No. 1364 Information Sheet August 2015

Feed Conversion Ratio for Pond-Raised Catfish

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Introduction

Feed conversion ratio (FCR) is a measure of how efficiently an animal converts feed to body mass, and it is determined by dividing the weight of feed fed by live weight gain over some time interval (feed/gain). Catfish grown from fingerlings to marketable size (about 1.5 pounds) in research ponds routinely exhibit an FCR of 1.8:1 or less. While this ratio may be achieved on an individual commercial catfish farm, it is rare. Averaged over the catfish industry as a whole, the farm-level FCR (feed fed divided by fish sold) is significantly higher, with a 5-year average of about 2.5. In this report, we will briefly examine various topics concerning FCR of farmed catfish.

FCR in farmed fish

Fish are generally more efficient in utilizing feed than most other farmed animals. The primary reason for this efficiency is that maintenance energy requirements are lower for fish than for warm-blooded animals. There are four reasons for the decreased energy requirements: (1) fish do not have to maintain a constant body temperature; (2) they expend less energy to maintain their position; (3) energy losses in urine and gill excretions are lower; and (4) the increase in energy cost associated with the assimilation of ingested food is less. So, the less energy needed for maintenance, the more that can be used for growth.

In our work with catfish, we typically get a FCR of 1.8 or less in fish grown to a marketable size of about 1.5 pounds. Similar values are typical for tilapia. However, FCR values for Atlantic salmon and rainbow trout are generally about 1.0 to 1.2, mainly because salmon and trout feeds contain more protein, much more fat, and less fiber.

Fingerling catfish convert feed at 1.0 to 1.2, but, as they grow, efficiency declines. When comparing FCR values among studies with various fish or other animals, diet composition and quality, as well as culture practices, should be considered because they impact FCR. These factors could lead to an incorrect conclusion about the feed efficiency of a specific fish species.

Importance of FCR

Historically, feed cost has accounted for about 50% of variable operating costs in commercial catfish culture in the United States and presently is closer to 60%. Thus, the efficiency with which catfish convert feed to body mass is perhaps the single most important factor in determining profitability. The impact of FCR on production costs can be

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seen in Table 1, which presents the cost of raising a pound of fish at varying feed prices and FCR values.

Assuming that current federal energy policies and competition for feedstuffs among farmed-animal industries continue, a decrease in catfish feed prices is unlikely. Catfish feed prices will probably remain in the range of $400 to $500 per ton. Using a farm level FCR of 2.5, which is a 5-year industry average using the numbers reported for feed sold and fish processed, the feed cost of raising a pound of catfish is between 50 and 63 cents. If using the middle of this range ($450 per ton), the feed cost for raising a pound of catfish would be 56 cents.

Given current market conditions and considering other production costs, high feed cost makes it difficult, if not impossible, to make a profit. If the average farm-level FCR could be reduced from 2.5 to 2.0 (assuming feed at $450 per ton), it would cut the feed cost of producing a pound of catfish to 45 cents, a reduction of about 20%.

In addition to its direct economic impact, FCR reflects the overall efficiency of the culture system. That is, since catfish are highly efficient in using commercial catfish feeds, if the FCR increases dramatically, it typically indicates that there are issues beyond biological efficiency that may be responsible.

Table 1. Feed cost in cents per pound of catfish produced at different feed conversion ratios (FCR) and feed prices.

FCR	Feed price in dollars per ton (cents per pound in parenthesis)						
	300 (15.0)	350 (17.5)	400 (20.0)	450 (22.5)	500 (25.0)	550 (27.5)	600 (30.0)
1.5	23	26	30	34	38	41	45
1.6	24	28	32	36	40	44	48
1.7	26	30	34	38	43	47	51
1.8	27	32	36	41	45	50	54
1.9	29	33	38	43	48	52	57
2.0	30	35	40	45	50	55	60
2.1	32	37	42	47	53	58	63
2.2	33	39	44	50	55	61	66
2.3	35	40	46	52	58	63	69
2.4	36	42	48	54	60	66	72
2.5	38	44	50	56	63	69	75
2.6	39	46	52	59	65	72	78
2.7	41	47	54	61	68	74	81
2.8	42	49	56	63	70	77	84
2.9	44	51	58	65	73	80	87
3.0	45	53	60	68	75	83	90
3.1	47	54	62	70	78	85	93
3.2	48	56	64	72	80	88	96
3.3	50	58	66	74	83	91	99
3.4	51	60	68	77	85	94	102
3.5	53	61	70	79	88	96	105

Factors Affecting FCR

Since FCR is based on weight gain, any factor that affects weight gain impacts FCR, and that could potentially be any culture practice. Some of the more important factors to consider are feeds, feeding, genetics, environment, and fish health, size, and body composition.

