caused by the decomposition of dead phytoplankton. A producer may apply algicides to ponds in an attempt to kill off blue-green algae suspected of producing earthy-musty flavors which may result in sewage off-flavors from the decomposition of the blue-green algae.

Fish are usually checked for off-flavor the day before harvest and from the transport truck before fish are unloaded at the processing plant. A sample is taken each time. Any time off-flavor is shown in a sample the fish are rejected from processing. To get rid of the off-flavor fish must be moved to a clean environment, clean water. The only algicide marketed in the United States that claims to prevent or eliminate off-flavor problems associated with blooms of blue-green algae is Solricin 135.

Off-flavor in fish can take several days or weeks to eliminate, depending on the cause of off-flavor. This can cost the producer. Care must be taken when moving fish to clean water, as they will be stressed.

Aquatic plants are also a situation that can cause a problem in water quality management. Some plant life will always be present in channel catfish ponds, but in some instances steps must be taken to eliminate or control their abundance. There are two groups of plant life that grow in catfish ponds. One is primitive plants that have no true roots, stems or leaves, such as algae. The primitive plants do not produce flowers or seeds. The second group consists of higher aquatic plants that have roots, stems and leaves.

They produce flowers and seeds, and can be either submersed or emergent. Examples of higher aquatic plants that are submersed are Naias (bushy pondweed), Ceratophyllum (coontail), Cabomba (fanwort), and Myriophyllum (parrot feather). Examples of emergent plants are Polygonum (smart weed), Typha (cattails), and Salix (willows) (Tucker and Robinson, 1990, p. 270).

Control of these aquatic weeds can be done biologically. This consists of using several fish species to consume unwanted aquatic vegetation. These fish include grass carp, common carp, and various tilapias. The grass carp or "white amur" was introduced into the United States in 1963 from Southeast Asia. The white amur is banned in more than thirty states but is a valuable tool for control of aquatic weeds where it is legal. The problem with this fish is that the distribution of them can cause an effect on native fish and wildlife. These carp need running water to reproduce, so every effort must be made by the producer to prevent their escape into natural waters.

Tucker and Robinson (1990) stated:

> To diminish further the likelihood that grass carp will reproduce and thrive in natural waters, it is recommended that only sterile, triploid carp be used in channel catfish ponds (p. 276).

Grass carp can survive in water temperatures of 32 to 105 degrees Fahrenheit. When used to prevent the establishment of submersed weeds, grass carp are stocked five to ten (three- to six-inch) carp per acre. For severe weed problems, 10 to 15 carp per acre are used, and for heavily weed infested ponds 15 to 25 carp are stocked per acre.

The most common means of aquatic weed control in catfish ponds is with the use of chemicals. There are about 43 herbicides on the market used to control weeds in catfish ponds. Two herbicides that are available are discussed below. Simazine (Aquazine), which kills most algae and submersed plants, is a wettable powder that is slow-acting and very persistent in ponds. Because it is slow-acting and persistent, water quality can remain poor for weeks after it is used. Glyphosate (Rodeo) is used on emergent and shoreline plants. It is a broad spectrum herbicide used to control cattails, grasses, smartweed and willows around pond margins.

Tucker and Robinson (1990) stated that herbicides are seldom directly toxic to fish when used according to the manufacturer's specifications (p. 281). A problem that can occur from the use of an herbicide is reduced concentrations of dissolved oxygen. As the aquatic plants die they begin to decompose, which increases oxygen consumption, carbon dioxide, and total ammonia concentrations. It is important that the producer read the labels of the herbicide they use and follow the directions. The use of herbicides has practically allowed agriculture to produce twice or triple the amount that was produced 40 years ago. Herbicides are safe as long as they are used properly. As aquaculture grows, more chemical companies will be willing to spend the money needed to gather data necessary for registration review of unregistered herbicides.

The two main problems in water quality management are low dissolved oxygen concentrations and high ammonia or by-products. Both are the result of uncontrolled phytoplankton growth in heavily fed ponds. Though there are methods to control phytoplankton, most of these methods are ineffective. The researcher feels that more work needs to be done on this problem.

Tucker and Robinson (1990) stated that although water quality problems are common at higher feeding rates, the use of chemical or biological measures to control phytoplankton density cannot be recommended (p. 282).

The leading cause of stress among farm-raised fish is poor water quality (Beem, 1990, p. 1). Producers must regularly test water quality factors to help prevent problems before they occur. Langston University in Langston, Oklahoma, and Oklahoma State University in Stillwater, Oklahoma offer workshops in learning the basics in water quality management. Beem (1990) indicated that learning the basics of water quality management is fairly simple, and requires only a day (p. 2).

Catfish Diseases

Producers must understand the causes of fish disease to help detect a problem when it starts. Most fish diseases are caused by stress, which Beem (1990) defined as the reaction of an animal to any kind of irritation (p. 1). Stress can be caused by a number of things, such as rough handling, poor nutrition, and poor water quality. All of these factors relate to management. Signs producers should watch out for are reduced feeding of fish that cannot be explained due to climate, chemical application, different feeding practices, or disturbance from seining, fishing in ponds, or fish eating birds. Strange swimming behaviors can be signs of a disease problem. Fish that: crowd around water inlets, hang listlessly close to the surface, rapidly turn on their sides, swim erratically with heads pushed out of the water, or rub against the bottom of the pond, can be showing a sign of disease problems. Abnormal signs are:

* Sores
* Redness around mouth or anywhere on body
* White, grey or red spots
* Bulging or sunken eyes
* Bulging abdomen
* Excess or discolored slime on body
* Gills other than normal red color
* Swollen, eroded, ragged or discolored fins

* White lips, pale or colorless blood (Beem, 1990, p. 2)

Just like working with any type of livestock, the producer will be able to detect outbreaks of diseases on their own through experience. There are numerous diseases associated with channel catfish and when an outbreak occurs it is always best to use the help of a professional. In the long run this will save the producer time and money.

Oklahoma has three professionals to aid producers in diagnosing diseases in catfish. They are:

* The Southeast District Fish Disease Diagnostic Laboratory in Ada, Oklahoma. Dr. Marley Beem. Phone (405) 332-4100.
* Diagnostic Lab on the campus of Langston University in Langston, Oklahoma. Operated by Dr. Conrad Kleinholz. Phone (405) 466-3836.
* Theop Inslee, a certified fish pathologist. Does diagnostic work on his fish farm at Connerville, Oklahoma. Phone (405) 836-7150.

The producer should collect five sick fish using a dip net. A good way is to feed fish at one end of the pond and collect samples at the other end of the pond. This is because sicker fish will not be feeding. Dead fish are useful iftheir gills are still red but this is a poor second choice as compared to live fish. If the lab is more than an hour away, place individual fish in watertight plastic bags

FISH DISEASE INFORMATION SHEET

OSU Fish Disease Diagnostic Laboratory
Ada, Oklahoma (405) 332-4100

Name ____________________________

Address ____________________________
____

Telephone __________________________

Lab Use Only:
Date Rec.________
Case No. ________
Est. Value ______

1. Pond Number or Name________

2. Water Temperature ________
(10 inches below surface)

3. Fish are from which of the following? (circle A,B, or C)

A. Pond
size =_____surface acres
or ___X___ feet

depth = ____ feet

Number of fish in pond? _____

B. Cage
Cage size = ___X___X___ ft

Number of fish in cage = ____
pond size = ____ surface acres or ___X___ feet

pond depth = ___ feet

number of fish in pond = ____

C. Other: ________________
(describe)
Total number of fish = _____

4. Describe any change in water color or odor
____
____
____

5. Have any other animals died in or around pond? yes no
If yes, describe:
____
____

6. How many fish died?...
- The day these fish were collected? _____
- 1 day before? _____
- 2 days before? _____
- 3 days before? _____

7. How much feed was eaten?...
- The day these fish were collected? _____
- 1 day before? _____
- 2 days before? _____
- 3 days before? _____

8. Has there been any runoff into the pond recently?
yes no

If yes, how much was there?
light medium heavy

How many days ago? _____

9. What treatments have you already applied to the fish or pond? (give chemical, pesticide or antibiotic name and amounts applied)
____
____
____
____

10. Additional pertinent information
____
____
____
____

11. Please attach recent water quality records, if available.

Figure IV

Fish Disease Information Sheet

without water and pack in crushed ice. To transport fish live use a picnic cooler with water oxygenated by an agitator or compressed oxygen. It is best to keep the water at 65 degrees Fahrenheit. Water temperature can be cooled by placing sealed plastic bags of ice in the container. Also, one quart of pond water in a clean glass jar should be collected and placed on ice. A Fish Disease Information Sheet should be filled out and brought with the samples (see Figure IV).

The researcher feels that diseases of channel catfish should not be written about in depth in this Review of Literature. Though textbooks list pictures and descriptions of diseases, the producer should not take it on their own to identify diseases. These textbooks can be helpful in detecting a disease or problem associated with channel catfish and are a good management tool, but the use and help of professionals is a must in detecting diseases. This is important because, as Beem (1990) pointed out, the same disease signs are shared by many diseases.

Harvesting Techniques

Harvesting of channel catfish must be planned way in advance. Harvesting must go smoothly to prevent stress among the catfish. Harvesting can be costly to the producer, and not just in equipment or labor.

Tucker and Robinson (1990) listed some guidelines to follow during harvest time:

* Arrangements for harvest, transport, and sale should be made days or even weeks before harvest.
* Keep equipment in good working condition. Breakdowns in the middle of harvest can cause delays, resulting in stressing fish.
* Check for off-flavors before harvest. Poor-tasting fish in the marketplace may cause future sales problems.
* Do not harvest sick fish.
* Do not feed fish 48-72 hours before harvest. Fish with empty stomachs will stand stress better than fish full of feed. Fish disgorge feed recently consumed, which will foul the water in holding tanks. Most processors will deduct from the fish purchase price if fish have noticeable amounts of feed in their stomachs.
* Take special care in harvesting fish in hot weather. Fish handle poorly when temperatures are above 85 degrees Fahrenheit.
* Do not harvest fish if water quality is poor. The fish will already be stressed due to the poor water quality and handling them can easily kill fish (pp. 382-83).

