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Economic Analysis of Channel Catfish Production in Ponds

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This study was designed to evaluate the economic analysis of channel catfish production in 1998 based on fish value and total feed cost. Catfish received higher protein feeds with lesser amount based on the dietary protein levels, but received the constant total protein input for all treatments.

Weight gain per pond for treatment 1 (28% protein, 100% of satiation) was higher ($P<0.10$) than for treatment 3 (36% protein, 77.8% of satiation), but not significantly higher than for treatment 2 (32% protein, 87.5% of satiation) at constant DE. At constant DE/P (treatments 4, 2 and 5), weight gain per pond for treatment 5 (36% protein, 77.8% of satiation) was lower ($P<0.10$) than for treatment 2, but not significantly lower than for treatment 4 (28% protein, 100% of satiation). At constant DE, feed conversion slightly improved as dietary protein level increased from 28% to 32% and feed allowance decreased by 12.5%, but did not improve further as dietary protein level increased from 28% to 36% and feed allowance decreased by 22.2%. At constant DE/P, feed conversion improved as dietary protein level increased from 28% to 32% increased and feed allowance decreased by 12.5%, but did not improve as dietary protein level increased from 28% to 36% and feed allowance decreased by 22.2%.

Total feed cost for treatment 1 was slightly, but not significantly higher than for treatments 2 and 3 at constant DE. At constant DE/P, total feed cost for treatment 5 was higher ($P<0.05$) than for treatment 2, but not significantly higher than for treatment 4. Total value of fish ($/ha) produced for treatment 1 was highest and lowest was for treatment 5.

Return above feed cost was highest for treatment 1 and nearly the same as treatment 2. Return over feed cost for treatments 3 and 4 were slightly lower than for treatments 1 and 2. Economic analysis showed that feeding fish the diet containing 28% protein and 3.08 kcal/g DE to satiation and the diet containing 32% protein and 3.08 kcal/g DE to 87.5% of satiation produced the highest profit to farmer.

Key words: Channel catfish, protein, DE/P, feed allowance, feed cost, economic analysis

Introduction

Protein is the most expensive component in making commercial feeds. Therefore, the production cost of many species may be much affected by dietary protein level in feed. Many studies were peformed to reduce protein portion in the feed to minimize its expense and recently, Robinson and Li (1997) showed that dietary protein content could be reduced to 24% for channel catfish when they were daily fed to satiation. Several factors affect the optimum amount of protein to use in channel catfish feeds. These include fish size, protein quality, dietary energy content, and feed allowance. And Li and Lovell (1992a, b) demonstrated that 28% protein was sufficient for maximum growth when channel catfish were fed as much as they would eat at each daily feeding, but that 32% or 36 % protein was necessary for maximum growth when channel catfish were fed to less than satiation.

However, feeding fish to satiation may cause less efficient feed conversiton (Minton 1978; Andrews 1979; Li and Lovell 1992a; Munsiri 1992). This is primarily because more feed is wasted when fish are fed to satiety each day. And wasted feed may deteriorate water quality and reduce catfish production (Tucker et al., 1979; Cole and Boyd 19 86; Li and Lovell 1992c). It is important to evaluate economic analysis of catfish production in considering fish value and several production costs, so it can be used to suggest the way to produce the highest benefit to farmer. However, none of above

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studies performed the economic analysis. The primary cost in fish production is feed. Therefore, both dietary protein content and feed allowance heavily influence on fish production cost.

This study was designed to evaluate the economic analysis of channel catfish grown at Auburn University in USA based on fish value and total feed cost in 1998.

Materials and Methods

An average fish weight of 16.7 g of catfish fingerlings were stocked in twenty 0.04-ha earthen ponds at a density of 13,750 fish/ha. A 2-m diameter of feeding ring made from 5-cm diameter black plastic pipe with a 20-cm deep plastic net attached around the perimeter of the ring was placed in each pond to retain the floating feed. A 0.25-kw lift-type aerator with time actuated switches was placed in each pond. Other experimental conditions were described in detail in a previous study (Cho, 1998).

