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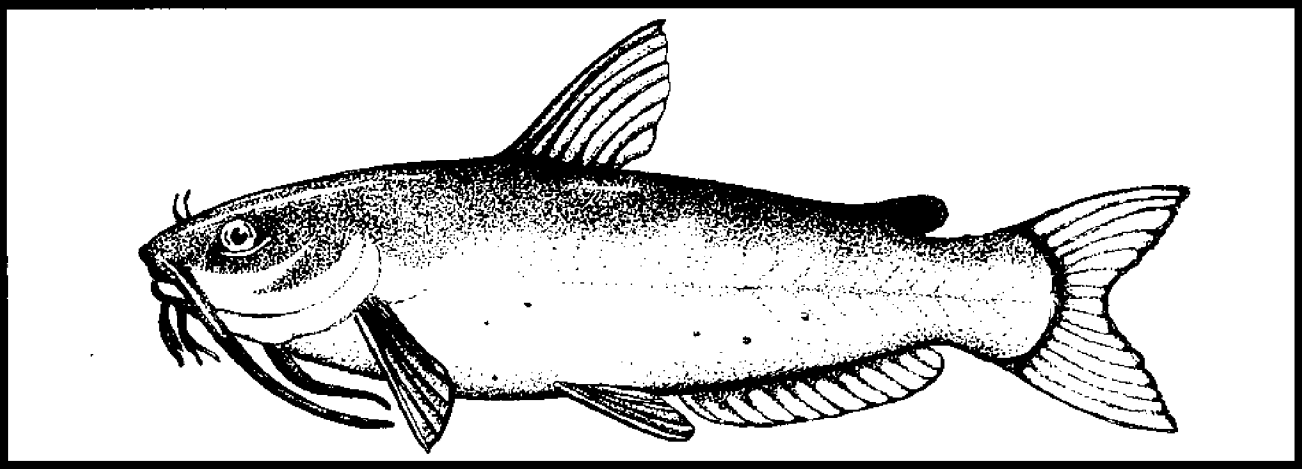

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Costs and Returns of Catfish Pond Production in the Mississippi Black Belt Area

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Costs and Returns of Catfish Pond Production in the Mississippi Black Belt Area

Introduction

Mississippi catfish production outside the Delta is concentrated in the heart of the Black Belt Region, mainly in Noxubee, Lowndes, and Kemper counties. A survey of all known east Mississippi catfish producers in 1991 also revealed a small number of catfish enterprises in Alcorn, Clay, Monroe, and Lee counties (Kelly et al. 1991). Results of the National Agricultural Statistics Service (NASS) survey in July 1995 identified 80 producers with almost 2,900 acres devoted to catfish production in or adjacent to Noxubee County (Harold Ishee, personal communication). Local agricultural extension and soil conservation service agents projected that total catfish acreage would exceed 5,000 acres in Noxubee and adjacent counties in 1996, based on pond construction activity (Malcolm Lowe and Dennis Reginelli, personal communication). About 9,000 water surface acres were devoted to catfish production in the Mississippi Black Belt area in January 2000 (Mississippi Agricultural Statistics Service, personal communication).

As catfish production continues to expand in non-Delta areas of Mississippi, the need for more area-specific economic information becomes more critical. Extension and research personnel are receiving more requests from both farmers and financial institutions for information on investment requirements and profitability of catfish farming in these areas.

Catfish enterprises in the Black Belt differ vastly from catfish farms in the Delta in at least five major areas: size, topography, water supply, diversification, and industry infrastructure (Posadas and Dillard 1997).

First, the average Black Belt catfish operation is approximately 35 acres (Harold Ishee, personal communication). The average Delta operation is approximately 430 acres (USDA 1995).

Second, the Black Belt's topography necessitates deeper ponds than those in the Delta do. Also unlike Delta ponds, Black Belt ponds often do not share common levees, which requires them to be configured differently.

Third, water supply for filling and replacing losses in Black Belt ponds is from surface runoff and/or from nearby streams. Delta ponds are supplied by water from shallow wells.

Fourth, catfish operations in east Mississippi are typically one enterprise on multienterprise, highly diversified farms dependent largely on family labor. Farming operations in the Delta are more specialized, and in many instances catfish farms are single-enterprise operations. When a large, multienterprise Delta farm includes both catfish and row crop production, catfish production is typically treated as an independent enterprise with its own labor force, equipment, and in some cases, even management.

Fifth, the Delta has a more highly developed infrastructure supporting catfish production, processing, and marketing. The Black Belt has three processing plants and some feed and specialized equipment suppliers, and the region is dependent on research, extension, and diagnostic support from Mississippi State University.

Several economic analyses have been conducted to estimate the costs of catfish farming in the Delta (Table 1).

Table 1. Technical characteristics of catfish pond production systems in the Mississippi Delta, 1972-90.

Author and year published	Water source and flow rate	Permanent aeration and aeration capacity[1]	Stocking rate[2]	Yield[3]	Feed conversion[4]
Foster and Waldrop (1972)	Wells ≥ 100 gpm/A[5]	A	2,000	2,375	1.60
Burke and Waldrop (1978)	Wells ≥ 43 gpm/A	B	4,000	4,631	1.60
Waldrop and Smith (1980)	Wells ≥ 43 gpm/A	B	4,000	4,631	1.60
Giachelli, et al. (1982)	Wells ≥ 43 gpm/A	C	4,500	5,344	1.85
Keenum and Waldrop (1988)	Wells ≥ 43 gpm/A	Electric paddlewheels ≥ 0.5 hp/pond	4,300	5,000	2.00
Garrard, et al. (1990)	Wells ≥ 43 gpm/A	Electric paddlewheels 0.5 ≤ hp/pond ≤ 2.0	4,300	4,500	2.00

[1]A – Pond aeration system consisted of 8-inch P.T.O.-driven relift pump with aeration attachment. B – Installed one 16-inch P.T.O.-driven relift pump for every 47-95 water surface acres. C – Used one PTO-driven relift pump for every 141-191 water surface acres and one PTO-driven paddlewheel for every 44-47 water surface acres.