Harvesting equipment and seines are some of the more expensive items used on a fish farm. The producer must find ways to cut cost of harvesting. Williams (1992) addressed this problem in the KCSA newsletter, stating:

> Much research needs to be done for methods of more efficient fish harvesting and in the breeding of more easily harvestable strains of fish (p. 4).

Small-scale producers can go in together on equipment such as seines and hauling tanks, provided equipment is cared for by all the producers and damages are repaired by the responsible parties.

Most processing plants have a minimum weight of fish that they will harvest or pick up. The minimum weight is usually 5,000 to 10,000 pounds. Plus, the producer is charged a flat fee for harvesting and death loss and shrinkage are deducted. This makes it hard for the small-scale producer, which is common in Oklahoma, to compete. Small-scale producers must work together to be able to cut these costs.

Record Keeping

Record keeping is one of the basic management tools for any livestock enterprise. Keeping records allows the channel catfish producer to establish a history of any problems that have occurred through their experience. It also gives them a source to look at to prepare for problems that can occur again in production. Also, many lending institutions require good records before they lend money (Tucker and Robinson, 1990, p. 195).

There is a record keeping program for computers. Computers make record keeping so much easier today. (A program is available free, on request, from Computer Applications and Service Department, P.O. Box 5405, Mississippi State, Mississippi, 39762.) The use of records helps the producer keep track of feeding, number and weight of fish in their ponds. Letlow and Verma (1990) recommended that records of water quality and feeding rate be kept for each pond, along with fish inventories, expenses, and general working operations (p. 3). Basically, good record keeping allows the producer to see if they are making any money or not.

Marketing in Oklahoma

As the research showed, there is a processing plant in Holdenville, Oklahoma and another plant should be in operation by 1993 in Morris, Oklahoma. The producer can also be creative and establish their own marketing abilities, especially a small-scale producer. This can be a major factor in profitability by cutting out the middleman, which Kuepper (1985) discussed in a Kerr Foundation Newsletter:

> Whatever route is taken, the reduction or elimination of middlemen in processing and marketing has been

identified as a key to profitability (p. 4).

Establishing other markets can provide extra income for many Oklahoma farmers and ranchers by utilizing existing resources such as ponds and reservoirs already established on their operation.

Williams (1992) pointed out some marketing potential for small-scale farmers:

* Sportsmen's clubs, Kiwanis, Rotary, or other civic club dinners or fund raising activities.
* Church or school functions.
* Youth camps.
* Lodges - Eagles, Elks, or VFW.
* Fire and police departments.
* Catering services.

Small-scale channel catfish farmers must be innovative and willing to take chances in establishing new markets to survive. Doing this can be profitable and open doors for other agricultural enterprises in Oklahoma and establish the growth of aquaculture in the state.

Total catfish sales were down in 1991 ($1,945,000) from 1990 ($2,235,000). The annual average price per pound in 1991 was 63.1 cents. The average price per pound has dropped fifteen cents since 1988.

Summary

The Review of Literature presented an overview of information on key areas related to this study. Those areas emphasized were: The History of Channel Catfish (*Ictalarus punctatus*); Financing Channel Catfish Production in Oklahoma; Stocking Procedures; Feeding Procedures; Water Quality Management; Catfish Diseases; Harvesting Techniques; Record Keeping; and Marketing in Oklahoma.

The channel catfish is the most important commercially cultured species in the United States. The channel catfish has been successfully introduced in states where they did not previously exist. There are several different types of culture systems used to raise channel catfish, such as levee ponds, cages, raceways, and recirculating systems.

Aquaculture is growing in Oklahoma's high schools, allowing students to get "hands on" experience and learn basic science concepts.

There are vaious financial support programs within the state to help farmers get started in the catfish business. Each program must be studied thoroughly by the farmer, and may require the farmer to educate his or her banker on the catfish industry.

Fingerlings in Oklahoma are usually stocked at six to eight inches in length, to reach fish-food size within 120 to 150 days. The more intense the stocking rate, the smaller the catfish at harvest time.

The feeding of channel catfish is very important in order to assure that the nutritional needs of the fish are met. Feeding of catfish can be done by hand or by mechanical feeders. It is best to feed catfish over a wide area to allow all fish a chance to eat. A good rule of thumb is to feed fish no more than they can eat in five to fifteen minutes.

Water quality is another important aspect of catfish farming. The farmer must learn the basics of water quality management to have a good knowledge of problems that can be caused by poor water quality.

The Oklahoma Cooperative Extension Service has several personnel who can help farmers with disease problems. It is important that farmers use these personnel in detecting disease, because many diseases have the same signs.

Special care must be taken when harvesting fish. Equipment can be very expensive, and this may cause small-scale farmers to pool together to cut costs.

Good record keeping is important for any enterprise. Good records can be used by the farmer to help in obtaining loans. A free computer program is available from Mississippi State University to help farmers with record keeping.

With only one processing plant currently in operation in Oklahoma, marketing can be a problem for small-scale farmers. With innovation, however, small-scale farmers can establish their own markets.

CHAPTER III

DESIGN AND METHODOLOGY

Introduction

The purpose of this chapter is to illustrate the methods used and the procedures followed in conducting this study. The purpose of this research was to determine management methods of commercial catfish farmers in Oklahoma.

With the intent of the research study in mind, the following objectives were established to accomplish this purpose:

1. Identify commonly applied catfish management methods, including those dealing with stocking, feeding, water quality, diseases, harvesting, record keeping, and marketing;

2. Identify problems experienced by Oklahoma catfish farmers;

3. Identify the number of farmers who are no longer in the catfish business; and

4. Identify farmers who are no longer in the catfish business but are raising other types of fish.

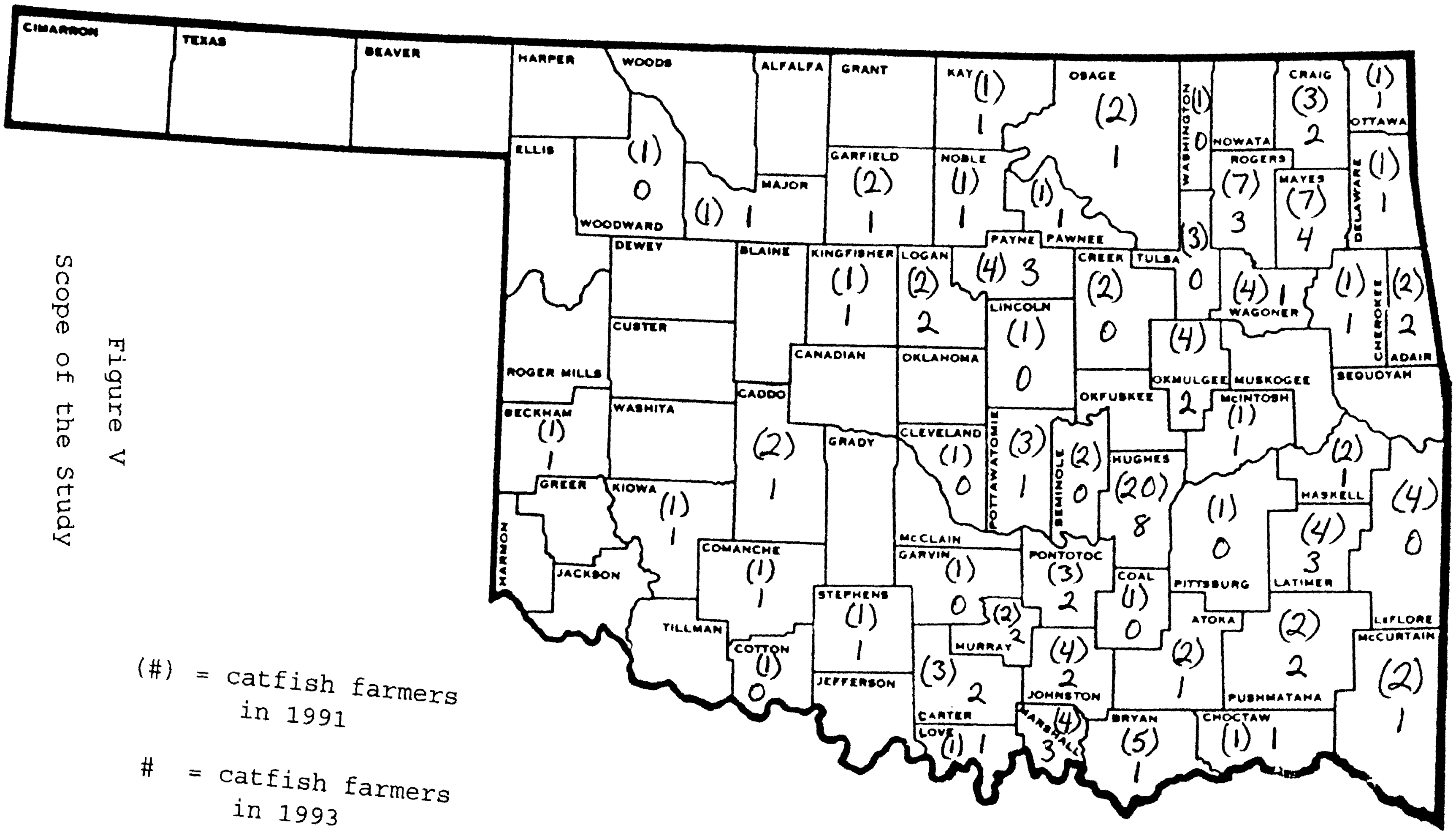
Institutional Review Board (IRB) Approval

Federal regulations and Oklahoma State University policy require review and approval of all research studies that involve human subjects before investigators can begin their research. The Oklahoma State University Research Services and the IRB conduct this review to protect the rights and welfare of human subjects involved in biomedical and behavioral research. In compliance with the aforementioned policy, this study received the proper surveillance, was granted permission to continue, and was assigned the following number: AG - 93 - 013 (Refer to Appendix A).