The practical feeds were prepared by a commercial feed manufacturer. Table 1 gives the ingredient and nutrient composition of the experimental feeds. Feeds were similar to commercial feeds and prepared to contain three kind of protein (P) percentages (28%, 32%, or 36%) at constant and variable digestible energy (DE) concentrations. One group of feeds contained a constant DE, 3.08 kcal/g at each protein percentage. Another group contained 2.70, 3.08, and 3.41 kcal of DE per gram of feed at each protein percentage so that the digestible energy/protein (DE/P) would be the same. The feed containing 28% protein and 3.08 kcal/g DE was the control which was fed at satiation rate. Feed allowance for the control fish was increased by 10% every 3 to 5 days, based upon observed feeding activity. The daily allowance of all of the other feeds was based upon the amount of protein consumed by the control fish; all treatments received the same daily protein allowance. Thus, the fish fed with 32% protein feed received 12.5% less feed than the control and those fed with 36% protein feeds received 22.2% less feed than the control. The low-energy, 28% protein treatment received the same feed allowance as the high-energy 28% protein feed, which was the control. Each treatment was assigned to four replicate ponds. Feed was supplied between 17:30 and 19:00 daily.

To determine the value of the fish produced, the weight of fish produced was multiplied by the current price of live fish ($1.5/kg of fish) in 1998. The total feed cost was calculated by multiplying the total feed fed by the feed cost per kilogram. The return over feed cost to grower per hectare was calculated by subtracting the cost of total feed from the total value of the live fish harvested, then multiplying by 25 to convert yields from the 0.04-hectare ponds to 1 hectare.

Data were analyzed as a completely randomized design. Mean differences were tested using Duncans New Multiple range test (Duncan 1955). All statistical analysis was performed on SAS version 6.11 (SAS Institute, Cary, North Carolina).

Results

Weight gain

Table 2 gives survival rate, weight gain and feed conversion. There was no significant difference in

Table 1. Composition of the experimental diets

Component	Diets				
	1	2	3	4	5
Ingredient (%)					
Corn	46.8	36.3	26.6	34.2	17.6
Soybean meal	38.3	49.5	60.0	39.9	61.7
Wheat middlings	5.0	5.0	5.0	5.0	5.0
Fish meal	7.5	6.8	6.0	7.5	6.0
Catfish oil	1.0	1.0	1.0	0	8.3
Alfalfa meal	0	0	0	12.0	0
Dicalcium phosphate	1.4	1.4	1.4	1.4	1.4
Trace mineral mix[1]	0.01	0.01	0.01	0.01	0.01
Vitamin mix[2]	0.01	0.01	0.01	0.01	0.01
Vitamin C, stable[3]	0.05	0.05	0.05	0.05	0.05
Nutrient					
Crude protein (%)	28	32	36	28	36
Digestible energy (kcal/g diet)[4]	3.08	3.08	3.08	2.70	3.41
DE/P (kcal/g)	11.0	9.6	8.6	9.6	9.5
Total phosphorous (%)	1.03	1.01	0.91	0.92	0.87

[1] Trace mineral mix provided the following minerals per kg of feed: Zn, 150 mg; Fe, 44 mg; Mn, 25 mg; I, 5 mg; Cu, 3 mg; Co, 0.05 mg.

[2] Vitamin mix provided all of the following vitamins in the amounts presented per kg of feed: retinyl acetate, 4000 IU; vitamin D_3, 2000 IU; alpha tocopherol acetate, 50 mg; menadione, 10 mg; choline chloride, 500 mg; niacin, 80 mg; riboflavin, 12 mg; pyridoxine, 10 mg; thiamin, 10 mg; pantothenic acid, 32 mg; folic acid, 2 mg; vitamin B_{12}, 8 g; ethoxyquin (antioxidant), 125 mg.

[3] Ascorbyl-1-phosphate, contains 15% vitamin C.

