Insurance Program Development for Catfish Margin Protection

D15PD00514 Data gathering report

Acquisition Services Directorate
and
Risk Management Agency

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A report for
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TABLE OF CONTENTS

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LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

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EXECUTIVE SUMMARY

The 2014 Farm Bill (Agricultural Act of 2014) instructed the Federal Crop Insurance Corporation (FCIC) to contract with an entity to conduct research and development toward a gross margin insurance program for catfish producers.

This data gathering report includes findings and analysis in response to the required statement of work for this project.

The gross margin insurance concept was shared with producers and other industry participants at listening sessions in Stoneville, Mississippi and Greensboro, Alabama in July 2015. Their feedback was solicited and incorporated in this report.

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Livestock gross margin (LGM) programs help insure producers against loss of gross margin, i.e., when the difference between market prices for their products and the cost of their key inputs (generally feed) narrow so much as to threaten or lead to widespread producer losses.

Other livestock gross margin plans offered by Risk Management Agency (RMA) rely on futures markets to determine estimated prices for products and inputs (feed) in order to calculate gross margin guarantees for insurance purposes. Unfortunately, there are neither futures for catfish feed nor for catfish. Solutions to these data challenges are reviewed in this report:

- Future catfish feed prices could be estimated using a least cost formulation that relies on futures prices of key ingredients as inputs. These estimated prices are likely useful only for short-term time horizons (a year or less), given the fact that futures for ingredients beyond one year are thinly traded, if at all, and their prices are highly volatile.
- Estimating future catfish prices, however, presents a greater challenge. An assessment of an econometric model used for this purpose by the Livestock Revenue Protection (LRP)-Lamb program, along with a review of a similar proposed model for catfish, suggest that this type of model would perform poorly in providing useful estimates of future catfish prices.

We concluded that this approach would not result in an actuarially sound program.

We further investigated three alternatives to the initial methodology:

- **Alternative 1 – Use an econometric model anyway** - The first alternative is one where an acceptable econometric model is developed. In this case, future prices for catfish and futures prices for feed could be used to provide "short" (<12 month) policies to guarantee some percentage of the expected gross margin.

  This alternative presents multiple challenges, including an inability to match feed purchases (costs) with catfish sales (revenue); an inability to cover the full growout cycle of the catfish; and the lack of a basis for assigning target marketings (the amount farmers are allowed to insure).
- **Alternative 2 – Use prior prices to forecast future prices** - A second alternative is using prior prices to predict future prices, with either a six month or full year lag. This alternative exhibited substantial error, indicating it would likely over-project the price and encourage growers to oversupply the market, inducing the precise pressure on margins the program is supposed to be alleviating.

- **Alternative 3 – Feed spike insurance** - The third alternative would not fall under a gross margin approach. Rather than protect against loss in margin, it would simply hedge on producers' behalf against sharp feed price increases. With this alternative, a synthetic "feed bundle" could be constructed using feed ingredient prices and allow RMA to insure the price of feed in the current or upcoming growing season. This would be little different, however, from catfish farmers hedging their feed costs themselves, or hedging by booking feed in advance, as many already do.

After careful review, we conclude that there are key data challenges and actuarial concerns that cannot be overcome. We are also concerned that a program could distort the catfish market and be vulnerable to adverse selection and moral hazard.

In order to develop an effective program that can be administered by RMA, there needs to be a clear methodology and data available. While a model using feed ingredient futures could generate short-term feed price forecasts, there is no viable source of future prices for catfish. And while alternative future prices could be defined, the actuarial rating, if set formulaically, may cause adverse selection in the program.

The challenges of creating a program for which insureds would be willing to pay, but that would not distort the market supply are significant. The current LGM programs without subsidy have almost no participation while the LGM-Dairy program sells out quickly. We do not believe there would be significant participation in the program without a large subsidy (or only in scenarios advantageous to the growers). If the participation is low, the cost to RMA of maintaining a program would be too high in relation to the benefits provided. If the subsidy were too high, this may distort the supply curve.

We recommend that RMA not try to develop a margin protection plan for catfish.