Region, Population, and Scope

The eastern half of Oklahoma has the most catfish producers in the state, with Hughes County having the most producers of any county. Catfish producers are spread out over the whole state, except for the Panhandle. The map in Figure V shows the counties in Oklahoma and the number of producers per county.

A population which consisted of 133 catfish farmers who were listed in a directory constructed by Southeast District Area Aquaculture Specialists and Associates and had access to a telephone or would agree to be interviewed were identified and selected. Growers within this sample



(#) = catfish farmers in 1991

\# = catfish farmers in 1993

Figure V
Scope of the Study

included all age groups of individuals, family farms, and corporate catfish farmers.

Development of the Instrument

In the development of the instrument a thorough review of the objectives was necessary to design a questionnaire that would address the problem and fulfill the objectives. Also, an instrument from a previous related study, developed by Letlow and Verma (1990), was evaluated. The researcher, with the assistance of his advisors, developed a questionnaire which encompassed the study's purpose and objectives. A pilot test of the survey instrument was used with a catfish farmer near Stillwater, Oklahoma, to determine its effectiveness.

The survey instrument was classified into two sections. The first section concerned information regarding the producers' demographic data, and contained 10 questions. The second section contained 41 questions which related to production practices of the operation, which covered 1) financing, 2) stocking, 3) feeding, 4) water quality, 5) diseases, 6) harvesting techniques, 7) record keeping, and 8) marketing.

A total of 51 questions were included on the survey. The questions consisted of forced response items. Consideration was given to the time constraint in answering the instrument questions. The survey was designed to take an average of thirty minutes or less to answer, yet still provide the information necessary to complete the study. However, the researcher noted that if a producer was not willing to answer a particular question, that question was dismissed and the survey interview continued.

Collection of the Data

After analyzing various methods of data collection, a multiple survey was deemed the most efficient way to obtain the maximum response rate from the population of catfish farmers. This multiple survey included an interview survey which was conducted at the 1993 Catfish Farmers of Oklahoma Annual Conference and Trade Show in Wetumka, Oklahoma. A total of 30 catfish farmers were interviewed. Key (1989) stated the following with regard to an interview:

> An interview is a direct face-to-face attempt to obtain reliable and valid measures in the form of verbal responses from one or more respondents. It is a conversation in which the roles of the interviewer and the respondent change continually (p. 107).

By using an interview, the researcher is allowed to clarify questions which the informant might not understand and which could result in incorrect information. Allowing the informant to see the interviewer face to face reduces the anxiety so that often threatening topics can be studied.

The second type of survey was a telephone survey, which consisted of 86 catfish farmers and was used due to transportation costs and also farmers not being available at particular times. This allowed the researcher to determine which farmers were no longer in operation or were growing other types of fish. In addition, a mail survey was used with 17 farmers who did not have time for a phone survey.

The interview survey was conducted during the months of January through June, 1992.

There were 60 respondents to the survey, while four of the farmers chose not to participate in the study. Thirty respondents were interviewed. Eighty-six farmers were surveyed over the phone; of these sixty-nine were no longer in business or were growing other types of fish. The mail survey consisted of 17 farmers, of whom four chose not to participate.

Analysis of the Data

Information from the survey involved management methods of commercial catfish farmers that resulted in qualitative data. The data gathered from the interviews were then tabulated by computer using descriptive statistics, which involved measures of frequency distribution (N), percentages, central tendency, ranges, and standard deviations. Key (1974) stated that qualitative research emphasizes the importance of looking at variables in the natural setting in which they are found (p. 163). Bartz (1988) stated that the purpose of a descriptive statistic is to tell us something about a particular group of observations.

The researcher noted that the responses from the producers were totally voluntary. The total number of respondents per question varied and may not have been equal.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

Introduction

The purpose of this chapter is to report the findings from the questionnaire used to conduct the study. The intent of the study was to determine production practices of commercial catfish farmers in Oklahoma.

The scope of the study included a total of 133 catfish farmers in Oklahoma. Catfish farmers were identified through the Oklahoma Fish Producers Directory, and District Area Specialists. A personal interview survey, with the exception of a telephone and mailer survey for distant areas of the state, was used to elicit responses from the catfish farmers. The questionnaire was given to the catfish farmers from January 1, 1992 to July 15, 1992. Of the 64 catfish farmers currently operating in Oklahoma, 60 (94 percent) responded to the questionnaire.

Findings

Reported in Table I is the distribution of respondents by demographic variables. Of the 60 respondents, 57 (95.0 percent) were male and three (5.0 percent) were female. The

TABLE I

DISTRIBUTION OF RESPONDENTS BY DEMOGRAPHIC VARIABLES

Demographic Variables	Frequency (N)	Distribution (%)
Gender		
Male	57	95.0
Female	3	5.0
Subtotal	60	100.0
Age		
14 - 33	6	10.2
34 - 53	26	43.0
54 - 70	28	46.8
Subtotal	60	100.0
Note: Mean = 50.36	S.D. = 12.70	
Years Catfish Farming		
1 - 11	45	75.0
12 - 22	10	16.6
22 - 32	5	8.4
Subtotal	60	100.0
Note: Mean = 8.75	S.D. = 7.55	

distribution of respondents by age ranges was based on a natural grouping. Of the 60 respondents, six (10.2 percent) were in the age range of 14 to 33 years old. Twenty-six (43.0 percent) were in the 34 to 53 age group, and 28 (46.8 percent) were in the 54 to 70 age group.

Distribution of respondents by number of years catfish farming was based on a natural grouping. Of the 60 respondents, 45 (75.0%) have been farming from one to eleven years, ten (16.6%) for 12 to 22 years, and five (8.4 percent) for 23 to 31 years.

This showed that there are not many of the younger generation getting into the catfish farming business. this could be due to the fact that the majority of farmers had only been growing catfish from one to eleven years, and the industry has not been in the state very long.

Table II contains a summary of the distribution of respondents by percentage of income from catfish farming and status as catfish farmers. Percentage of income from catfish farming was based on natural grouping to show the discrepancy among farmers who consider their status as full-time catfish farmers as compared to farmers who say they make 100 percent of their income from growing catfish. Of the 58 respondents to this question, 52 (89.7 percent) made 1 - 50 percent of their income from their catfish enterprise, one (1.7 percent) made 75 percent, one (1.7 percent) made 80 percent, one (1.7 percent) made 90 percent, and three (5.2 percent) made 100 percent.

As to the question of their status as catfish farmers, fifteen (25.0 percent) of the 60 respondents considered themselves as full-time catfish farmers, and 45 (75 percent) as part-time catfish farmers.

TABLE II

DISTRIBUTION OF RESPONDENTS BY PERCENTAGE OF INCOME AND STATUS AS CATFISH FARMERS

% of Income and Status	Frequency (N)	Distribution (%)
% of Income		
1 - 50	52	89.7
75	1	1.7
80	1	1.7
90	1	1.7
100	3	5.2
Subtotal	58	100.0
Note: Mean = 18.55 S.D. = 27.27		
Status		
Full-time	15	25.0
Part-time	45	75.0
Subtotal	60	100.0

The discrepancy between the two questions showed that only three farmers within the state actually make their income from growing catfish. The study showed that a majority of the catfish farmers in Oklahoma raised catfish as a side income.

Table III reports the distribution of respondents by how their catfish operation was financed. Of the 57 respondents, five (8.8 percent) used a conventional bank, 48 (84.2 percent) used personal capital, and four (7.0 percent) used other means. Through personal interviews the researcher found out that it was hard for catfish farmers to

TABLE III

FREQUENCY DISTRIBUTION OF RESPONDENTS BY FINANCING FOR CATFISH OPERATION

Type of Financing	Frequency (N)	Distribution (%)
Conventional Bank	5	8.8
Personal Capital	48	84.2
Other	4	7.0
Total	60	100.0

obtain a loan on such an operation, mainly due to a lack of knowledge about the subject on the bankers' part. The researcher felt this also had bearing in Table I as to the age of catfish farmers. Because it is even harder for a young person to get a loan, this could be the reason fewer young people are getting into the business.

Table IV contains the summary of the distribution of respondents by acreage variables. The distribution of respondents by number of acres of water in catfish production was based on natural grouping. Of the 60 respondents, 44 (73.3 percent) have zero to fifteen acres, nine (15.0 percent) have 16 to 30 acres, three (5.1 percent) have 31 to 45 acres, and four (6.6 percent) have 46 to 80 acres.

TABLE IV

FREQUENCY DISTRIBUTION OF RESPONDENTS BY ACREAGE VARIABLES

Acreage Variables	Frequency (N)	Distribution (%)
# of acres of water in catfish production		
0 - 15	44	73.3
16 - 30	9	15.0
31 - 45	3	5.1
46 - 80	4	6.6
Subtotal	60	100.0
Note: Mean = 13.56 S.D. 15.81		
Expect to increase catfish production within next 2 years		
Yes	19	32.2
No	40	67.8
Subtotal	59	100.0
Number of acres by which farmers plan to increase catfish production		
1 - 8	14	78.0
9 - 16	2	11.0
17 - 24	0	0.0
25 - 32	2	11.0
Subotal	18	100.0
Note: Mean = 7.88 S.D. 9.56		

The second finding reported in Table IV is the distribution of respondents by whether they expect to increase their catfish acreage within the next two years.