[2]In fingerlings per water surface acre; stocking size was 6-inch fingerlings, except Giachelli et al. (1982), who used 4- to 6-inch fingerlings.

[3]In pounds per water surface acre; harvest size was 1.25 pounds per fish.

[4]In pounds of feed fed per pound of fish produced.

[5]Per water surface acre.

Foster and Waldrop (1972) determined optimum pond size to be 20 land acres for a 160-acre farm. A later study by Garrard et al. (1990) showed that for a 323-acre catfish farm, the optimum pond size was also 20 land acres. Costs of production of various farm sizes have been determined periodically from the time catfish farming was recognized as an industry (Burke and Waldrop 1978; Waldrop and Smith 1980; Giachelli et al. 1982; Keenum and Waldrop 1988).

Fuller et al. (1988) estimated multiperiod cost and revenue variations that the stocking of various fingerling sizes and alternative stocking dates cause in the production of channel catfish for food. The effects of stocking density and cropping systems on discounted net revenues from catfish production in the Mississippi Delta were evaluated by Tucker et al. (1992). Engle and Pounds (1994) studied the effects of alternative management strategies on net revenue under different risk situations for the Delta areas of Arkansas. The effects of inflation on the costs of producing catfish in the Mississippi Delta were examined by Engle and Kouka (1996).

There has been no economic analysis of catfish production for non-Delta areas of Mississippi. Crews et al. (1992) prepared enterprise budgets for catfish production in Alabama, where production is concentrated in an area geographically similar to the Black Belt Region of Mississippi. An analysis of catfish farming in west-central Alabama was conducted by Nerrie et al. (1990) using a Cobb-Douglas production function. However, there may be important differences between catfish farming in the Black Belt of Mississippi and western Alabama, particularly in relation to the level of farm diversification. Furthermore, cost data are out of date because of changes in both technology and prices. Consequently, results of the Alabama and Delta studies cannot be applied with confidence to farms in the Black Belt Region of Mississippi.

Operational characteristics of farms with catfish enterprises were based on data obtained from a survey of area catfish farmers (Posadas 1998). The survey of catfish farmers was conducted in January and February 1996 to obtain both technical and economic information concerning catfish farming in the Mississippi Black Belt. Personal interviews were conducted with owners of 15 Noxubee County farms. These included five farms in each of three size categories: less than 29 acres, 30-49 acres, and 50 or more acres. Because of confidentiality restrictions, NASS could not provide a list of catfish farms with accompanying size. With the specified size ranges, however, NASS provided a list of producers in each size category. The Noxubee County Extension agent then selected five "typical" or "representative" catfish producers in each of the three size categories.

Farm Enterprises, Acreage, and Experience

Results of the survey revealed that Black Belt catfish production generally occurs on highly diversified, or multienterprise family farms. Fourteen of the 15 farms surveyed had one or more enterprises other than catfish in 1995; 11 produced corn, 11 produced soybeans, three produced cotton, one produced wheat, two raised swine, two raised beef cattle, one operated a dairy, and two participated in the Conservation Reserve Program. Total acreage of the sample farms averaged 581 acres with a standard deviation of 403 acres (Table 2). Crop-producing farms devoted an average of 223 acres to corn, 123 acres to cotton, 262 acres to soybeans, and 50 acres to wheat. Land devoted to catfish production averaged 57.2 acres, or about 10% of the total farm land acreage. Total farm size was not significantly correlated with the size of the catfish enterprise (Pearson correlation coefficient, $r = 0.34$; level of significance, $\alpha = 0.24$).

Farms surveyed in 1996 averaged 47.5 water acres in catfish production, more than twice the average size (23.1 acres) of the Black Belt catfish enterprises examined in 1990 (Kelly et al. 1991). Land area devoted to catfish production in 1996 was 57.2 land acres, indicating that 17% of the acreage was used for the construction of levees, roads, and surrounding grassed areas. The surveyed enterprises averaged two ponds for 10-29 acres, six ponds for 30-49 acres, and eight ponds for 50 acres or more. For all farms surveyed, there was an overall average of six ponds (Table 2).

Typically, farmers gradually entered into catfish production by constructing one pond, learning to raise catfish, then constructing additional ponds. Eleven of the 15 farms surveyed added at least one pond in 1995. Most catfish farms have grown to their present size over a period of years. Therefore, farms with the most acreage in catfish production are those that have been in the catfish business the longest. Statistical analysis showed that there is a very strong direct correlation between number of ponds and fish farming experience ($r = 0.75$, $\alpha = 0.002$). Farmers with 50 acres or more devoted to catfish production averaged 10.3 years of fish farming experience. However, farmers with less than 30 acres averaged only 4.3 years of experience (Table 2).

Table 2. Mean farming acreage, fish pond size, and fish farming experience in multienterprise farms in the Mississippi Black Belt, 1996.[1]

Item (units)	Fish farm size (acres)			
	10-29 N = 5	30-49 N = 5	≥ 50 N = 5	All farms N = 15
Total farm acreage (acres)	519.50 a (273.04)	531.25 a (538.15)	656.00 a (438.09)	581.35 (402.96)
Fish farm water acreage (acres)	16.50 a (8.74)	38.50 a (2.08)	74.17 a (50.96)	47.50 (40.82)
Fish farm land acreage (acres)	20.50 a (12.12)	46.25 a (2.50)	89.00 a (60.97)	57.21 (48.82)
Number of fish ponds (fishponds)	2.00 b (1.15)	6.00 a (1.41)	7.83 a (1.47)	5.64 (2.82)
Size of fishponds (acres/pond)	8.50 a (1.04)	6.76 a (2.01)	9.28 a (5.22)	8.34 (3.58)
Fish farming experience (years)	4.25 a (4.27)	8.00 a (3.92)	10.33 a (3.50)	7.93 (4.39)

[1]Means with the same letter are not significantly different at $P \geq 0.05$. Numbers in parentheses are standard deviations.