1. OBJECTIVES AND METHODOLOGY

1.1. Farm Bill requirement

The 2014 Farm Bill instructed the Federal Crop Insurance Corporation (FCIC) to contract with an entity to conduct research and development toward a gross margin insurance program for catfish. Development of the program would take place if the Board agrees it is likely result in a viable, marketable insurance program that adequately protects the interests of producers. The language from the Farm Bill is as follows:

> **SEC. 11022. RESEARCH AND DEVELOPMENT PRIORITIES.**
> (a) AUTHORITY TO CONDUCT RESEARCH AND DEVELOPMENT, PRIORITIES.—Section 522(c) of the Federal Crop Insurance Act (7 U.S.C. 1522(c)) is amended—
> …
> "(17) MARGIN COVERAGE FOR CATFISH.—
> "(A) IN GENERAL.—The Corporation shall offer to enter into a contract with a qualified entity to conduct research and development regarding a policy to insure producers against reduction in the margin between the market value of catfish and selected costs incurred in the production of catfish.
> ''(B) ELIGIBILITY.—Eligibility for the policy described in subparagraph (A) shall be limited to freshwater species of catfish that are propagated and reared in controlled or selected environments.
> ''(C) IMPLEMENTATION.—The Board shall review the policy described in subparagraph (B) under section 508(h) and approve the policy if the Board finds that the policy—
> ''(i) will likely result in a viable and marketable policy consistent with this subsection;
> ''(ii) would provide crop insurance coverage in a significantly improved form;
> ''(iii) adequately protects the interests of producers; and
> ''(iv) meets other requirements of this subtitle determined appropriate by the Board.

Agricultural Act of 2014, H.R. 2642, pp. 321-22

1.2. Objective & scope

Objectives and scope of the project were identified in the solicitation. These are reproduced below.

1.2.1. Objective

The objective of this contract is to provide information and analysis to aid in the potential development of a crop insurance program for catfish producers that will stabilize the margin between rising selected costs incurred in the production of catfish and the market value of catfish.

The contractor shall produce a data gathering report that identifies any issues related to insuring catfish producers, and the most viable type of insurance plan to be developed. This data gathering is to be utilized in the actual development of a plan of insurance.

If deemed feasible, the contractor's further objectives are to develop a pilot program, that:

1) Provides meaningful and timely risk management benefits to producers without distorting markets;
2) Is cost effective from the perspective of insured producers;
3) Is actuarially sound so that premium rates will cover expected losses plus a reasonable reserve;
4) Is able to be administered given the structure and resources of RMA and approved insurance providers; and
5) Demonstrates sound program integrity.

Any development submitted to the FCIC Board of Directors for approval must adhere to the format provided in Section 2.4.2. The contractor may be required to serve as a resource when RMA presents the developed program to the FCIC Board of Directors when seeking its approval to offer it as a pilot program. If the program is approved for implementation, the contractor shall provide a training package.

1.2.2. Scope

The contractor shall gather data, provide analyses, and prepare a report that encompasses the objectives in Section 2.2. The contractor shall develop an insurance program if RMA deems it is feasible. Any potential insurance programs shall meet the following criteria and the criteria for development shall include the following rationale:

1) Conform to RMA's enabling legislation, regulations, and procedures that cannot be changed;
2) Charge a premium that the insureds must be willing to pay for the insurance;
3) Be effective, meaningful and reflect the actual risks of producers;
4) Have best management practices that can be defined, required of an insured and be monitored;
5) Identify and appropriately categorize perils affecting production and/or revenue as insurable and non-insurable;
6) Be ratable and operable in an actuarially sound manner;
7) Contain underwriting, rating, pricing, loss measurement, and insurance contract terms and conditions;
8) Be an appropriate geographic distribution of production to ensure a sound financial insurance program;
9) Produce enough interest for the risk to be spread over an acceptable pool of insureds;
10) Not allow insureds to select insurance only when conditions are adverse;
11) Avoid or mitigate moral hazards; and,
12) Not allow a change in market behavior or market distortions that change the quantity supplied or shift the supply curve.

Both objectives and scope are revisited in Section 9 of this report.