Nineteen (32.2 percent) of the respondents said yes, they do expect to increase acreage, while 40 (67.8 percent) did not.

The third finding in Table IV is the distribution of respondents by number of acres by which they plan to increase their catfish production. Ranges were based on natural grouping. Fourteen (78.0 percent) of the 18 respondents to this question plan to increase acreage by one to eight acres, two (11.0 percent) plan to increase by nine to sixteen acres, while two others (11.0 percent) expect to increase by 25 to 32 acres.

The majority of those farmers who expect to increase acreage within the next two years were those in the range of zero to fifteen acres of water currently in catfish production. This meant that the majority of those farmers who planned to increase acreage were small-scale farmers. Of the 18 respondents, 13 (73.0 percent) were in the range of zero to fifteen acres in production, three (17.0 percent) were from the range of 16 to 30 acres in production, one (5.0 percent) was from the range of 31 to 45 acres, while one (5.0 percent) was from the range of 46 to 80 acres of water in catfish production.

Reported in Table V is the distributions of respondents by numbers and types of employees. Ranges in this table are based on natural groupings. The first finding shown is the distribution of respondents by the number of non-salaried family members employed in their catfish operation. Of the 60 respondents, 54 (89.9 percent) employed zero to two non-

TABLE V

FREQUENCY DISTRIBUTION OF RESPONDENTS BY NUMBERS AND TYPES OF EMPLOYEES

Numbers and Types of Employees	Frequency (N)	Distribution (%)
Non-Salaried Family Members		
0 - 2	54	89.9
3 - 4	6	10.1
Subtotal	60	100.0
Full-Time Employees		
0	49	81.7
1	6	10.0
2	1	1.7
4	2	3.2
5	1	1.7
30	1	1.7
Subtotal	60	100.0
Part-Time Employees		
0	41	68.3
1	5	8.3
2	4	6.7
3	3	5.1
4	2	3.3
5	5	8.3
Subtotal	60	100.0

salaried family members, while six (10.1 percent) employed three to four.

The second finding is the distribution of respondents by the number of full-time employees in their catifsh operation. Forty-nine (81.7 percent) of the 60 respondents employed no full-time employees, six (10.0 percent) employed one, one (1.7 percent) employed two, two (3.2 percent) employed four, one (1.7 percent) employed five, while one (1.7 percent) employed between 30 full-time employees.

The third finding is the distribution of respondents by the number of part-time employees in their catfish operation. There was a wide variety of responses to this question. Forty-one (68.3 percent) of the respondents employed no part-time workers. Five (8.3 percent) had one part-time employee, four (6.7 percent) had two, three (5.1 percent) had three, two (3.3 percent) had four, and five (8.3 percent) had five part-time employees in their catfish operation.

Table VI contains a summary of the distribution of respondents by source of fingerling variables. Thirty-six (60.0 percent) of the farmers grew their own fingerlings, while 24 (40.0 percent) obtained their fingerlings from another source.

The distribution of respondents by the number of acres of water used in fingerling production's ranges were based on natural groupings. Of the 33 producers responding to this question, 30 (91.0 percent) had between one and ten acres, and three (9.0 percent) had between 11 and 20 acres.

TABLE VI

DISTRIBUTION OF RESPONDENTS BY SOURCE OF FINGERLING VARIABLES

Fingerling Variables	Frequency (N)	Distribution (%)
<u>Source of Fingerlings</u>		
Raise own	36	60.0
Other source	24	40.0
Subtotal	60	100.0
Number of acres in <u>fingerling production</u>		
1 - 10	30	91.0
11 - 20	3	9.0
Subtotal	60	100.0
Fingerlings checked by <u>a diagnostic lab</u>		
Yes	5	8.3
No	55	91.7
Subtotal	60	100.0

The distribution of respondents by whether they have their fingerlings checked by the diagnostic lab showed that only five (8.3 percent) of the respondents had their fingerlings checked, with 55 (91.7 percent) saying they did not have their fingerlings checked.

TABLE VII

FREQUENCY DISTRIBUTION OF RESPONDENTS BY CATFISH FEED VARIABLES

Feed Variables	Frequency (N)	Distribution (%)
How they purchase feed		
50 lb. bags	53	88.3
Bulk loads	7	11.7
Subtotal	60	100.0
How the determine the amount of feed		
Amount they will eat	43	72.9
Use seine sample	5	8.5
Other means	11	18.6
Subtotal	59	100.0
How they feed their catfish		
By hand	54	90.0
Mechanical Feeder	5	8.3
Automatic Feeder	1	1.7
Subtotal	60	100.0
Whether they feed in winter based on water temperature		
Yes	36	60.0
No	24	40.0
Subtotal	60	100.0

Table VII contains a summary of the distribution of respondents by catfish feed variables. The first variable is the distribution of respondents by how they purchase catfish feed. Fifty-three (88.3 percent) respondents indicated that they purchase feed in fifty pound bags, while seven (11.7 percent) buy their feed in bulk loads.

The second variable shows the distribution of respondents by how they determine the amount of feed to be fed. Forty-three (72.9 percent) give the fish all the feed they will eat. Five (8.5 percent) use a seine sample, and 11 (18.6 percent) use other means.

The third variable is the distribution of respondents by how they feed their catfish. The majority (54, or 90.0 percent) feed by hand. Five (8.3 percent) of the respondents use a mechanical feeder, and one (1.7 percent) uses an automatic feeder.

The fourth variable in Table VII is the distribution of respondents by whether they feed their catfish in winter based on water temperature. Thirty-six (60.0 percent) said yes, they do feed in winter based on water temperature, while 24 (40.0 percent) said no.

Reported in Table VIII is the distribution of respondents by their primary water source. Eight (13.6 percent) respondents have a well as their primary source, one (1.7 percent) uses a river, 34 (57.6 percent) use watershed run-off, and 16 (27.1 percent) have other sources.

Reported in Table IX is the distribution of respondents by aerator variables. The first variable is the distribution of respondents by how their aerators are powered. Twenty-seven (60.0 percent) of the forty-five respondents had electric motors. Nine (20.0 percent) had

TABLE VIII

FREQUENCY DISTRIBUTION OF RESPONDENTS BY THEIR PRIMARY WATER SOURCE

Water Source	Frequency (N)	Distribution (%)
Well	8	13.6
River	1	1.7
Watershed run-off	34	57.6
Other source	16	27.1
Total	59	100.0

diesel motors, four (8.9 percent) had gasoline motors, and five (11.1 percent) had some other source of power for their aerators. Of the 45 respondents, 33 (73.0 percent) had five acres or more of water in catfish production, while 12 (27.0 percent) had less than five acres of water in production.

The second variable is the distribution of respondents by the number of portable backup aerators they have for emergency aeration. Twenty-one (36.8 percent) of the producers had no backup aerators. Twenty (35.1 percent) had one, seven (12.3 percent) had two, two (3.4 percent) had three, and four (7.0 percent) had four backup aerators. Also, one producer (1.8 percent) reported having six backup aerators, another reported seven, and one had nine backup aerators for emergency operation.

The third variable is the distribution of respondents by the dissolved oxygen level for operating aerators. Two

TABLE IX

FREQUENCY DISTRIBUTION OF RESPONDENTS BY AERATORS VARIABLES

Aerator Variables	Frequency (N)	Distribution (%)
How their aerators are powered		
Electricity	27	60.0
Diesel Motor	9	20.0
Gasoline Motor	4	8.9
Other source	5	11.1
Subtotal	45	100.0
Number of portable backup aerators		
0	21	36.8
1	20	35.1
2	7	12.3
3	2	3.4
4	4	7.0
6	1	1.8
7	1	1.8
9	1	1.8
Subtotal	57	100.0
Dissolved oxygen level for operating aerators		
6 ppm	2	3.8
5 ppm	1	1.9
4 ppm	9	17.0
3 ppm	9	17.0
2 ppm	11	20.8
1 ppm	5	9.4
Never	16	30.1
Subtotal	53	100.0

TABLE IX, continued

Aerator Variables	Frequency (N)	Distribution (%)
Whether they keep records on cost of power for aeration		
Yes	38	63.3
No	22	36.7
Subtotal	60	100.0
Whether they keep records on hours of aeration per pond		
Yes	13	21.7
No	47	78.3
Subtotal	60	100.0

(3.8 percent) of the respondents cited 6 ppm as the oxygen level they used as a determining factor, one (1.9 percent) reported 5 ppm, nine (17.0 percent) said 4 ppm, nine others (17.0 percent) said 3 ppm, 11 (20.8 percent) reported 2 ppm, five (9.4 percent) said 1 ppm, and 16 (30.2 percent) said never.

The fourth variable shown is the distribution of respondents by whether they keep records on the cost of power for aeration. Thirty-eight (63.3 percent) do keep records, while 22 (36.7 percent) do not.

The final variable in Table IX is the distribution of respondents by whether they keep records on the hours of aeration for each pond. Thirteen (21.7 percent) of the respondents said yes, they do keep records, while 47 (78.3 percent) said they do not.

Table X shows the distribution of respondents oxygen level variables. The first variable is their frequency of checking oxygen levels in ponds. Twenty-six (48.1 percent) check their oxygen levels once per day. Six (11.1 percent) reported twice per day, four (7.4 percent) three times per day, and 18 (33.3 percent) said never.

The second variable is the distribution of respondents by when they check oxygen levels in their ponds. Twenty-five (42.4 percent) said they checked at dawn. Two (3.4 percent) said noon, six (10.2 percent) reported dusk, and 26 (44.1 percent) said other.

A discrepancy was found between the two variables. Twenty-six (44.1 percent) of the 59 respondents said "Other" when asked when they check oxygen levels, whereas 18 respondents (30.1 percent) said "Never" in response to their frequency for checking oxygen levels in ponds.