Pond Design and Construction

Pond sizes did not vary significantly among the three farm size categories. Overall, the average pond size was 8.3 water surface acres (Table 2). The average size of surveyed ponds built within the last 5 years was 10.1 acres, whereas older ponds averaged 7.7 acres, indicating a trend toward larger ponds. Existing pond depth averaged 3.8 feet on the shallow end and 7 feet on the deep end.

The size, shape, depth, and location of the ponds varied from one farm to another, depending on the topography of the land. Several pond configurations were observed on the fish farms visited. Fishponds were built either as a single pond or as a set of two, three, or four ponds sharing common levees. The average volume of earth moved varied inversely with the number of adjacent ponds built. Construction of a single pond required the movement of an average of about 1,700 cubic yards per acre. Conversely, construction of two, three, and four ponds sharing common levees averaged 1,550, 1,500, and 1,250 cubic yards per acre, respectively.

Water Source

High costs associated with constructing deep wells prompt Black Belt catfish to rely primarily on surface water runoff to replenish their ponds. A 1,620-foot-deep well built 15 years ago and equipped with a 40-horsepower electric pump cost about $83,000. Thirteen of the 15 farmers surveyed filled their ponds with water from surface runoff. One farmer used his well and pump to provide water for both his crops and ponds. Another used his well and pump primarily for his catfish farm.

Water Quality Analysis

Forty percent of the farmers visited in the spring of 1996 stated that private consultants performed water quality analyses for their ponds. One-third of the respondents analyzed their own water quality, while the rest did not test their water. Consultants did the analyses between May and October, charging an average of about $10.49 per pond per month. These analyses covered the standard water quality parameters needed to effectively manage catfish farms, such as alkalinity, ammonia, nitrite, chloride, and pH.

Three-fourths of the farmers interviewed monitored dissolved oxygen in the ponds on a regular basis. They checked dissolved oxygen twice a day from April to October and used the data to decide whether to aerate the ponds. Although computerized pond monitoring technology was available at the time of the survey, none of the surveyed farmers reported using it.

Fish Stocking

Farmers typically began catfish production by applying relatively low stocking and feeding rates, thereby minimizing water-quality and off-flavor problems. The 1991 survey in the Black Belt revealed average stocking rates of 3,200, 3,500, and 4,000 fish per acre in 1988, 1989, and 1990, respectively (Kelly et al. 1991). The 15 farmers interviewed in the spring of 1996 reported stocking rates of 4,700 in 1993, 5,100 in 1994, 5,700 in 1995, and 6,000 in 1996, indicating a dramatic increase in the number of fish stocked per acre. Analysis of variance (ANOVA) results showed that stocking rates in 1995 were not statistically different among the three farm sizes (Table 3). Fish farmers stocked their ponds once a year with catfish fingerlings averaging 5.8 inches in length. Farmers bought fingerlings from commercial hatcheries in the Mississippi Delta and Arkansas. Pond stocking took place year-round, depending on the availability of ponds and catfish fingerlings.

Table 3. Mean stocking density, gross feed conversion ratio, and catfish harvest in multienterprise farms in the Mississippi Black Belt, 1996.[1]

Item (units)	Fish farm size (acres)			
	10-29 N = 5	30-49 N = 5	≥50 N = 5	All farms N = 15
Fish stocking density (fish/acre)	5,500 a (577)	5,125 a (629)	6,208 a (1,676)	5,696 (1,217)
Gross feed conversion ratio (lb of feed/lb of fish)	1.65 b (0.04)	1.90 a (0.10)	1.80 a,b (0.09)	1.80 (0.12)
Annual catfish harvest (lb/acre)	4,034 a (920)	5,136 a (649)	5,790 a (1,865)	5,183 (1,487)

[1]Means with the same letter are not significantly different at P ≥ 0.05. Numbers in parentheses are standard deviations.

Feeds and Feeding

All farms had catfish feed bins for storing bulk feed. Each of the farms visited had some type of feed truck equipped with a blower for applying feed to ponds and a metering device for controlling the feeding rate. Most farmers tried to feed at a daily ration of 3% of body weight. Floating feed was used so feeding activity could be observed. If fish did not actively consume feed as it was blown across the pond surface, feeding was halted. Fish were fed twice daily during warmer months and once a day, depending on the temperature, during colder months.

An attempt was made to obtain gross feed conversion ratios (GFCR), defined as the total quantity of feed fed divided by the total quantity of fish harvested during a complete production cycle. Although some producers interviewed did not produce records from which GFCR could be computed, all seemed to be very confident in reporting their GFCR. The average GFCR was 1.8 for all 15 farms surveyed (Table 3). There were no significant differences in GFCR noted among the three farm sizes.

Fish Harvesting

Fish were generally harvested once or twice each year by a contract crew. Farmers usually provided two tractors and at least one driver during fish harvest. The tractors were used an average of 5.1 hours per harvest. Farmers lowered the pond levels by about 1 foot in order to facilitate fish harvest. Harvest crews used wider seines because of the greater depth of the Black Belt ponds.

Farmers paid an average of 5 cents per pound for contract harvesting and transportation of fish to processing plants. This cost was automatically deducted by the processing plant from the pond bank price paid for the fish. The farm-gate price in the Black Belt averaged about 5 cents less than that in the Mississippi Delta.