1.3. Methodology

1.3.1. Project

The project itself was set up to take place in multiple stages:

- Data gathering report (this report);
- Draft and Final Development Submission Packages;
- Expert Review Comments for Development; and
- Training Package

1.3.2. Data gathering report

The steps taken to prepare for and develop this data gathering report were as follows:

- Kickoff meeting with RMA
- Data gathering and review
- Listening session planning
- A review of other gross margin plans and other plans that could be instructive in developing a catfish margin plan
- Conferring with subject matter experts, particularly on issues related to catfish data availability, prevailing feed composition, and feeding patterns.
- Conducting listening sessions in both Mississippi and Alabama, visiting production facilities, and meeting with experts
- Further data gathering, review, and summary of key issues in response to the Statement of Work
- Consideration of ways a catfish margin insurance program might be structured
- Actuarial review of data;
- Development of conclusions and recommendations; and
- Finalizing the report.

2. LISTENING SESSIONS

This section summarizes the listening sessions and includes additional information required by the Statement of Work. Several of the topics discussed are areas fleshed out in more detail later in this report.

Venues. The listening sessions were held at the National Warmwater Aquatic Center (NWAC) at the Delta Research and Aquatic Center (DREC) at Mississippi State University in Stoneville, Mississippi on July 9th, and at the Alabama Fish Farming Center (AFFC) in Greensboro, Alabama, on July 10th. In addition to the listening sessions, we spent July 8th meeting with experts at the DREC and visiting a catfish farm and hatchery, and on July 9th we also visited the DREC's own indoor facilities and catfish ponds.

Attendance. Both sessions were well attended. The Stoneville listening session had almost 35 people: three RMA extension representatives, 14 catfish growers, three processors, five individuals from FSA/RMA, one insurance representative, four representatives from the Catfish farmers of America and the Catfish Institute, one catfish feed producer, and three others. One observer commented that over one-third of all catfish production was represented in the room.

Over 25 attended in Greensboro: six catfish growers, three insurance agents, two processors, two government representatives, one catfish feed producer, one industry representative, one extension officer, five bankers, a journalist, and four others.

We conferred with industry experts ahead of the listening sessions and determined that it would be helpful to arrive with a practical example, however imprecise, to help explain how livestock gross margin insurance programs work and what it might look like in the case of catfish. We prepared a handout, distributed at the listening sessions (and included as appendix A which provided a basis for discussion. In our example, we provided time series for catfish prices and for catfish feed, and a second graph plotting the difference (the average industry margin).

2.1. Potential interest in insurance on the part of producers and insurance providers

At each session, we began with introductions and an explanation of how the LGM program works in principle, i.e., covering industry margin as opposed to on-farm perils. In each case, this was a point we had to reinforce. We also reviewed historic gross margins with the attendees.

Given the roughly 50c/pound average gross margin for catfish in recent years, we explained that a gross margin policy for catfish might cover margins at the 40 cent per pound level, with variations. We asked what farmers thought of the general concept.

In Stoneville, one attendee reflected the room, saying, "At a price, definitely interested". "Anytime you can take the risk out, people will be more comfortable staying in it." One farmer with significant production said, "At 80 cents margin, people would be interested. At 40 cents, I wouldn't be interested."

In Alabama, there was no response as to whether such an insurance mechanism would be acceptable or not. The group was skeptical. "There are so many variables…I don't know whether I'd be interested or not," one farmer said.

At the Alabama session, there was widespread concern with the LGM program's capacity to include catfish policies, its ability to pay indemnities, and skepticism about the scale of support the industry would get in the event of narrowing margins. The farmers zeroed in with great concern and interest on exactly how much of a subsidy there would be in the premiums for the program. Several were skeptical as to why a program would be helpful, wondering how it would differ from them saving on their own. Examples of feedback included:

- "What is the financial benefit? Basically it's just averaging our margins over the long term."
- "If everybody has a claim, there's not going to be any money to pay out…if we're paying a premium, then all we'll be doing is getting our premium back…plus 1-1/2 cents from the government."
- "Unless somebody is investing profitably the premiums that the farmers are paying in when everything's good, I don't understand [what the benefit would be]."
- "All we're doing is we're investing money in this program, it's going to average the highs and the lows, but all the money we're going to get back is the money we paid into it. There is no free lunch."
- "We could put that money in a savings account…same thing."
- Over what time period are we assessing that margin? Last twenty years? Last year? Last four years? If you set the margin based on the last four years, even if counting last year, the previous three years don't make it worthwhile.