Reported in Table XI is the distribution of respondents by the type of water quality kit used to test water quality. Four respondents (6.8 percent) used a portable meter and 22 (37.3 percent) used a water quality kit. Seventeen (28.8 percent) used both, and 16 (27.1 percent) reported other.

TABLE X

FREQUENCY DISTRIBUTION OF RESPONDENTS BY OXYGEN LEVEL VARIABLES

Variable	Frequency (N)	Distribution (%)
Frequency for checking oxygen levels in ponds		
Once per day	26	48.1
Twice per day	6	11.2
Three times per day	4	7.4
Never	18	33.3
Subtotal	54	100.0
When oxygen levels are checked		
Dawn	25	42.4
Noon	2	3.4
Dusk	6	10.1
Other	26	44.1
Subtotal	59	100.0

TABLE XI

DISTRIBUTION OF RESPONDENTS BY METHOD OF WATER QUALITY TESTING

Type of Kit	Frequency (N)	Distribution (%)
Portable Meter	4	6.8
Water Quality Kit	22	37.3
Both	17	28.8
Other	16	27.1
Total	59	100.0

Reported in Table XII is the distribution of respondents by how often they check water quality variables. The first variable shown is how often respondents check chlorides in their ponds. Two (3.4 percent) said once per week. Seven (11.8 percent) said once per two weeks, six (10.2 percent) once a month, and five (8.5 percent) reported other frequencies. Thirty-nine of the respondents (66.1 percent) never check the chloride level in their ponds.

The second variable is the distribution of respondents by how often they check hardness in their ponds. Two (3.4 percent) respondents said once per week, eight (13.6 percent) said once per two weeks, five (8.5 percent) said once a month, and six (10.1 percent) reported other frequencies. Thirty-eight (64.4 percent) said they never check their ponds for hardness.

The third variable shown is the distribution of respondents by how often they check alkalinity in their ponds. Two (3.4 percent) respondents said once per week, nine (15.2 percent) said once per two weeks, five (8.5 percent) said once a month, and seven (11.9 percent) reported other frequencies. Thirty-six (61.0 percent) said they never check their ponds for alkalinity.

The fourth variable in Table XII is the distribution of respondents by how often they check ammonia in their ponds. Five (8.3 percent) respondents said once per day, four (6.7 percent) said twice per week, seven (11.7 percent) said once a week, and nine (15.0 percent) reported other frequencies.

TABLE XII

FREQUENCY DISTRIBUTION OF RESPONDENTS BY HOW OFTEN THEY CHECK WATER QUALITY VARIABLES

Variable and frequency	Frequency (N)	Distribution (%)
How often they check chlorides in their ponds		
Once per week	2	3.4
Once per two weeks	7	11.8
Once per month	6	10.2
Never	39	66.1
Other	5	8.5
Subtotal	59	100.0
How often they check hardness in their ponds		
Once per week	2	3.4
Once per two weeks	8	13.6
Once per month	5	8.5
Never	38	64.4
Other	6	10.1
Subtotal	59	100.0
How often they check alkalinity in their ponds		
Once per week	2	3.4
Once per two weeks	9	15.2
Once per month	5	8.5
Never	36	61.0
Other	7	11.9
Subtotal	59	100.0
How often they check ammonia in their ponds		
Once per day	5	8.3
Twice per week	4	6.7
Once per week	7	11.7
Never	35	58.3
Other	9	15.0
Subtotal	60	100.0

TABLE XII, continued

Variable and frequency	Frequency (N)	Distribution (%)
How often they check pH in their ponds		
Once per day	5	8.3
Twice per week	4	6.7
Once per week	8	13.3
Never	34	56.7
Other	9	15.0
Subtotal	60	100.0
How often they check temperature in their ponds		
Once per day	12	20.3
Twice per week	2	3.4
Once per week	7	11.9
Never	31	52.5
Other	7	11.9
Subtotal	59	100.0
How often they check nitrates in their ponds		
Once per day	6	10.0
Twice per week	5	8.3
Once per week	7	11.7
Never	33	55.0
Other	9	15.0
Subtotal	60	100.0

Thirty-five (58.3 percent) said they never check their ponds for ammonia.

Shown next in the table is the distribution of respondents by how often they check pH in their ponds. Five

(8.3 percent) respondents said once per day, four (6.7 percent) said twice per week, eight (13.3 percent) said once a week, and nine (15.0 percent) reported other frequencies. Thirty-four (56.7 percent) said they never check their ponds for pH level.

The sixth variable is the distribution of respondents by how often they check temperature in their ponds. Twelve (20.3 percent) respondents said once per day, two (3.4 percent) said twice per week, seven (11.9 percent) said once a week, and seven others (11.9 percent) reported other frequencies. Thirty-one (52.5 percent) said they never check the temperature of their ponds.

The last variable in the table is the distribution of respondents by how often they check nitrates in their ponds. Six (10.0 percent) respondents said once per day, five (8.3 percent) said twice per week, seven (8.5 percent) said once a week, and nine (15.0 percent) reported other frequencies. Thirty-three (55.0 percent) said they never check their ponds for nitrates.

Reported in Table XIII is the distribution of respondents by how often they check oxygen in their ponds. Twenty (33.9 percent) respondents said once per day, one (1.7 percent) said twice per week, six (10.2 percent) said once a week, and eight (13.5 percent) reported other frequencies. Twenty-four (40.7 percent) said they never check the oxygen level in their ponds.

TABLE XIII

DISTRIBUTION OF RESPONDENTS BY HOW OFTEN THEY CHECK OXYGEN IN THEIR PONDS

Frequency	Frequency (N)	Distribution (%)
Once per day	20	33.9
Twice per week	1	1.7
Once per week	6	10.2
Never	24	40.7
Other	8	13.5
Total	59	100.0

A discrepancy was found in Table XIII where 24 respondents said they never checked oxygen levels in their ponds. Comparatively, Table IX showed 16 respondents never checked dissolved oxygen levels to operate aerators, and Table X showed 18 respondents who never checked oxygen levels.

TABLE XIV

DISTRIBUTION OF RESPONDENTS BY WHETHER THEY LIME THEIR PONDS

Lime	Frequency (N)	Distribution (%)
Yes	18	30.5
No	41	69.5
Total	59	100.0

Reported in Table XIV is the frequency distribution of respondents by whether they lime their ponds. Eighteen (30.5 percent) of the farmers do lime their ponds, while 41 (69.5 percent) do not.

TABLE XV

DISTRIBUTION OF RESPONDENTS BY WHETHER WATER QUALITY MANAGEMENT IS A PROBLEM

Problem	Frequency (N)	Distribution (%)
Yes	22	36.7
No	38	63.3
Total	60	100.0

Reported in Table XV is the distribution of respondents by whether they consider water quality to be a problem. Twenty-two (36.7 percent) of the respondents said that water quality is a problem, while 38 (63.3 percent) said it was not.

Reported in Table XVI is the distribution of respondents by the percentage of total pounds of fish lost to disease. Thirty-three (57.9 percent) of the producers reported no loss to disease. Eight (14.0 percent) said one percent, four (7.0 percent) said two percent, one (1.8 percent) said four percent, and five (8.8 percent) reported five percent loss. Three (5.2 percent) reported ten percent

TABLE XVI

DISTRIBUTION OF RESPONDENTS BY PERCENTAGE OF TOTAL POUNDS OF FISH LOST TO DISEASE

Percentage	Frequency (N)	Distribution (%)
0	33	57.9
1	8	14.0
2	4	7.0
4	1	1.8
5	5	8.8
10	3	5.2
20	1	1.8
30	2	3.5
Total	57	100.0

loss, one (1.8 percent) twenty percent, and two (3.5 percent) said they lost 30 percent of their total fish to disease.

Reported in Table XVII is the distribution of respondents by how they diagnose fish disease problems. Twenty-five (41.7 percent) of the producers diagnose disease problems themselves, while three (5.0 percent) rely on other farmers and five (8.3 percent) use private consultants. Twelve (20.0 percent) use the Oklahoma Cooperative Extension Service at Langston, and 15 (25.0 percent) use the Ada branch of the CES.

TABLE XVII

DISTRIBUTION OF RESPONDENTS BY HOW THEY DIAGNOSE FISH DISEASE PROBLEMS

Method	Frequency (N)	Distribution (%)
Yourself	25	41.7
Other farmers	3	5.0
Private consultant	5	8.3
OK CES-Langston	12	20.0
OK CES-Ada	15	25.0
Total	60	100.0

Reported in Table XVIII is the distribution of respondents by the pounds of food size fish harvested in 1992. Three (7.7 percent) of the farmers did not harvest any fish in 1992, while one farmer (2.6 percent) harvested two pounds and another three pounds. One farmer (2.6 percent) reported harvesting 200 pounds, one reported 250 pounds, and two (5.1 percent) harvested 300 pounds of food size fish. Three hundred fifty and 400 pounds of fish were each reported by one farmer, and two producers harvested 500 pounds. Six hundred, 800, and 900 pounds of fish were each reported by one farmer each. Two farmers reported 1000 pounds of harvest, while one reported 1200 pounds and seven (17.9%) reported 2000 pounds. One farmer reported 2100 pounds of harvest, and another 2300 pounds. Two farmers each reported 2500 and 3000 pounds of harvest. One farmer

TABLE XVIII

DISTRIBUTION OF RESPONDENTS BY THE POUNDS OF FOOD SIZE FISH HARVESTED IN 1992

Pounds	Frequency (N)	Distribution (%)
0	3	5.3
2	1	1.7
3	1	1.7
200	1	1.7
250	1	1.7
300	2	3.5
350	1	1.7
400	1	1.7
500	2	3.5
600	1	1.7
800	1	1.7
900	1	1.7
1000	2	3.5
1200	1	1.7
2000	7	15.4
2100	1	1.7
2300	1	1.7
2500	2	3.5
3000	2	3.5
3600	1	1.7
4000	2	3.5
5000	2	3.5
5500	1	1.7
8000	1	1.7
10000	3	5.3
12000	1	1.7
14000	1	1.7
15000	1	1.7
17000	1	1.7
20000	3	5.3
21000	1	1.7
21500	1	1.7
24000	1	1.7
30000	1	1.7
40000	1	1.7
45000	1	1.7
180000	1	1.7
Total	56	100.0

TABLE XIX

DISTRIBUTION OF RESPONDENTS BY PRIMARY SIZE FISH MARKETED IN 1992

Size	Frequency (N)	Distribution (%)
Less than 1 lb/fish	8	13.8
Less than 1.5 lb/fish	16	27.6
Less than 2 lb/fish	17	29.3
More than 2 lb/fish	17	29.3
Total	58	100.0

reported 3600 pounds, two said 4000 and 5000 pounds, and one farmer said 5500 pounds and another 8000 pounds of harvest.