Fish health

It is reasonable to assume a healthy animal converts feed more efficiently than a sick one. However, diseased catfish feed poorly, if at all, so lack of feed ingestion is really the issue. In fact, feed is often withheld for a short time when certain diseases occur, and feeding is resumed as the disease recedes. In some instances, medicated feed may be used with the assumption that some marginally sick fish may eat and thus recover. Also, in a population of catfish experiencing a disease episode, there are individuals that are not sick and consume feed normally and convert efficiently.

Mortalities that occur during a disease outbreak are lost gains that contribute to the inflated farm-level FCR and decrease profitability. Fish mortality may be the major cause of FCRs greater than 2:1. Overall weight gain and FCR are negatively impacted during disease episodes, but the actual cost associated with the occurrence is difficult to quantify.

Genetics

In most animal industries, genetics play an important role in developing strains that grow rapidly and convert feed more efficiently. In recent years, various catfish strains have been developed that actually show a significant improvement in weight gain as compared with strains generally used in catfish production. Typically, research with these new strains has demonstrated that this improved gain is associated with increased feed ingestion rather than an improvement in feed efficiency. The fish are simply more aggressive and consume more of the feed offered, but they convert at rates similar to commonly used strains. However, this trait could indirectly reduce FCR by shortening the production cycle and thus reducing overall mortality.

Some reports indicate that hybrid catfish (cross between channel catfish females with blue catfish males) are more efficient in utilizing feed, but there are conflicting reports. Even so, genetics is an important tool with potential to improve various characteristics in catfish, including FCR.

Environment

Fish raised in an optimum environment obviously convert feed more efficiently than those raised under less than ideal conditions. Commercially raised catfish are exposed to various stressors, particularly extremes in water temper-

ature. For example, catfish raised in earthen ponds in the Southeast are exposed to water temperatures from near freezing to as high as 100°F in a typical year. It has been demonstrated that high temperatures decrease growth of channel catfish in large part due to decreased feed consumption, higher FCR, and an increase in activity. Also, when the temperature during cool months falls to somewhere near 70°F, feeding is erratic; at 50°F or below, it slows dramatically or stops completely.

There are reports of high FCR values (6:1 or higher) from catfish raised during the winter in ponds, but these do not represent the true FCR because most of the feed was likely uneaten. The effect of winter temperatures on FCR is more of an academic interest because catfish are fed minimally during winter months, if at all.

Given the volume of water in commercial catfish ponds, most environmental factors cannot be controlled economically. Some potential stressors, such as low levels of dissolved oxygen (D.O.), can be managed somewhat by using aeration and good husbandry practices, such as stocking at reasonable rates, feeding carefully, and controlling algae blooms.

Fish size and body composition

An underlying principle in animal production is that young, smaller animals grow faster and utilize feed more efficiently than older, larger animals. The primary reason smaller animals are more efficient in utilizing feed is that rapid gains exhibited by young, smaller animals are generally lean (protein) gains that have less than half of the energy density compared with body fat, so it is more efficient to deposit a pound of lean tissue versus a pound of fat. The effect of fish size on FCR has been demonstrated in catfish in numerous studies (for example, see Figure 1) and on commercial catfish farms.

If the size of catfish processed for marketing was based strictly on feed efficiency, the smaller, marketable-size fish (0.75 to 1.25 pounds) would be the most economical choice. However, the average size of fish processed by the industry has increased over the past 15 years. In addition to reduced feed efficiency, growing larger fish also requires the fish be kept in the pond longer, which increases the chances that more mortality will occur, resulting in increased FCR.

Feeds

Catfish feeds are relatively simple in composition, typically composed of a mixture of a few feedstuffs supplemented with vitamins, minerals, a little fat, and sometimes the amino acid lysine and/or the enzyme phytase. However, they are complex in regard to nutrient and energy content because they must provide some 40 nutrients and energy in a palatable and digestible form necessary for rapid growth and good health of catfish.

Therefore, modern feeds are formulated to be nutritionally complete and balanced so catfish can efficiently utilize them for rapid growth. However, the quality of feedstuffs used, as well as pellet quality, can affect FCR. That is, feedstuffs should be of sufficient quality to ensure the feed is energy and nutrient dense, is low in fiber, and has desirable physical characteristics. Further, they are manufactured into water-stable pellets that float on the water surface and are highly palatable and digestible.

Regardless of which brand of catfish feed is used, commercial producers can expect a good-quality feed that can be efficiently converted by catfish. Often when FCR is higher than expected, the feed is suspected as the problem. But, given that commercial catfish feeds are designed specifically for catfish, and that feeds are similar in composition, factors other than feed are generally causing the problem.