The reported average yield of all farms surveyed in 1996 was 5,183 pounds per acre (Table 3) with most of the fish weighing between 1.25 and 1.5 pounds. The annual yield reported by the 10- to 29-acre farms was 4,034 pounds per acre; 30- to 49-acre farms, 5,136 pounds per acre; and 50+-acre farms, 5,790 pounds per acre. The correlation analysis revealed that the more experienced fish farmers had higher average yields ($r = 0.57$, $\alpha = 0.04$) and higher stocking rates led to higher average yields ($r = 0.82$, $\alpha = 0.001$).

Equipment Requirements

With multiple cropping on most of the farms visited, equipment and facilities used in either crop or livestock production were also applicable to catfish farming. First, tractors were used in emergency aeration, pond maintenance, and fish harvesting. Monthly tractor time required to run a 48-acre catfish enterprise was estimated from the average tractor time (hour/acre/month) devoted to harvesting fish year-round, maintaining ponds, and operating PTO-driven emergency paddlewheels from May to September. The required monthly tractor time fluctuated from 2 hours during cooler months to as much as 85 hours during hotter months. Second, a truck was needed in some miscellaneous tasks, such as marketing, off-flavor testing, pond monitoring, and scaring off fish-eating birds. Third, a service building was used to store farm supplies and equipment. Fourth, a water well/pump could be used in both agricultural and fish farming enterprises, depending on the economic circumstances of the entire farm, in general, and the catfish farm, in particular.

Equipment used primarily in the operation of a catfish farm includes aeration, feeding, water quality, and disease, parasite, and weed control equipment. Aeration equipment consists of a dissolved oxygen meter, cable and probe, electric paddlewheels, and emergency aerators. Pond aeration capacity averaged 1.33 horsepower per acre, which consumed 1,424 kilowatt-hours or $124 per acre annually (Table 4). Feeding equipment includes a feed bin, feeder, feed truck, and electronic scale. The control of diseases, parasites, and weeds is done with the use of a boat, motor, trailer (to transport boat and motor), chemical sprayer, and rear or side-mounted mower.

Table 4. Mean aeration capacity and electricity use and cost of catfish farms in multienterprise farms in the Mississippi Black Belt, 1996.[1]

Item (units)	Fish farm size (acre)			
	10-29 N = 5	30-49 N = 5	≥50 N = 5	All farms N = 15
Average aeration (hp/acre)	1.14 a (0.16)	1.50 a (0.47)	1.34 a (0.29)	1.33 (0.33)
Annual electricity use (kwh/acre)	1,056 a (175)	1,956 a (955)	1,314 a (615)	1,424 (705)
Annual electricity cost ($/acre)	102 a (29)	168 a (47)	110 a (42)	124 (47)

[1]Means with the same letter are not significantly different at $P \geq 0.05$. Numbers in parentheses are standard deviations.

Labor Requirements

The monthly labor requirements of a 48-acre fish farming enterprise were estimated from the average man-hours devoted to feed the fish year-round, operate the aerators from May to October, monitor dissolved oxygen from April to October, maintain ponds from May to September, and perform miscellaneous tasks year-round. Monthly labor required to operate the catfish enterprise fluctuated from as low as 25 hours during cooler months to as high as 140 hours during hotter months. Most of the tasks required in the fish farming enterprise were performed by the fish farmer or another family member, usually a son. Of the 15 farmers interviewed, only one employed some seasonal hired labor in his catfish enterprise.

Investment Requirements, Annual Costs, and Returns

Investment and operating costs, including input levels, prices, and yields were mainly based on the results of the 1996 survey of fish farmers in the area (Posadas 1998; Posadas and Dillard 1997). Additional information on the costs of farm equipment and other inputs were taken from previous estimates on catfish farming (Keenum and Waldrop 1988; Moore and Waldrop 1994), crop (Caillavet 1996; DAE 1995a; DAE 1995b; DAE 1995c), catfish processing plants, and input suppliers. Actual annual quantities and costs of electricity used by the 15 farms surveyed were provided by the local power distributor.

The representative farm used in estimating the investment, annual costs, and returns of catfish production in the Mississippi Black Belt area consisted of 48 water surface acres or 57.812 land acres. It had two sets of three 8-water-acre or three 9.635-land-acre ponds sharing common levees and water source. Each pond was equipped with a 10-horsepower electric aerator, which was connected to an electrical panel. A separate electric meter was installed by the power company in each pond to monitor consumption.

Investment Requirements

The total initial investment on a 48-acre catfish farm in the Black Belt area was $169,097, or $28,183 per 8-acre pond (Table 5). Land and surveying costs amounted to $6,745 and $482 per 8-water-acre pond, respectively. The costs of pond construction primarily depend on the lay of the land. Assuming two sets of three 8-water-acre ponds with some form of common levees, the volume of earth moved would be 72,768 cubic yards (12,128 cubic yards per pond). At 80 cents per cubic yard, the total cost of earth moving was $58,214 ($9,702 per pond). Including the costs of earth moving, drainage structure, gravel, and vegetative cover, the total cost of pond construction was $64,693 ($10,782 per pond). The electrical panel added $1,300 ($217 per pond), while additional farm equipment would cost $59,745 ($9,958 per pond) (Tables 5-6).

Table 5. Initial investment in six 8-water-acre catfish ponds in multienterprise farms in the Mississippi Black Belt, 1996.

Item (units)	Quantity	Unit cost	Total cost	Percent of total	Per pond	Per water acre	Per land acre
		$	$	%	$	$	$
Land (land acre)	57.812	700.00	40,469	23.9	6,745	843	700
Surveying (land acre)	57.812	50.00	2,891	1.7	482	60	50
Pond Construction:							
Earth moving (cu yd)	72,768.000	0.80	58,214	34.4	9,702	1,213	1,007
Drainage structure (water acre)	48.000	81.00	3,888	2.3	648	81	67
Gravel (water acre)	48.000	43.00	2,064	1.2	344	43	36
Vegetative cover (land acre)	4.906	107.25	526	0.3	88	11	9
Subtotal			**64,693**	**38.3**	**10,782**	**1,348**	**1,119**
Electrical (unit)	1.000	1,300.00	1,300	0.8	217	27	22
Equipment[1]			59,745	35.3	9,958	1,245	1,033
Total investment			**169,097**	**100.0**	**28,183**	**3,523**	**2,925**

[1]List of equipment is given Table 6.