Three farmers reported 10,000 pounds harvested. One farmer reported 12,000; 14,000; 15,000; and 17,000 pounds of fish harvested. Three farmers harvested 20,000 pounds while one farmer reported 21,000; 21,500; 24,000; 30,000; 40,000; 45,000; and 180,000 pounds of catfish harvested for 1992.

Reported in Table XIX is the distribution of respondents by the primary size fish marketed in 1992. Eight (13.8 percent) marketed their fish when less than one pound per fish. Sixteen (27.6 percent) reported less than one and one half pounds per fish, while 17 (29.3 percent) producers said less than two pounds per fish and 17 others (29.3 percent) reported more than two pounds per fish as their primary size fish.

TABLE XX

DISTRIBUTION OF RESPONDENTS BY FISH HARVESTING VARIABLES

Variable	Frequency (N)	Distribution (%)
Method of fish harvesting		
Remove all fish	32	53.3
Partial removal	28	46.7
Subtotal	60	100.0
Who (primarily) harvests fish		
Yourself/Family	51	85.0
Custom Harvester	3	5.0
Other Farmer	1	1.7
Other	5	8.3
Subtotal	60	100.0

Reported in Table XX is the distribution of respondents by fish harvesting variables. The first variable is method of fish harvesting used. Thirty-two (53.3 percent) of the farmers remove all the fish, while 28 (46.7 percent) remove only part of the fish. The second variable shown is the frequency distribution of respondents by who primarily harvests their fish. Fifty-one (85.0 percent) of the farmers reported that either they or family members harvest their fish. Three (5.0 percent) farmers used a custom harvester, and one (1.7 percent) has another farmer harvest his fish. Five (8.3 percent) of the farmers reported other means of harvest.

Reported in Table XXI is the distribution of respondents by how various percentages of food size catfish are sold, beginning with the amount sold to a processor. Forty-five (75.0 percent) of the farmers do not sell any fish to a processor. One (1.7 percent) farmer was reported in each of the following categories - 60, 80, 90, and 99 percent. Two farmers (3.3 percent) said they sold 95 percent of their fish to a processor, and nine (15.0 percent) sold all of their fish to a processor.

Of food size catfish sold to a live hauler, fifty-four (90.0 percent) of the farmers do not sell any fish to a live hauler. One (1.7 percent) farmer was reported in each of the following categories - five, ten, 25, 34, 50, and 100 percent.

The third variable shown is the distribution of respondents by the percentage of food size catfish sold to a local retailer. Thirty-three (55.0 percent) of the farmers do not sell any fish locally. One (1.7 percent) farmer was reported in each of the following categories - two, 20, 25, 33, 40, 50, and 75 percent. Twenty farmers (33.1 percent) said they sold all of their fish to a local retailer.

Of the percentage of food size catfish they sell by fee fishing, forty-nine (81.7 percent) do not sell any of their fish by this method. One (1.7 percent) farmer was reported in each of the following categories - three, ten, 33, and 80 percent. Seven (11.5 percent) of the farmers sell all of their fish this way.

TABLE XXI

DISTRIBUTION OF RESPONDENTS BY THE HOW PERCENTAGE OF FOOD SIZE CATFISH IS SOLD

Percentage	Frequency (N)	Distribution (%)
<u>Sold to a Processor</u>		
0	45	75.0
60	1	1.7
80	1	1.7
90	1	1.7
95	2	3.2
99	1	1.7
100	9	15.0
Subtotal	60	100.0
<u>Sold to a live hauler</u>		
0	54	89.8
5	1	1.7
10	1	1.7
25	1	1.7
34	1	1.7
50	1	1.7
100	1	1.7
Subtotal	60	100.0
<u>Sold to local retail</u>		
0	33	55.0
2	1	1.7
20	1	1.7
25	1	1.7
33	1	1.7
40	1	1.7
50	1	1.7
75	1	1.7
100	20	33.1
Subtotal	60	100.0

TABLE XXI, continued

Percentage	Frequency (N)	Distribution (%)
Sold by fee fishing		
0	49	81.7
3	1	1.7
10	1	1.7
33	1	1.7
80	1	1.7
100	7	11.5
Subtotal	60	100.0
Sold other ways		
0	48	80.0
1	1	1.7
20	1	1.7
25	1	1.7
40	1	1.7
100	8	13.3
Subtotal	60	100.0

The fifth variable shows the distribution of respondents by the percentage of food size catfish sold in other ways. Forty-eight (80.0 percent) of the farmers do not sell any fish other than by previously mentioned methods. One (1.7 percent) farmer was reported in each of the following categories - one, 20, 25, and 40 percent. Eight (13.2 percent) sold all of their fish in other ways. The farmers who sold their fish by other ways were mainly small-scale fish farmers. They would sell their fish

TABLE XXII

DISTRIBUTION OF RESPONDENTS BY WHETHER THEY FLAVOR-CHECK FISH BEFORE MARKETING

Flavor-Check	Frequency (N)	Distribution (%)
Yes	45	77.6
No	13	22.4
Total	58	100.0

individually off the farm, and for local gatherings in the community such as firemen's picnics, clubs, and organizations.

Reported in Table XXII is the distribution of respondents by whether they flavor-check their fish before marketing them. Forty-five (77.6 percent) of the farmers do flavor-check their fish, while 13 (22.4 percent) do not.

Reported in Table XXIII is the distribution of respondents by their record keeping practices. The first variable is whether they keep records on annual operating expenses. Fifty-one (85.0 percent) do keep records, while nine (15.0 percent) do not.

In response to the question of whether they keep records on their catfish production per acre, thirty-four (56.7 percent) do keep records, while 26 (43.3 percent) do not.

TABLE XXIII

DISTRIBUTION OF RESPONDENTS BY RECORD KEEPING PRACTICES

Records Kept	Frequency (N)	Distribution (%)
Annual operating expenses		
Yes	51	85.0
No	9	15.0
Subtotal	60	100.0
Catfish production by acre		
Yes	34	56.7
No	26	43.3
Subtotal	60	100.0
Monthly cash flow		
Yes	41	68.3
No	19	31.7
Subtotal	60	100.0
Water quality in ponds		
Yes	25	41.7
No	35	58.3
Subtotal	60	100.0
Fish inventories in ponds		
Yes	39	65.0
No	21	35.0
Subtotal	60	100.0
Number of mortalities per pond		
Yes	24	60.0
No	36	40.0
Subtotal	60	100.0

TABLE XXIII, continued

Records Kept	Frequency (N)	Distribution (%)
Feed per pond		
Yes	44	73.3
No	16	26.7
Subtotal	60	100.0
Disease problems per pond		
Yes	26	44.1
No	33	55.9
Subtotal	59	100.0
Other aspects of their catfish operation		
Yes	3	5.2
No	55	94.8
Subtotal	58	100.0

The third variable shown is the distribution of respondents by whether they keep records on their monthly cash flow. Forty-one (68.3 percent) do keep records, while 19 (31.7 percent) do not.

Next is the distribution of respondents by whether they keep records on the water quality in their ponds. Twenty-five (41.7 percent) do keep records, while 35 (58.3 percent) do not.

The respondents were asked whether they keep records on the fish inventories in their ponds. Thirty-nine (65.0 percent) do keep records, while 21 (35.0 percent) do not.

The next variable shown is the distribution of respondents by whether they keep records on the number of mortalities per pond. Twenty-four (60.0 percent) do keep records, while 36 (40.0 percent) do not.

The seventh variable in Table XXIII is the distribution of respondents by whether they keep records on the feed per pond. Forty-four (73.3 percent) do keep records, while 16 (26.7 percent) do not.

Shown next is the distribution of respondents by whether they keep records on disease problems per pond. Twenty-six (44.1 percent) do keep records, while 33 (55.9 percent) do not.

The last variable in this table is the distribution of respondents by whether they keep records on other aspects of their catfish operation. Three (5.2 percent) do keep records, while 55 (94.8 percent) do not.

Reported in Table XXIV is the distribution of respondents by whether they use a computer to assist in keeping records for their catfish operation. Sixteen (27.1 percent) do use a computer to keep records, while 43 (72.9 percent) do not.

TABLE XXIV

DISTRIBUTION OF RESPONDENTS BY WHETHER THEY USE A COMPUTER TO ASSIST IN KEEPING RECORDS

Computer Used	Frequency (N)	Distribution (%)
Yes	16	27.1
No	43	72.9
Total	59	100.0

Reported in Table XXV is the distribution of respondents by their perception of the seriousness of problems facing their catfish operations. Birds (predator problems) seem to be the biggest problem farmers have. When ponds are stocked with fingerlings is the worst time for birds to come in and eat the fish. The birds causing the most problems are cranes, which are protected by law. A farmer who has a serious problem can aquire a permit to shoot up to 50 cranes per year.