2.2. Risks that affect producers

Attendees identified multiple risks faced by catfish farmers. The primary risk noted was power outage, which reduces available oxygen and quickly leads to fish death. Others included new diseases (in recent years, Aeromonas hydrophila), feed costs, and depredation from birds. Bird depredation impacts farmers differently; it appears to be growing worse. Alabama farmers also spoke of algae problems: "algae release a toxin and the pond goes belly up. This doesn't seem to happen in the Delta."

Another risk faced by farmers is difficulty selling at the best time - there can be difficulties selling to the processor when supplies are plentiful and the processor's capacity is fully utilized. At these times, a farmer's ability to be slotted in by the processors depends on their relationship. Farmers reported facing a lot more processor deferrals/refusals attributed to "off flavors" during times of oversupply.

2.3. Identify insurance programs that meet needs and operations

There is no insurance program, public or private, directly covering catfish losses. Whole-Farm Revenue Protection provisions were recently changed to allow up to $1 million of expected revenue from animals and animal products. A provision of the predecessor policy (Adjusted Gross Revenue) which required no more than 35% of expected revenue from animal sources was removed. Therefore catfish growers with less than $1 million expected revenue might theoretically be covered by this program.

However, though we did not explore the Whole-Farm plan in depth, it appears unlikely it would cover catfish:

- Animal species covered by WFRP must be grown in a controlled environment; for all the care and effort that goes into raising catfish in ponds, they are not controlled environments (e.g., they are vulnerable to predation);

- Revenue-to-count for the WFRP policy includes unsold inventory, but prior research has not come up with a cost effective way to count catfish inventory;
- The handbook indicates that Allowable revenue specifically excludes revenue from all uninsurable commodities – catch 22 - catfish is not currently an insurable commodity.

Other government programs exist that cover other aspects of animal agriculture, but explicitly exclude catfish.

There are some forms of property insurance available to farmers but they would not cover the loss of fish.

At both sessions, reference was made to a private company that years ago offered catfish policies. Apparently, claims overwhelmed the program and it was ended within a year or two. Growers have seen no such insurance since.

Catfish grower familiarity with more traditional crop insurance products (e.g., Revenue Protection) varies – some have diversified operations and use such insurance; some may not use them but are familiar with them; and yet others – particularly smaller scale farmers focusing solely on catfish production – have little familiarity with them.

2.4. Previous industry losses / aid

The catfish industry has declined by half in output over the past decade. This shift has happened primarily due to economic forces, not unusual on-farm events that would affect a significant share of producers.

At the sessions, attendees referred to past instances of government payments to catfish farmers. They mentioned indemnities from both disaster programs and grant payments to help with high feed prices. They made reference to the following programs:

- Trade Adjustment Assistance (TAA) from the USDA (2010).
- Feed Assistance under the Aquaculture Grant Program upon proof of feed purchases (2009)
- Federal disaster assistance of $11 million in response to loss or damage of feed, increased feed costs, and loss of feeding days (2007)
- $34 million in payments in 2003 to offset high feed expenses in 2002.

Further details are provided in 6.6.d) Disaster programs.

2.5. Why interested in insurance and willingness to pay

The detailed example we provided of how the indemnity mechanism of the gross margin insurance program might work, using actual catfish and catfish feed prices, though not precise, should be reasonably close to what an actual program might look at, after reviewing the other types of LGM policies. Nevertheless, at a price point of paying a penny or two to guarantee a 40 or 45-cent margin, we did not have any farmers say that represented a useful tool.

There was an indication that, should a program be put in place, some farmers that would otherwise not be interested in a program may take out policies because not doing so would leave them at a disadvantage.