[4] Digestible energy was calculated from tabular values of the feed ingredients (National Research Council, 1993).

survival rate among treatments (P<0.10). Mean survival rates for all treatments were over 90%. Weight gain per pond for treatment 1 (28% protein, 100% of satiation) was higher (P<0.10) than for treatment 3 (36% protein, 77.8% of satiation), but not significantly higher than for treatment 2 (32% protein, 87.5% of satiation) at constant DE. At constant DE/P (treatments 4, 2 and 5), weight gain per pond for treatment 5 (36% protein, 77.8% of satiation) was lower (P<0.10) than for treatment 2, but not significantly lower than for treatment 4 (28 % protein, 100% of satiation). Feed conversion slightly improved as dietary protein level increased from 28% to 32% and feed allowance decreased from 100% of satiation to 87.5% of satiation, but did not improve further as dietary protein level increased from 28% to 36% and feed allowance decreased from 100% of satiation to 77.8% of satiation at constant DE. At constant DE/P, feed conversion improved as dietary protein level increased from 28% to 32% and feed allowance decreased by 12.5%, but did not improve further as dietary protein level increased from 28% to 36% and feed allowance decreased by 22.2%.

Economic Analysis

Table 3 shows an economic analysis (total feed cost, total value of fish produced and return over feed cost) of fish production in this study. Feed cost increased as dietary protein level increased. Feed costs per kg for diets 1 and 4 containing 28% protein were $0.34 and $0.35, respectively. And feed cost per kg for diet 2 containing 32% protein was $0.36. Feed costs per kg for diets 3 and 5 containing 36% protein but diet 5 contained 7.3% additional fat to increase DE were $0.39 and $0.44, respectively. Because feed allowance was based upon protein content in the diet, total feed cost decreased as protein percentage increased except for treatment 5.

Total feed cost for treatment 1 was slightly, but not significantly higher (P>0.05) than for treatments 2 and 3 at constant DE. At constant DE/P, total feed cost for treatment 5 was higher (P <0.05) than for treatment 2, but not significantly higher than for treatment 4. Total value of fish ($/ha) produced for treatment 1 was highest, $5,158 and lowest was $4,437 for treatment 5.

Return above feed cost ($/ha) was highest for treatment 1, $3,524 and nearly the same as

Table 2. Means for survival rate (%), weight gain per pond (kg/pond), and feed conversion (weight gained/feed fed) of channel catfish fed experimental diets containing variable protein and energy levels in earthen ponds[1]

	Treatments				
	1	2	3	4	5
Protein (%)	28	32	36	28	36
Digestible energy (kcal/g)	3.08	3.08	3.08	2.70	3.41
Feed allowance (%)	100	87.5	77.8	100	77.8
Item:					
Survival rate (%)	94.4[a]	94.0[a]	93.5[a]	91.0[a]	89.5[a]
Initial weight (g/fish)	10.6	10.6	10.6	10.6	10.6
Final weight (g/fish)	282.9	278.6	250.9	273.6	259.7
Weight gain (kg/pond)	137.6[a]	134.9[a]	119.9[b]	127.6[ab]	118.3[b]
Feed conversion (weight gained/feed fed)	0.717[ab]	0.768[a]	0.773[a]	0.668[b]	0.753[a]

[1] One pond was excluded because of poor feeding activity and disease.
Pooled SE for survival rate, weight gain and feed conversion were 4.7, 8.87 and 0.02, respectively.
Different superscript letters mean significant difference (P<0.10).

Table 3. Economic analysis of five feeding regimens: return per hectare above feed costs

	Treatments				
	1	2	3	4	5
Protein (%)	28	32	36	28	36
Digestible energy (kcal/g)	3.08	3.08	3.08	2.70	3.41
Feed allowance (%)	100	87.5	77.8	100	77.8
Item:					
Weight gain (kg/ha)	3,439.2	3,371.9	2,996.3	3,190.0	2,958.1
Feed fed (kg/ha)	4,815.0	4,392.5	3,882.5	4,777.5	3,927.5
Feed cost ($/kg)	0.34	0.36	0.39	0.35	0.44
Total feed cost ($/ha)	1,634.7[ab]	1,588.3[b]	1,532.0[b]	1,648.2[ab]	1,728.5[a]
Total value of fish1 ($/ha)	5,158.8	5,057.8	4,494.4	4,785.0	4,437.2
Return over feed cost ($/ha)	3,524.1[a]	3,469.5[a]	2,962.3[ab]	3,136.8[ab]	2,708.7[b]

[1] Price received for fish at farm; $1.50/kg.
Means in rows with same superscript letter are not different at P<0.05.

treatment 2, \$3,469. Return over feed cost for treatments 3 and 4 were \$2,962 and \$3,136, respectively and slightly but not significantly lower than for treatments 1 and 2 ($P<0.05$). Return over feed cost for treatment 5 was lowest, \$2,708.