Table 6. Description, number, and cost of equipment for six 8-water-acre catfish ponds in multienterprise farm in the Mississippi Black Belt, 1996.

Item	Description	Quantity	Unit cost	Total cost
			$	$
Electric aerator	10 hp	6	3,800	22,800
PTO-driven paddlewheel	w/ 540 rpm shaft	2	3,500	7,000
Truck-mounted feeder	4,000 lb	1	6,500	6,500
Side-mounted mower	6 ft	1	4,500	4,500
Tractor[1]	50-69 hp	2	20,100	4,020
Feed truck	used	1	3,400	3,400
Electronic feeder scale	w/ printer	1	3,200	3,200
Feed storage bin	10 ton	1	2,200	2,200
Outboard motor	30 hp	1	1,600	1,600
Chemical boat	14 ft, 42-in bottom	1	1,425	1,425
Truck[1]	3/4 ton	1	13,000	1,300
Dissolved oxygen meter	w/ 12 ft cable	1	800	800
Boat trailer	14-in wheels	1	500	500
Service building[1]	25 ft x 50 ft	1	5,000	500
Total investment				**59,745**

[1]Ten percent of annual use allocated to catfish enterprise.

Annual Fixed Costs

The annualized cost of fixed inputs does not vary with the level of their use. Annual fixed costs are those associated with the total initial investment in pond construction, farm equipment, and facilities. Included in this cost item are annual depreciation, interest on average investment, taxes, and insurance on farm equipment and facilities. Total annual fixed cost in a 48-water-acre catfish pond production system was $25,869 per year, $4,312 per pond, or 10.4 cents per pound of catfish harvested (Table 7).

Depreciation

Depreciation is the anticipated reduction in the value of the asset over time brought about through physical use or obsolescence (Gittinger 1982). It was computed by using the straight line method based on replacement cost, estimated economic life, and zero salvage value of pond construction, electrical panel, and equipment (Tables 8-9). Total depreciation expense was $14,098 per year, $2,350 per pond, or 5.7 cents per pound of fish harvested (Table 7).

Interest on Investment

Interest on investment is the opportunity cost of capital used to purchase land, design and construct pond structures, and buy and install farm and electrical equipment. Interest on average investment was estimated using a 10% annual interest rate on average investment. Average investment was equal to half the replacement cost of depreciable assets and the full amount of land and surveying costs (Tables 8-9). Total investment interest was $10,478 per year, $1,746 per pond, or 4.2 cents per pound of fish harvested (Table 7).

Taxes and Insurance

According to the county tax assessor's office, there are no special ad valorem taxes imposed on catfish farms in Noxubee County in addition to the tax on farmland. The county agent estimated the average tax for unimproved farmland in Noxubee County at $1.70 per land acre (Dennis Reginelli, personal communication), a total of $98 per year ($16 per pond).

Fish farms can carry three types of farm liability insurance coverage: general farm liability, equipment coverage, and workman's compensation. Farms with only family labor, however, would not carry workman's compensation. A reputable insurance company based in Jackson, Mississippi, provided estimates for the necessary insurance coverage for equipment in these fish farming operations. The cost of the insurance coverage amounted to about 2% of the value of tractor, feeder, feed bin, vehicles, and aeration equipment. The total cost of insurance was $1,195 per year ($199 per pond).

Table 7. Annual fixed costs of six 8-water-acre catfish ponds in multienterprise farms in the Mississippi Black Belt, 1996.

Item	Total fixed cost	Per pond	Per water acre	Per land acre	Per pound	Percent of total
	$	$	$	$	$	%
Depreciation[1]	14,098	2,350	294	244	0.057	54.5
Interest on investment[1]	10,478	1,746	218	181	0.042	40.5
Taxes and insurance	1,293	216	27	22	0.005	5.0
Total fixed cost	**25,869**	**4,312**	**539**	**447**	**0.104**	**100.0**

[1]Detailed cost estimates are given in Table 8.

Table 8. Economic life, average investment, depreciation, interest, and repair and maintenance of pond structures in multienterprise farms in the Mississippi Black Belt, 1996.

Item	Economic life	Average investment	Annual depreciation	Annual interest	Annual[1] R&M
	yr	$	$	$	$
Land	NA	40,469	NA[2]	4,047	NA
Surveying	NA	1,445	NA	145	NA
Earth moving	10	29,107	5,821	2,911	0
Drainage structure	10	1,944	389	194	0
Gravel	10	1,032	206	103	688
Vegetative cover	10	263	53	26	340
Electrical	10	650	130	65	50

[1]Annual repair and maintenance costs: vegetative cover - $69.27 per land acre; gravel - $14.33 per water acre; electrical - $50 per unit.
[2]NA = not applicable.

Table 9. Economic life, average investment, depreciation, interest, and repair and maintenance of equipment used in catfish production in multienterprise farms in the Mississippi Black Belt, 1996.

Item	Economic life	Annual R&M	Average investment	Annual depreciation	Annual interest	Annual R&M
	yr	%	$	$	$	$
Tractor	12	75	2,010	335	201	251
Truck	5	45	650	260	65	117
Feed truck	2	45	1,700	1,700	170	765
D.O. meter	10	200	400	80	40	160
Paddlewheel	10	25	3,500	700	350	175
Aerator	10	50	11,400	2,280	1,140	1,140
Mower	6	20	2,250	750	225	150
Feeder	10	30	3,250	650	325	195
Scale	10	25	1,600	320	160	80
Feed bin	20	10	1,100	110	110	11
Building	20	50	250	25	25	13
Boat	15	75	713	95	71	71
Motor	10	50	800	160	80	80
Trailer	15	40	250	33	25	13

Annual Variable Costs

Variable costs incurred in the fish farming enterprise are those directly related to the volume of catfish production. The major variable cost items consisted of feed (42.9%), fingerlings (17%), harvesting and hauling (10.3%), interest on operating capital (6.1%), labor (5.9%), electricity (4.9%), repair and maintenance (3.6%), fuel (3.5%), chemicals (2.5%), and interest on inventory (2%). Total variable costs on a 48-water-acre catfish pond production system was $121,010 per year, $20,168 per pond, or 48 cents per pound of catfish sold (Table 10).