Reported in Table XXVI is the number of catfish farmers in Oklahoma counties in 1991 and 1993. There was a decrease of 69 (51.87 percent) producers during this time period. This information is further illustrated in Figure VI. Each county had a decrease of catfish farmers, although through interviews with farmers the researcher found that a small number of farmers are converting their catfish operations to other types of fish. Bass, trout, baitfish, and Australian crabs are just a few of the new types of aquaculture enterprises farmers are starting in Oklahoma.

TABLE XXV

DISTRIBUTION OF RESPONDENTS BY SERIOUSNESS OF PROBLEMS

Problem	No Problem 1 N	%	2 N	%	3 N	%	4 N	%	Serious Problem 5 N	%	Total N	Mean	SD
Aquatic Weeds	31	51.7	10	16.7	11	18.3	4	6.7	4	6.7	60	2.000	1.262
Birds	11	18.3	9	15.0	11	18.3	6	10.0	23	38.3	60	3.350	1.560
Fish Diseases	32	53.3	10	16.7	12	20.0	3	5.0	3	5.0	60	1.916	1.183
Farm Financing	42	70.0	3	5.0	7	11.7	3	5.0	5	8.3	60	1.766	1.319
Monitoring Oxygen	38	63.3	10	16.7	8	13.3	4	6.7	0	0	60	1.700	1.139
Marketing	28	46.7	10	16.7	11	18.3	4	6.7	7	11.7	60	2.200	1.399
Harvesting	34	56.7	11	18.3	5	8.3	5	8.3	5	8.3	60	1.933	1.325
Labor	34	56.7	8	13.3	6	10.0	5	8.3	7	11.7	60	2.050	1.442
Availability/Chem.	35	58.3	9	15.0	8	13.3	3	5.0	5	8.3	60	1.900	1.297
Off-Flavor Fish	41	70.7	10	17.2	1	1.7	3	5.2	3	5.2	58	1.568	1.109
Technical Assist.	45	76.3	6	10.2	3	5.1	4	6.8	1	1.7	59	1.474	0.988
Water Quality	45	75.0	4	6.7	8	13.3	2	3.3	1	1.7	60	1.500	0.965
Information Avail.	47	79.7	8	13.6	0	0	3	5.1	1	1.7	59	1.355	0.866
Record Keeping	41	68.3	8	13.3	7	11.7	3	5.0	1	1.7	60	1.583	0.996

TABLE XXVI

NUMBER OF CATFISH FARMERS IN OKLAHOMA COUNTIES

County	1991 (N)	1993 (N)
Adair	2	2
Atoka	2	1
Beckham	1	1
Bryan	5	1
Caddo	2	1
Carter	3	2
Cherokee	1	1
Choctaw	1	1
Cleveland	1	0
Coal	1	0
Comanche	1	1
Cotton	1	0
Craig	3	2
Creek	2	0
Delaware	1	1
Garfield	2	1
Garvin	1	0
Haskell	2	1
Hughes	20	8
Johnston	4	2
Kay	1	1
Kingfisher	1	1
Kiowa	1	1
Latimer	4	3
LeFlore	4	0
Lincoln	1	0
Logan	2	2
Love	1	1
Major	1	1
Marshall	4	3
Mayes	7	4
McCurtain	2	1
McIntosh	1	1
Murray	2	2
Noble	1	1
Okmulgee	4	2
Osage	2	1
Ottawa	1	1
Pawnee	1	1
Payne	4	3

TABLE XXVI, continued

County	1991 (N)	1993 (N)
Pittsburg	1	0
Pontotoc	3	2
Pottawatomie	3	1
Pushmataha	2	2
Rogers	7	3
Seminole	2	0
Stephens	1	1
Tulsa	3	0
Wagoner	4	1
Washington	1	0
Woodward	1	0
Total	133	64

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This chapter summarizes the procedures and findings of the study and presents the following conclusions and recommendations which are based upon the analysis of data collected by the author.

Scope of the Study

The scope of this study included 133 Oklahoma catfish farmers who were listed in the Oklahoma Fish Producers Directory June 26, 1991. The number of catfish farmers who responded to this survey was 60 (45.2 percent). Sixty-nine (51.8 percent) of the catfish farmers listed were out of business, and four (3.0 percent) did not respond to the survey.

Statement of the Problem

Profitability in catfish production is directly related to managerial practices. Management of production, economics, and disease control is vital to any animal operation.

Oklahoma has had some decline in the number of catfish farmers due to improper management skills. People have gone into the catfish business with the idea that the operation is easy to manage. Many people think that all they have to do is throw catfish in a pond, feed and harvest them, and then make money. However, catfish farming requires intensive management.

Oklahoma has a small number of catfish farmers compared to other states, but these farmers manage to stay in business. Little is known about their actual management procedures.

Purpose of the Study

The purpose of this study was to determine the management practices of commercial catfish farmers in Oklahoma.

Objectives of the Study

In order to complete this study, the researcher had the following specific objectives:

1. Identify commonly applied catfish management methods, including those dealing with stocking, feeding,

water quality, diseases, harvesting, record keeping, and marketing;

2. Identify problems experienced by Oklahoma catfish farmers;

3. Identify the number of farmers who are no longer in the catfish business; and

4. Identify farmers who are no longer in the catfish business but are raising other types of fish.

Summary of Findings

Based upon the analysis and interpretation of the data, the following findings were presented as follows:

1) In general, the number of Oklahoma catfish farmers has decreased by half of the initial population. The majority of farmers are 36 years of age and older. There is no significant sign of a younger generation getting into the catfish farming business. This could be due to finances as well as the age of the industry in this state. The majority of catfish farmers have been in the business less than eleven years. Also, the majority of catfish farmers started their operations with personal capital.

2) In general, respondents have fifteen acres or less of water in catfish production, and the majority do not plan to increase acreage within the next two years. Also, the majority of catfish farming in Oklahoma is on a part-time basis.

3) The majority of respondents do not have their fingerlings checked by a diagnostic lab.

4) The majority of respondents purchase their feed in 50 pound bags, instead of less expensive bulk loads.

5) In general, respondents feed catfish based on the amount they will consume, and feed fish by hand. The majority of the respondents do not feed in the winter based on temperature.

6) In general, respondents check the oxygen level of the water once per day.

7) The majority of respondents have a water quality kit, but do not check chlorides, hardness,alkalinity, ammonia, pH, temperature or nitrates. Yet the majority of respondents feel water quality management is not a problem.

8) In general, the majority of respondents use the Oklahoma Cooperative Extension Service or a private consultant to diagnose fish disease problems.

9) The majority of respondents sold food size fish by local retail.

10) The majority of respondents flavor-checked fish before marketing.

11) In general, respondents kept records on cash flow, operating expenses, feed, and catfish production per acre.

12) The majority of the respondents felt that bird predication was their major problem.

Conclusions

Based upon the analysis of the findings of the study, the following conclusions were drawn.

1) Catfish farming is not for everyone. Catfish farming takes intensive management and money. People who are considering going into the catfish business should start out small. All aspects should be studied before going into business.

2) All management methods are tied together. Of all the managemenht methods, water quality is the most important. Poor water quality can be caused due to overstocking and overfeeding. Feed that is not consumed settles to the bottom of the pond and starts to decompose, causing poor water quality. By properly stocking ponds a farmer can possibly never have problems with low dissolved oxygen rates, which can cut costs by eliminating the need for an aerator. All of these factors, if handled improperly, can lead to fish diseases in a pond.

3) Before beginning a catfish operation, a person should spend some time with the Oklahoma Cooperative Extension Service and/or a well-established fish farmer. These people have already experienced the problems of the business, and can save a beginner time and expenses.

4) Marketing can be a problem with any business, but with initiative and imagination a small-scale catfish farmer can get more per pound of fish than by simply selling to a

processor. Ways to increase profit include selling to groups for local gatherings and fee fishing, although liability must be checked out thoroughly for the latter.

5) Catfish farming can be a good teaching tool in the public schools. It helps students practice basic math and science skills, and in addition may stimulate interest to learn.

6) As in any business, there is always room for improvement. Many improvements are blocked due to costs, but management methods can be improved at little or no cost.

7) Financing is a major problem and could require the farmer to start using personal capital, and to educate bankers on the catfish industry.

8) The respondents of this study are very informative people who have learned a lot about the catfish industry on their own. This, the researcher feels, is what makes the foundation for the catfish industry in Oklahoma. The next step for these farmers is to follow the guidance of state personnel. The majority of these farmers know the basics of the business, but the study shows that improvements can be made in the areas of water quality management, record keeping, and marketing.

Recommendations

Based on the findings of the study and the conclusions derived from the analysis of the data, the following recommendations are made:

1) Emphasis needs to be placed on getting a younger generation involved in aquaculture. This can be established in high school agriculture programs. This can help the industry, as well as teach students valuable skills in science and math.

2) Catfish farmers should enroll and/or continue to utilize programs offered by the Oklahoma Cooperative Extension Service.

3) Though farmers thought that water quality management was not a major problem for them, the results of the study showed that many respondents did not check water quality. Farmers need to work on better water quality management.

4) Farmers need to keep working on establishing their own markets to achieve a higher price for their product.

5) More emphasis needs to be placed on record-keeping for water quality management. If a fish kill was found in a public stream or river, a farmer could show that he was not at fault by the use of water quality management records. They could show what chemicals had been used in their pond, at what rate, and that the fish in their pond are still alive. This would prove that any seepage from their pond to a public river could not have caused the fish kill, because any chemical would have diluted to a low concentration in the river.

6) Farmers need to work on cutting expenses with proper management to fit the price of their product.

Recommendations for Additional Research

The following recommendations are made in regard to additional research. The recommendations are judgements based on having conducted the study and on evaluation of the data.

1) There should be a study conducted in the future to determine whether management methods have improved, especially in water quality management.

2) There should be a study conducted in the future to determine whether acreage and production are increasing.