2.6. Perceptions of conflicts and difficulties of implementing an insurance program

The listening sessions surfaced potential resistance to a program. Part of the resistance seem to be that the program would not address a farmer's individual risks, but rather pay them an indemnity when prices were going against the whole industry.

There was not only skepticism about the very idea of a program — i.e., that the government would spend money only to take premiums from farmers and redistribute them to the same farmers later. Some were even skeptical that the money would be there when the indemnity triggering situation occurred. In addition, they were very focused on the level of subsidy that would be provided by the program.

Some of the opposition to a potential program appeared to be linked to concerns about it distorting market behavior, in particular that it might encourage marginal producers to stay in business when they ought not to — presumably keeping prices lower for the more efficient producers. Several producers voiced concern.

The insurance agents in attendance did not voice specific concerns. Bankers attending the Alabama session said that if there were catfish insurance, it may be made mandatory in connection with loans (e.g., currently row crops are generally assigned to the bank in the insurance policy).

One farmer (in Mississippi) said, "I'm concerned about the unintended consequences of government programs…if you create a chronic oversupply… if someone is getting a government check, they might not cut back."

Attendees did not believe that the creation of an insurance program would have an impact on feed prices. The market for catfish feed was considered competitive enough. Moreover, there was consensus across both farmers and bankers at the Alabama session that the availability of insurance would not draw many new catfish farmers to the business.

At both sessions, the groups were concerned about caps. Not just "indemnity caps", (which would not apply with RMA products), but also about the LGM $20 million cap.

In Alabama, several growers also expressed concern that processors might offer less for a producer's fish if the market gross margin gets close to the trigger point for insurance. "If margin gets close to trigger, processors might say 'you're going to collect insurance, I'll give you 85 cents [per pound]…'"

A couple of attendees noted that it would be very important to educate producers and agents *before* a new program hits the ground, i.e., having the education process take place before/during the development process. It would be important to show producers what would have happened had insurance been in place.

There were concerns expressed by several individuals that producers affected by something on farm would impact the insurance policy they had. E.g., if they had coverage for a million pounds of fish but birds and disease halved that, would they be compensated based on one million pounds? "What if birds eat the fish, so there's nothing there to feed?"

2.7. Describe typical production activities

Mississippi has the largest catfish acreage and overall production. Most of it takes place in the Delta, in 4'-6' deep ponds of varying sizes. There is additional production in east Mississippi, which more closely resembles the production in Alabama.

Production in Alabama tends to be different. Ponds in Alabama are of variable depth, taking advantage of the local topography. Many Alabama growers grow hybrids, and use multi-batch practices that have fish of multiple sizes in their ponds. The larger producers have to sell year-round; their ponds are never empty. Moreover, whereas in the Delta they might stock 5,000-7000 pounds per acre, in Alabama it could be 8,000-10,000 pounds per acre. Because of the higher stocking densities, there is more potential for profit in Alabama, but also more risk. Alabama attendees reported a trend toward use of deeper ponds at higher stocking densities.

In the Delta, fingerlings are stocked around May. In Alabama, typically they stock fingerlings in December-January and May-June. Fingerlings come mostly from Mississippi – even for the Alabama farmers.

Delta ponds often need to be emptied and re-shaped every 5-8 years. In Alabama, farmers do not empty ponds are unless they have to.

2.8. Feed and feed conversion

One attendee suggested keeping a rolling average for feed prices over several years. Also, averaging the feed conversion ratio – say over the last 3 years. "The difference between 2.5 and 2.7 is substantial."

Another suggested using a rolling average of fish sold to account for production.

Conversion factors are different: in Mississippi the factor would be 2.7; in Alabama, 2.3. Greg Whitus of the AFFC indicated that 2.5 would be a "happy average".

At Greensboro, attendees mentioned there being three local catfish feed mills.

2.9. Risk mitigation

One grower noted that some producers use options to hedge against potential increases in the costs of key feed components (feed prices follow grain markets). However, another noted that hedging requires having enough capital to do so, and said that many lack the capital. Another said, "Insurance companies could hedge feed costs, or loans could be provided to producers to allow them to hedge – they don't have the capital to do it".