Feed

The total amount of feed required was about 225 tons per year, which is 37 tons per pond or 1.8 pounds per pound of fish produced. Using the average price of feed during the last 4 years ($231 per ton), total feed cost was $51,892 per year, $8,649 per pond, or 20.79 cents per pound of fish produced (Table 10).

Catfish Fingerlings

Fingerlings were bought from commercial hatcheries at a cost of 1.3 cents per inch or 7.5 cents per fingerling. At an average stocking rate of 5,700 fingerlings per acre, annual purchases reached 273,600 fingerlings or 45,600 fingerlings per pond. Total fingerling cost was $20,520 per year, $3,420 per pond, or 8.22 cents per pound of fish produced (Table 10).

Harvesting and Hauling

The cost of harvesting and hauling consists of the charges imposed by the contract harvest crew on the catfish harvested and hauled to the processing plant. This cost item amounted to $12,480 per year, $2,080 per pond, or 5 cents per pound of fish harvested (Table 10).

Interest on Operating Capital

The cost of operating capital consists of the charges on all variable costs excluding harvesting, hauling, and interest on fish inventory at the current market interest rate for a period of 9 months. At an interest rate of 10% per year, the total cost of operating capital was $7,405 per year, $1,234 per pond, or 2.97 cents per pound of fish harvested (Table 10).

There are no interest charges on harvesting and hauling of fish. The harvest and hauling equipment and crew are owned and operated by the processing plant, and these costs are automatically deducted from the price received by farmers.

Labor

The total number of hours of operator and family labor employed in a 48-water-acre catfish farm was about 1,000 man-hours per year. The Mississippi average operator's wage rate, which includes the cost of workman's compensation and other benefits, was used in computing labor costs. At a wage rate of $7.10 per hour, total imputed labor cost would

Table 10. Annual variable costs of six 8-water-acre catfish ponds in multienterprise farms in the Mississippi Black Belt, 1996.

Item (unit)	Quantity	Unit cost	Total cost	Per pond	Per water acre	Per land acre	Per pound	Percent of total
Feed (tons)	224.64	231.000	51,891	8,648	1,081	897	0.2079	42.9
Fingerlings (pieces)	273,600.00	0.075	20,520	3,420	427	354	0.0822	17.0
Harvesting and hauling (pounds)	249,600.00	0.050	12,480	2,080	260	215	0.0500	10.3
Operating interest[1] (percent)	74,056.63	10.000	7,405	1,234	154	128	0.0297	6.1
Labor[2] (man-hours)	1,000.16	7.100	7,101	1,183	147	122	0.0285	5.9
Electricity (kWh)	68,352.00	0.087	5,952	992	124	102	0.0238	4.9
Repair and maintenance (dollars)			4,299	716	89	74	0.0172	3.6
Fuel (dollars)			4,276	712	89	73	0.0171	3.5
Chemicals (water acres)	48.00	62.000	2,976	496	62	51	0.0119	2.5
Inventory interest (percent)	23,831.04	10.000	2,383	397	49	41	0.0095	2.0
Miscellaneous[3] (dollars)			800	133	16	13	0.0032	0.7
Water quality analysis (pond)	6.00	63.000	378	63	7	6	0.0015	0.3
Liability insurance (dollars)			300	50	6	5	0.0012	0.2
Telephone expense (water acres)	48.00	5.160	247	41	5	4	0.0010	0.2
Total variable cost (dollars)			**121,010**	**20,168**	**2,521**	**2,093**	**0.4848**	**100.0**

[1]Charged for 9 months on all items except harvesting and hauling.
[2]Unpaid family labor.
[3]Includes costs associated with flavor testing, bird scaring, and office supplies.

be $7,101 per year, $1,184 per pond, or 2.85 cents per pound of fish harvested (Table 10).

Electricity

The local power company provided the monthly breakdown of electrical usage and costs for all farmers included in the survey. On average, the annual power consumption of the aerators was 1,424 kilowatt-hours per water acre. The cost of electricity used for aeration was $5,952 per year, $992 per pond, or 2.38 cents per pound, which represents 5% of total variable costs (Table 10). These costs also reflect the minimum monthly charges imposed by the power company. These charges vary depending on the distance of the ponds from power lines and cover a period of 5 or 7 years after the installation of the electrical connections to the ponds.

Repair and Maintenance

The annual cost of repair and maintenance was estimated from the replacement cost, repairs as a percent of replacement cost, and estimated economic life of farm equipment, electrical panel and meters, vegetative cover, and gravel (Tables 8-9). Repair and maintenance amounted to $4,299 per year, $716 per pond, or 1.72 cents per pound (Table 10). Farmers interviewed reported no renovation expenses on ponds and drainage structures built 10 years ago. The cost of repair and maintenance does not include repairs on ponds and drainage structures. Engle and Kouka (1996) reported that annual pond renovation in the Mississippi Delta ranged from $36 to $45 per acre.

Fuel

Fuel cost amounted to $4,276 per year, $713 per pond, or 1.71 cents per pound, which represents 3.5% of total variable costs (Tables 7-8). This expense item includes fuel consumed by the tractors, truck, feed truck, and outboard motor. The fuel consumption of the tractors, feed truck, and outboard motor was estimated from the monthly equipment-hour requirements and the average fuel consumption of each piece of equipment. The fuel consumption of the truck was computed from the monthly mileage used in the fish farm.