Feeding

Feeding is perhaps the single most important task on a catfish farm, particularly given the high cost of feed today. The actual act of feeding catfish is relatively simple in that feed is blown onto the surface of the pond, but what makes it a bit more complicated is judging how much to feed to satiate the fish without wasting feed. This decision is difficult on a large commercial operation with many ponds to feed. It is a highly subjective process, in which the feeder decides how much to feed based on mostly subjective criteria.

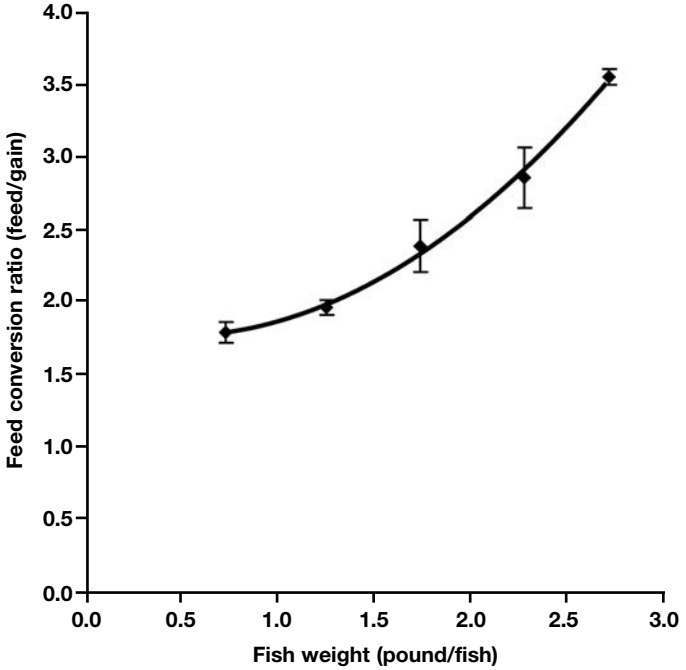

Figure 1. Relationship of feed conversion ratio and body weight of pond-raised channel catfish. Data are from a study conducted with small experimental ponds.

If fish are overfed and feed is wasted, FCR will increase dramatically. If they are somewhat underfed, feed efficiency is increased but generally live yield is decreased. However, severe feed restriction will increase FCR because most of feed ingested goes to maintenance, rather than growth.

There may be no one "best" way to feed catfish. Some producers feed an allotted amount on days fed, and others try to feed all the fish will eat. This is a choice based on the economics of individual farms, but one thing that should be done regardless of feeding strategy is to use an experienced person to feed.

Research Versus Farm-Level FCR

Numerous research studies have demonstrated that catfish grown to a marketable size convert feed efficiently. In research ponds, we typically get an FCR of 1.8 or less for catfish raised from fingerlings to a size of 1 to 1.5 pounds; conversely, the average farm-level FCR over the catfish industry is 2.6. There are many reasons for this discrepancy, and, in large part, it is simply due to the scale on which commercial catfish are cultured.

Because of the smaller size of ponds used in research, the environment—at least dissolved oxygen concentrations—can be more easily controlled. In addition, feeding is more precise in research conditions, and, in some cases, uneaten feed can be accounted for. Also, mortalities can generally be accounted for, and weight is sometimes included in the calculation of FCR. Further, most research is based on an annual growth cycle, in which the fish are clean harvested and the ponds drained so all fish are accounted for.

Researchers fare little better than catfish producers when research projects are conducted on a scale similar to that used in commercial catfish culture. That is, when we conduct feeding trials in large ponds over multiple years, topping fish and under stocking with fingerlings, FCR values increase. Research FCR values obtained under semi-controlled environments closely reflect the physiological efficiency catfish are capable of in converting feed. Actually, feed consumed by healthy fish raised in commercial ponds is basically converted as efficiently as feed consumed by fish raised in a research environment, but this efficiency is lost through primarily unaccounted mortalities, wasted feed, and delayed harvest that results in fish too large for efficient feed utilization (over 3 pounds or so).

Regardless of the reasons for the inflated farm-level FCR, it is the economic reality. We know catfish are capable of converting commercial catfish feeds efficiently and the farm-level FCR needs to be improved, but that it is easier said than done. To begin to make changes, we must evaluate what can be done on a commercial scale to improve FCR.

One thing to note is that feed is generally not the issue. All commercial feeds are similar in composition, regardless of manufacturer, and they are efficiently utilized by the fish.

Some suggestions to improve FCR include keeping controllable environmental factors in recommended ranges by providing adequate aeration, stocking at reasonable rates, stocking as large a fingerling as economically possible, using a "single-batch" cropping system, harvesting more often to remove large fish if multiple-batch is used, and feeding carefully to avoid wasted feed. There are anecdotal reports of producers who follow these suggestions and achieve a 2:1 FCR over their farms.