Catfish farmers often "book feed", locking feed prices in advance. Some may book all of their feed this way, though they may do it in stages (e.g., 3-6 times per year) rather than booking all of it a year in advance.

Quite a few catfish farmers do effectively mitigate risk with crops. However, these other activities are generally set up as independent entities, and not all catfish farmers are so diversified. The two activities hardly ever balance out…some will be "way bigger catfish farmers", others "way bigger row crop farmers." Finally, switching acreage from catfish to crops is not a short-term proposition; rather, it is something that would take place over several years.

One farmer noted that fish can be carried over from one season to another- so that fish sold "may be zero" – indicating that this should be factored into any insurance plan.

Farmers also noted that inventories are lowest by April-May.

Anything that adversely affects water quality is potentially disastrous to a catfish farmer. Power outages are one major threat identified. Water oxygen levels are monitored continuously at most ponds. Many/most farmers have adopted more sophisticated oxygen monitoring systems that may relay quality measurements back automatically at intervals throughout the night. Nevertheless, farmers often have a person checking the ponds in addition to the sensors.

In addition, water quality is checked once per week. Algae are controlled using a chemical.

There tend to be more off-flavor problems with catfish in summer. However, this issue is more controllable then. There is little that can be done in the winter, as fish are not feeding, so the off-flavor cannot easily be fixed.

At both listening sessions, a farmer mentioned that one risk mitigation option is that producers can self-insure.

FSA representatives noted that FSA has an ELAP program, but it has no payouts related to catfish.

2.10. Nature of sales / Use of contracts / Processing

Growers indicated that there is generally a written agreement between the processor and the grower as to what one plans on selling. It usually specifies poundage but not price. Most farmers are thus "tied" to a specific processor. Agreements help processors know where they will be getting their fish from.

The current arrangement of informal written agreements appears to provide a system of checks and balances; it serves as a commitment device, not as a lock-in device. Producers know there are consequences for selling elsewhere, and processors generally have excess capacity and know producers can take their fish elsewhere if they want to do so.

The verbal consensus was that these were informal agreements that processors would not bother enforcing directly. However, given the limited number of buyers for catfish, growers made clear that processors gave preferential treatment to some when supplies were plentiful – this has the effect of forcing some producers to hold onto their fish longer than they would like until such time as a processor would be willing to take them.

Processors have to run the same amount of fish every month. They have to have fish year-round. "When fish get plentiful, they buy the best fish they can."
Growers noted that the price of fish is size specific.

2.11. Timing of sales / timing of insurance

Catfish sales timing varies by producer. One producer said he sold all his fish over the winter: "October to January and I'm done." Other catfish farmers may sell at different times, or year-round.

Producers indicated that local markets are volatile, even from one state/processor to the next.

When asked about the period of time that would need to be covered, Alabama farmers pointed out that they are feeding year-round but that the feeding pressure is strongest in summer when they are feeding the most. "We cash flow well until July." At that point, they may be spending more on feed than they are bringing in. "We look great in the beginning of the year."

2.12. Describe other commodities typically produced, revenue relationships between other commodities

There is no typical relationship between catfish farming and other forms of agricultural activities. Some catfish farmers produce catfish exclusively; others grow row crops or raise cattle, and yet there are others for whom catfish farming is a relatively insignificant part of their operations. Listening session participants stressed that the importance of catfish in each farm varied dramatically, from relatively insignificant to the entire operation.

Though there is no typical relationship, some generalizations can be drawn. Many Mississippi Delta catfish farmers are also engaged in row crop production. Over the past decade, tens of thousands of catfish production acres have been either retired; a decade ago, many acres were retired for conservation; in more recent years, catfish land has been shifted over to row crops.

At the Alabama session, we were told that Eastern Mississippi farmers might have 40 to 60 acres of catfish plus row crops, and there might be 50 or so farmers there. In Alabama, there are roughly 75 catfish producers, many of whom were said to raise cattle as well.

No information has been found indicating the proportion of farm revenue coming from catfish, either as an average or as reflecting a typical producer.