Chemicals

Fish farmers used a variety of farm chemicals to deal with water quality and off-flavor problems, including copper sulfate, lime, salt, and other chemicals. The annual expenditures on farm chemicals averaged $496 per pond, $2,976 per year, or 1.19 cents per pound (Table 10). These costs represent about 2.5% of total variable costs.

Interest on Fish Inventory

Keenum and Waldrop (1988) defined the cost of fish inventory as an enduring investment that must be accounted for annually. This item was included in the cost analysis of catfish production to account for the number of fish that remain in production ponds from one growing season to another. The authors' estimate of the cost of maintaining this inventory is equal to the interest charges on the investment in the purchase of the fingerlings.

In this study, the cost of fish inventory is treated as an opportunity cost of catfish production. The fish inventory consists of the catfish that remained in the ponds during harvest due to their size or evasion from capture. Pond seines are designed to catch market-sized fish but allow unmarketable-sized fish to remain in the ponds. In order to conserve water during harvest, ponds in the Mississippi Black Belt area are not drained. Consequently, some market-sized fish evade capture during harvest and remain in the pond. Although catfish ponds were harvested once or twice a year, a continuous fish inventory was kept in the ponds.

The number of undersized fish (less than 0.75 pound) remaining in the ponds after harvest can be estimated from stocking densities, mortality rates, and number harvested. The average stocking rate was 5,700 fingerlings per water surface acre. Annual harvest reported was 5,200 pounds, or 4,160 food-sized fish (at least 1.25 pounds) per water surface acre. At an assumed annual fish mortality of 5% (Keenum and Waldrop 1988), an average of 285 fish per acre die, and 1,255 fish per acre remain in the ponds on a continuous basis.

The change in inventory of undersized fish equals beginning inventory value less ending inventory value. The value of the inventory depends on the number and farm-gate prices of each size of fish remaining in the ponds after harvest. Assuming that the number and size composition of the fish remaining in the ponds after harvest are constant over time, then the change in inventory will depend primarily on the changes in the farm-gate prices of catfish. Since the current markets for catfish consider undersized fish as scrap, we can assume that the market value of fish weighing less than 0.75 pound is negligible. As fish farmers maintain the inventory of undersized fish in ponds, however, additional operating costs are incurred until the fish are harvested. For the purpose of this study, the average value of the continuous inventory of undersized fish in the ponds is equal to the average operating cost less the costs of harvesting, hauling, and operating capital. At a 10% annual interest rate, the interest on fish inventory would be $2,383 per year, $397 per pond, or 0.95 cents per pound of fish harvested (Table 10).

Miscellaneous

Miscellaneous expenses include costs associated with flavor testing, bird scaring supplies, and office supplies. Miscellaneous expenses averaged $800 per year, $133 per pond, or 0.32 cents per pound of fish harvested (Table 10).

Water Quality Analysis

The analysis of water quality in ponds was based on fees charged by consultants who routinely provide such services to the area. These charges amounted to $378 per year, $63 per pond, or 0.15 cents per pound (Table 10).

Liability Insurance

A reputable insurance company based in Jackson, Mississippi, estimated an annual premium of $300 for a 50-acre general farm liability insurance coverage of not more than $1 million. Since the workforce on these fish farms is less than five people, no workman's compensation insurance is required. In this study, however, workman's compensation and other benefits are included in the computation of labor costs.

Telephone

Telephone expenses are incurred by the fish farm in the procurement of farm supplies and equipment and marketing of fish. They amounted to $247 per year, $41 per pond, or 0.1 cents per pound (Table 10).

Annual Total Costs and Returns

Total cost of catfish production was estimated by summing the annual costs of variable and fixed inputs. Total variable cost includes the imputed cost of operator and family labor employed in catfish production. The total cost of producing catfish was $146,880 per year, $24,480 per pond, or 58.85 cents per pound of fish harvested (Table 11). It should be noted, however, that these cost estimates pertain to catfish production as one enterprise in a multienterprise farming operation. These cost estimates do not include the costs of fishpond renovation, catfish farm management, and construction and operation of water wells and pumps.

The annual cost estimates for catfish production are lower than those reported recently for catfish production in the Mississippi Delta. The lower cost of production is attributable to the nature of the catfish production systems in the Mississippi Black Belt area. Some farm-wide assets (e.g., management, building, tractor) are jointly used in several enterprises (catfish, crops), thereby reducing fixed cost. There were no pond renovation costs included in the variable cost of producing catfish in the Mississippi Black Belt area. For a 160-acre catfish farm in the Mississippi Delta, the average cost of pond renovation was $0.0103 per pound of fish harvested; management, $0.0071 per pound; and water supply, $0.0300 per pound (Engle and Kouka 1996).

At a stocking density of 5,700 6-inch fingerlings per acre and an annual mortality rate of 5%, the annual yield of marketable catfish was 5,200 pounds per acre, 41,600 pounds per pond, or 249,000 pounds per year (Table 11). Black Belt farmers generally received 5 cents less than the industry average farm gate price, which was about 77 cents per pound in 1996 (USDA 1997). At 72 cents per pound, total sales were $179,712 per year, $29,952 per pond, or $3,744 per water acre. Net returns from catfish production were $32,832 per year, $5,472 per pond, or $684 per water acre.

Table 11. Annual catfish sales, costs, and net returns from six 8-water-acre catfish ponds in multienterprise farms in the Mississippi Black Belt, 1996.