Discussion

Weight gain per pond for treatments 1 (28% protein, 100% of satiation) and 2 (32% protein, 87.5% of satiation) were higher than for treatment 3 (36% protein, 77.8% of satiation) at constant DE. At constant DE/P, weight gain per pond for treatment 2 was higher than for treatment 5 (36% protein, 77.8% of satiation) and slightly higher than treatment 4 (28% protein, 100% of satiation).

Minton (1978) reported that channel catfish fed from fingerling to harvest size in ponds at 87.5% of satiation rate gained as much weight as fish fed to satiation and showed improved feed conversion with both 30% and 36% protein diets. However, as feed allowance decreased to 75%, weight gain was significantly reduced at 30% protein but not at 36% protein. Also, Andrews (1979) found that weight gain of channel catfish fed 90% of control, which was satiate feeding, was not significantly different from that of control but was significantly lower than that of fish fed 50, and 75% of control. Li and Lovell (1992a) showed that weight gain of channel catfish grown in ponds increased as dietary protein content increased from 26% to 38 % under restricted feeding, but under satiate feeding, weight gain of fish did not increase as dietary protein level increased from 22% to 38%.

When the feeder attempts to feed fish to satiation, feeding fish in small experimental ponds does not result in significant amounts of wasted feed, but feeding in commercial ponds can often result in a large amount of wasted feed. This may dramatically increase fish production cost. In this study, as dietary protein level increased from 28% to 32% and feed allowance decreased from 100% of satiation to 87.5% of satiation, feed conversion improved, but as dietary protein level increased from 28% to 36% and feed allowance decreased from 100% of satiation to 77.8% of satiation, feed conversion did not improve at constant DE and constant DE/P because of poor growth in the catfish fed 36% protein diets. Feeding higher levels of protein and DE in diets for channel catfish improved feed conversion (Page and Andrews 1973; Reis et al., 1989). And Li and Lovell (1992a) showed that feed efficiency ratio was lower under satiation feeding than under restricted feeding. Munsiri (1992) found that improving protein quality improved weight gain and feed conversion of channel catfish under both satiate and restricted feeding. Robinson and Li (1997) showed that feed conversion ratios for 28% and 24% protein diets in channel catfish were significantly better than those for 20% or 16% protein diets.

Feed cost increased as dietary protein content increased in this study. Feed costs per kg for diets 1 and 4 containing 28% protein were \$0.34 and \$0.35, respectively. And feed cost per kg for diet 2 containing 32% protein was \$0.36. Feed costs per kg for diets 3 and 5 containing 36% protein, but diet 5 contained 7.3% additional fat to increase DE were \$0.39 and \$0.44, respectively, which explain the higher cost. Because feed allowance was based upon protein content in the diet, total feed cost decreased as dietary protein content increased except for treatment 5. Total feed cost for treatment 1 was slightly, but not significantly higher than for treatments 2 and 3 at constant DE. At constant DE/P, total feed cost for treatment 5 was higher than for treatment 2, but not significantly higher than for treatment 4. Total value of fish produced for treatment 1 was highest and lowest was for treatment 5. Only feed cost was considered as catfish production cost in this study. But electricity utility in operating aerators and labor costs because of more labor cost spent to feed fish to satiation everyday should be considered to get the complete economic analysis.

Return above feed cost was highest for treatment 1 and nearly the same as treatment 2. Return over feed cost for treatments 3 and 4 were slightly lower than for treatments 1 and 2. Return over feed cost for treatment 5 was lowest.

These results showed that treatments 1 (28% protein, 3.08 kcal/g DE, 100% of satiation) and 2 (32% protein, 3.08 kcal/g DE, 87.5% of satiation) were the most profitable to farmer.

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