Only twenty catfish farmers attended the listening sessions. Though there were some very large farms represented by attending farmers, this still represented less than 10% of farmers. Moreover, information provided on insurance awareness and usage (for other commodities grown on diversified catfish farms) was anecdotal. There are no available data on catfish farmer usage of crop insurance.

However, broadly speaking, most crop farmers in both Mississippi and Alabama have insurance.

2.13. Estimate of revenue of each operation

A 50-acre farm stocking 6,000 pounds an acre would bring in $300,000 in revenue at $1/pound. Farm sizes vary dramatically, however. The 2010 National Animal Health Monitoring System (NAHMS) Aquaculture survey showed that the average stocking density across all sizes of operations was 5,838 pounds per acre. The actual stocking density for the smallest farms was 4,224, while the stocking density for the midsize and largest farms was over 5,800.

2.14. What percentage of producers are full time?

There are no statistics showing the percentage of full-time catfish producers. Anecdotally, farmers of the listening sessions claimed, "catfish farming is a full-time job." It is also clear, though, that "full-time" referred to the catfish farming requirement that ponds be monitored constantly.

2.15. Analyze, summarize, interpret data

We would characterize the level of interest of catfish farmers in a *gross margin* insurance program as mixed.

There is no question that the industry as a whole and plenty of farmers — as evidenced by the significant attendance at both listening sessions — are interested in any potential support that an insurance program could provide. Many of the attending farmers remained focused on farm perils, though, which would not be addressed by a gross margin program.

Both groups came to understand the way a gross margin program would work over the course of each meeting, and provided useful information, suggestions, and questions. In Mississippi, industry representatives were enthusiastic, while other attendees' responses there were more guarded. In Alabama, once the program concept was understood, there was primarily skepticism that a program would be of value to the farmers – many reasons were given.

3. CATFISH OVERVIEW

3.1. Sources of catfish data

The ability to analyze and analyze the feasibility of and produce a catfish margin insurance product relies on reliable long-term data covering the catfish industry. Although some data is still routinely collected and reported, the USDA stopped reporting catfish prices, pounds sold, pounds of feed sold, feed prices, and other vital data in February 2013. USDA has not announced any plans to resume collecting or publishing these data series. The lack of some of this data poses a challenge to producing a catfish insurance product.

However, as soon as the USDA announced it was going to stop collecting and reporting catfish data, The Catfish Institute hired Dr. Terry Hanson of the University of Auburn to continue collecting several data series: monthly prices paid to catfish producers and monthly catfish feed prices. Dr. Hanson is a well-respected catfish industry advocate who has built personal relationships with key people who supply him with the data. Once a month, he calls feed mills to get their feed price. He does the same with the processors to get prices paid to farmers. Once he has all the numbers he enters the figures into excel spreadsheets. A copy of these spreadsheets is included with this report in Appendix C.

Dr. Hanson began collecting the data immediately so there is no gap between the USDA time series and his data. Although Dr. Hanson collects feed and catfish prices, there are still data series that are vital to understanding the catfish industry that are missing: pounds of feed sold and pounds of processed catfish. These are no longer available.