Item (unit)	Total	Per pond	Per water acre	Per land acre	Per pound
Catfish sold (lb/yr)	249,600	41,600	5,200	4,317	NA
Catfish sales ($/yr)	179,712	29,952	3,744	3,109	0.7200
Fixed cost ($/yr)	25,869	4,312	539	447	0.1036
Operating cost ($/yr)	121,011	20,168	2,521	2,093	0.4848
Total cost ($/yr)	146,880	24,480	3,060	2,541	0.5885
Net returns ($/yr)	32,832	5,472	684	568	0.1315

Sensitivity Analysis

Variations in the marketable yield of catfish, which affect costs and returns, may arise from changes in the occurrence of off-flavor and mortality rates due to diseases and bird predation. Off-flavor forces farmers to maintain an inventory of market-ready, food-sized fish. The direct costs of holding this inventory include the opportunity cost of delayed income, the additional feed costs, and the extra risk of maintaining the inventory (Sindelar et al. 1987). Kelly et al. (1991) reported that the ability to sell fish on time by most of the farmers in east Mississippi had been adversely affected by off-flavor problems. Off-flavor lasted between 3 and 4 months and occurred in about 50% to 75% of the ponds stocked with catfish. Results of pond yield verification studies in Arkansas showed an average 16% annual catfish mortality (Heikes and Killian 1997). Migratory birds – primarily cormorants, herons, and egrets – are becoming a serious problem among fish farmers in Mississippi and neighboring states.

Sensitivity analysis showed that the average cost of catfish production in the Mississippi Black Belt area responded to changes in mortality rates and occurrences of off-flavor (Table 12). Without any off-flavor and an average yield of 5,200 pounds per acre, average production cost was 58.85 cents per pound. When off-flavor occurred in all ponds for 3 months and average yield fell to 4,000 pounds per acre, for example, average production cost was 74.29 cents per pound.

Variations in feed cost and feed efficiency also affected the cost of catfish production in the Mississippi Black Belt area (Table 13). When feed cost was $200 per ton and gross feed conversion ratio was 1.4, for example, the average cost of catfish production was 51.38 cents per pound. The average production cost expanded to 72.27 cents per pound when feed cost increased to $300 per ton and gross feed conversion ratio rose to 2.2.

Table 12. Average total cost sensitivity analysis to variations in yield, survival rate, and occurrence of off-flavor in six 8-water-acre catfish ponds in multienterprise farms in the Mississippi Black Belt, 1996.

Marketable yield [1] (survival rate)	Average costs when 0% to 100% of ponds experienced off-flavor for 3 months				
	0%	25%	50%	75%	100%
	¢/lb	¢/lb	¢/lb	¢/lb	¢/lb
4,000 lb/A (78.16%)	68.47	69.92	71.38	72.84	74.29
4,400 lb/A (83.95%)	64.66	65.86	67.06	68.25	69.45
4,800 lb/A (89.39%)	61.50	62.44	63.38	64.32	65.26
5,200 lb/A (95.00%)	58.85	59.53	60.21	60.89	61.57

[1]Assuming a constant ending fish inventory of 1,255 fish per acre.

Table 13. Average total cost sensitivity analysis to changes in feed cost and gross feed conversion ratio in six 8-water-acre catfish ponds in multienterprise farm in the Mississippi Black Belt, 1996.

Feed cost	Average costs when gross feed conversion ratio ranged from 1.4 to 2.2[1]				
	1.4	1.6	1.8	2.0	2.2
	¢/lb	¢/lb	¢/lb	¢/lb	¢/lb
$200/ton	51.38	53.58	55.78	57.98	60.18
$225/ton	53.31	55.78	58.25	60.73	63.20
$250/ton	55.23	57.98	60.73	63.47	66.22
$275/ton	57.15	60.18	63.20	66.22	69.24
$300/ton	59.08	65.67	65.67	68.97	72.27

[1]Feed conversion ratio is the number of pounds of feed required to grow each pound of fish.

Summary, Conclusions, and Limitations

The need for area-specific economic information on catfish production becomes more critical as acreage devoted to catfish production in the Mississippi Black Belt increases. Economic studies conducted on catfish production at the Mississippi Delta and western Alabama cannot be applied with confidence to the Mississippi Black Belt farms due to major differences. This report aims to provide economic information pertaining to catfish production in the Mississippi Black Belt area.

Operational characteristics of farms with catfish enterprises were obtained from a survey of catfish farmers in the Mississippi Black Belt. Catfish production in the Black Belt occurs generally on highly diversified, or multienterprise family farms. Total acreage of the sample farms averaged 581 acres with 57.2 acres devoted to catfish production. Farms surveyed averaged six ponds covering 47.5 water acres devoted to catfish production. The average pond was 8.3 water surface acres and averaged 3.8 feet on the shallow end and 7 feet on the deep end. The size, shape, depth, and location of the ponds varied from one farm to another, depending on the topography of the land. Due to the high cost of constructing a deep well, catfish farmers primarily relied on surface runoff as a water source.

Investment requirements, ownership, and operating costs were estimated for a multienterprise farm consisting of crop or livestock production and two sets of three adjacent 8-water-acre catfish ponds. The average initial investment on a 48-acre catfish farm in the Black Belt area was $3,523 per water acre. The total cost of producing catfish was $3,060 per water acre or 59 cents per pound. At an annual marketable catfish yield of 5,200 pounds per water acre, total sales were $3,744 per water acre or 72 cents per pound. Net returns from catfish production were $684 per water acre or 13 cents per pound.

The budgets generated indicated that catfish production in a multienterprise farm is an economically viable form of farm organization in the Mississippi Black Belt. Sensitivity analysis showed that total costs are affected by high mortality rates due to bird predation or fish diseases and low marketable yields due to catfish off-flavor. Increases in feed costs and lower feed efficiency also adversely affected the economic viability of catfish production in the Mississippi Black Belt area.

The estimated costs of catfish production as one enterprise in a multienterprise farming operation in the Mississippi Black Belt are lower than those reported for catfish production in the Mississippi Delta. These estimates do not include the costs of fishpond renovation, catfish farm management and construction and operation of water wells and pumps.

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