3) There should be a study conducted to determine whether farmers who market their fish independently consistently receive better prices for their fish than farmers who sell wholesale.

4) There should be a study conducted with Oklahomans to determine what other types of aquaculture production are being done in the state.

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APPENDICES

APPENDIX A

INTERNAL REVIEW BOARD

STATEMENT OF

APPROVAL

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Date: 1-18-93 **IRB#:** AG-93-013

Proposal Title: PRODUCTION PRACTICES OF COMMERCIAL CATFISH PRODUCERS IN OKLAHOMA

Principal Investigator(s): James P. Key, Mark A. Klimkowski

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL. ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

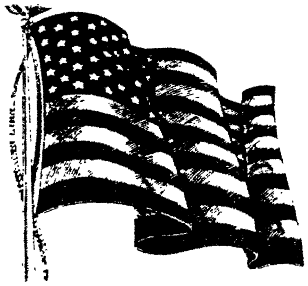
Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature: Marcia L. Tilley
Chair of Institutional Review Board

Date: January 20, 1993

APPENDIX B

COVER LETTER



American Agriculture

'So few people feed, so many.'

March 1, 19[illegible]

Dear Mr. _______,

My name is Mark Klimkowski. I am a graduate student at Oklahoma State University. My research deals with catfish production in Oklahoma. I would appreciate it if you would fill out the questionaire, and return it in the envelope provided. Your input will help out greatly in my research. Thank you very much for your help.

Sincerely,

Mark A. Klimkowski

Mark A. Klimkowski
Graduate Student (AgEd)
Oklahoma State University

APPENDIX C

SURVEY INSTRUMENT

The questions in this interview are confidential, and directed to find out the management skills of Oklahoma Channel Catfish producers.

GENERAL CATFISH FARMING INFORMATION

_____ 1. Gender:

(1) Male (2) Female

_____ 2. Age

_____ 3. How many years have you been farming catfish?

_____ 4. What percentage of your income is from catfish farming?

_____ 5. Where did you secure money for financing your catfish operation?

(1) FMHA
(2) Conventional Bank
(3) Personal Capital
(4) Other (specify) ______________________________

_____ 6. How many acres of water in catfish production do you have?

_____ 7. Do you expect to increase your catfish acreage over the next two years?

(1) Yes
(2) No

_____ 7A. If yes, how many acres do you plan to increase?

8. How many people work in your catfish operation? (Please fill in the number for each category)

________ Non-salaried family members
________ Full-time employees
________ Part-time employees

_____ 9. What is your catfish farming status?

(1) Full-time
(2) Part-time

STOCKING INFORMATION

_____ 10. Do you produce your own catfish fingerlings?

(1) Yes
(2) No

_____ 10A. If yes, how many acres of ponds do you have exclusively for catfish fingerling production?

____ 11. If you purchase some or all of your fingerlings, from what source did you obtain them?

(1) State Fisheries (Oklahoma)
(2) Individual Producers
(3) Out-of-State Producers
(4) Other (specify) ____________________

12. How many fingerlings per acre do you stock for producing food size fish in:

__________ New Ponds
__________ Ponds already in production

____ 13. Do you have your fingerlings checked by a diagnostic lab before you purchase and stock them in your pond?

(1) Yes
(2) No

13A. If yes, where do you get them analyzed? ____________________

FEEDS AND FEEDING

____ 14. How do you purchase your catfish feed?

(1) 50 lb. bags
(2) Bulk loads
(3) Other (specify) ____________________

15. How many pounds of feed do you use per day in your catfish operation for food fish?

__________ total lbs/day

16. How many pounds of feed do you use per day in your catfish operation for fingerlings?

__________ total lbs/day

____ 17. How do you determine the amount of feed to distribute to your catfish?

(1) Feed the catfish as much as they will eat.
(2) Calculate the amount of feed by taking a seine sample.
(3) Other (specify) ____________________

____ 18. How do you feed your catfish?

(1) By hand
(2) Mechanical feeders
(3) Automatic feeders
(4) Other (specify) ____________________

_____ 19. Do you feed your fish during the winter based on water temperature?

(1) Yes
(2) No

19A. If no, how do you determine when to feed? (specify)

____

WATER QUALITY MANAGEMENT

_____ 20. What is your primary water supply?

(1) Well
(2) River
(3) Watershed run-off
(4) Other (specify) ____________________________

_____ 21. How are aerators powered?

(1) Electricity
(2) Diesel motor
(3) Gasoline motor

_____ 22. How many portable backup aerators do you have for emergency aeration on your farm?

_____ 23. At what dissolved oxygen level do you begin to operate aerators in your ponds?

(1) 6 ppm
(2) 5 ppm
(3) 4 ppm
(4) 3 ppm
(5) 2 ppm
(6) 1 ppm

_____ 24. How often do you check oxygen levels in your ponds?

(1) Once per day
(2) Twice per day
(3) Three times per day

_____ 25. When do you check oxygen levels?

(1) Dawn
(2) Noon
(3) Dusk
(4) Other (specify) ____________________________

_____ 26. What type of water quality kit do you use?

(1) Portable meter
(2) Water quality test kit
(3) Both
(4) Other (specify) ______________________________

How often do you check the following in your ponds? (**1= Once per week, 2= Once every two weeks, 3= Once per month, 4= Never, 5= Other [specify]**).

_____ 27. Chlorides

_____ 28. Hardness

_____ 29. Alkalinity

How often do you check the following in your ponds? (**1= Once per day, 2= Twice per week, 3= Once per week, 4= Never, 5= Other [specify]**).

_____ 30. Ammonia

_____ 31. pH

_____ 32. Temperature

_____ 33. Nitrates

_____ 34. Oxygen

_____ 35. Do you lime your ponds?

(1) Yes
(2) No

_____ 36. Is water quality management a problem for you?

(1) Yes
(2) No

DISEASE

_____ 37. What percentage of total pounds of your fish do you estimate you lost in 1992 to disease?

_____ 38. How do you diagnose fish disease problems?

(1) Yourself
(2) Other farmers
(3) Private Consultant
(4) Oklahoma Cooperative Extension Service (Langston, Oklahoma)
(5) Oklahoma Cooperative Extension Service (Ada, Oklahoma)

HARVESTING

_____ 39. How many pounds of food size fish did you harvest in 1992?

_____ 40. What primary size of catfish did you market in 1992?

(1) Less than 1 lb/fish
(2) Less than 1 1/2 lb/fish
(3) Less than 2 lb/fish
(4) More than 2 lb/fish

_____ 41. Do you remove all fish from ponds at harvest (clean crop) or do you partial harvest larger fish several times during the year and restock with fingerlings?

(1) Remove all fish
(2) Partial removal, restock with fingerlings

_____ 42. Who (primarily) harvests your catfish?

(1) Yourself/family members
(2) Custom harvester
(3) Other farmer
(4) Other (specify) ______________________________

43. What percentage of your food size catfish was sold or marketed to the following:

<u>% of Crop</u>

________ Processor
________ Live hauler
________ Local retail market
________ Fee fishing
________ Other (specify) ______________________

_____ 44. Do you flavor-check your fish before they are marketed?

(1) Yes
(2) No

RECORD KEEPING

45. Do you use record keeping systems to determine: (put a check mark if Yes)

________ Cost of fuel or electricity for aeration
________ Annual operating expenses
________ Catfish production per acre
________ Monthly cash flow
________ Water quality condition in each pond
________ Fish inventories in each pond
________ Mortalities for each pond
________ Feed records for each pond
________ Hours of aeration per pond
________ Disease problems for each pond
________ Other (specify) ____

_____ 46. Do you presently use a computer to assist in farm record keeping?

(1) Yes
(2) No

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47. On a scale of 1 to 5, with "1" being No Problem and "5" being a very serious problem, rate the following in your catfish farming operation:

Aquatic Weeds	1	2	3	4	5
Birds	1	2	3	4	5
Fish Diseases	1	2	3	4	5
Farm Financing	1	2	3	4	5
Monitoring Oxygen Levels	1	2	3	4	5
Marketing	1	2	3	4	5
Harvesting	1	2	3	4	5
Labor	1	2	3	4	5
Availability of Chemicals	1	2	3	4	5
Off-flavor in Fish	1	2	3	4	5
Technical Assistance	1	2	3	4	5
Water Quality	1	2	3	4	5
Information Availability	1	2	3	4	5
Record Keeping	1	2	3	4	5

Please add any comments or perceptions you have about the catfish industry. Also, please list questions or needs you have concerning your operation and any topics you would like to receive information on. ***Thank you for your cooperation!***

VITA

Mark A. Klimkowski

Candidate for the Degree of
Master of Science

Thesis: MANAGEMENT METHODS OF COMMERCIAL CATFISH FARMERS IN OKLAHOMA

Major Field: Agricultural Education

Biographical:

Personal Data: Born in Oklahoma City, Oklahoma, January 15, 1963, the son of Valentine and Rosie Lee Klimkowski.

Education: Graduated from Harrah High School, Harrah, Oklahoma, in May 1981; received Associate Degree in Ranch Operations from Eastern Oklahoma State College at Wilburton, Oklahoma, in May 1983; received Bachelor of Science Degree in Animal Science from Oklahoma State University in Stillwater, Oklahoma, in May 1988; completed requirements for the Master of Science Degree at Oklahoma State University in December 1993.

Professional Experience: Survey Assistant, Department of Agricultural Engineering, Oklahoma State University, February 1992 to February 1993. Combat Engineer, United States Army, February 1989 to June 1991. Crew Boss, Nowakowski Farms, Harrah, Oklahoma, May 1984 to May 1988. Hired Hand, John Sokolosky, Wilburton, Oklahoma, August 1982 to May 1983. Hired Hand, Sheep Barn, Department of Agriculture, Eastern Oklahoma State College, January 1982 to May 1982.