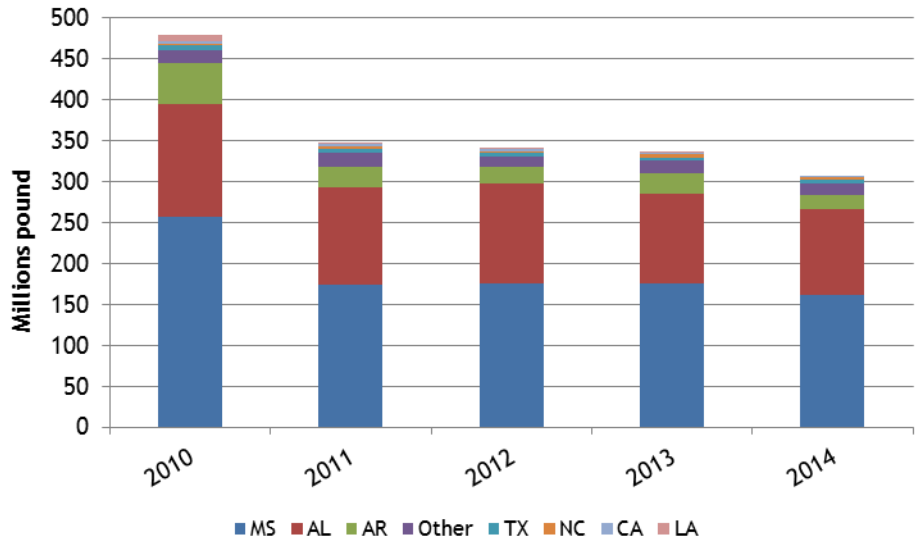
3.2. Economic context

Catfish is the most economically important aquaculture finfish in the United States. This native fish, indigenous to Southeast US, was introduced to other parts of the US as a game fish in the mid-1900s. Significant commercial production of farm-raised catfish began in 1970 and became the base of an important production and processing industry in southern states. Today, the catfish sector is under pressure, with competition from similar species from Southeast and East Asia.

3.2.1. US production

In 2003, 662 million pounds round weight of US catfish were processed. Sales fell to 307 million pounds in 2014, less than half of the volume at the peak. The acres of water used for catfish production in the US fell from 181,100 in 2011 to 126,910 in January 2015, a decline of 30% in just the last four years.

Figure 1: US catfish sales, million pounds



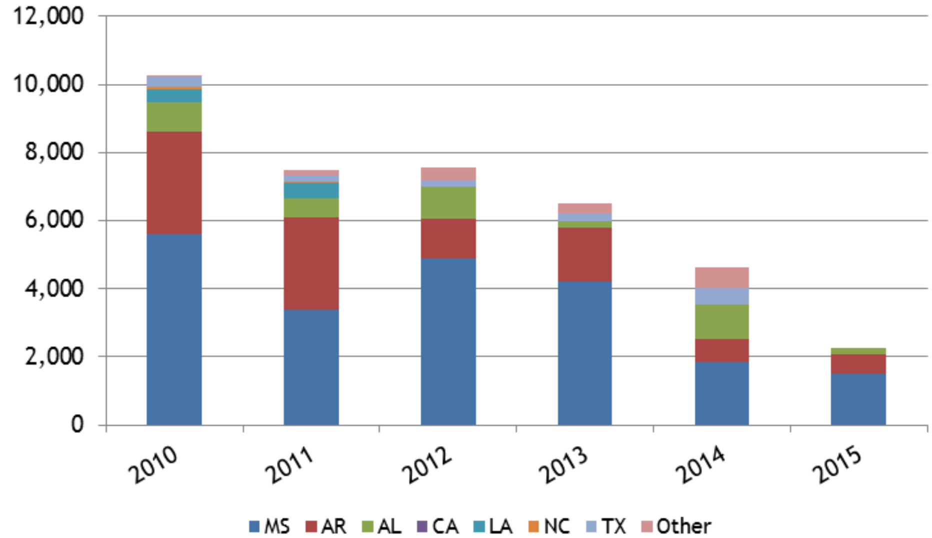
Source: USDA NASS

The impact of competition from imports and rising feed costs has resulted in a major contraction of the US catfish production sector. This has affected the sale of all domestic farmed catfish products including foodfish, broodfish, stockers, fry, and fingerlings.

Mississippi, Alabama, Arkansas, and Texas are the major catfish producing states in the US. In 2014, Mississippi remained the largest producer with 78,000 acres followed by Alabama with 30,500, Arkansas with 10,600, and Texas with 2,000 acres. All four states have experienced significant declines in catfish production acreage since acreage peaked in 2002. Total losses of production area are 30%, over 54,000 acres in the last five years. Over the period, Alabama has experienced the least contraction, losing 7,800 acres or 20% of its total catfish pond area. In contrast, the Mississippi catfish pond acreage has declined by 27% and Arkansas by 56%. The Alabama production area differs in character from Mississippi: it is located in more undulating areas, facilitating pond construction, and farmers often have fewer row crop alternatives. This is a partial explanation of the less dramatic impact on Alabama production.

The decline in catfish production acreage has slowed. Combined with higher stocking densities, the net effect has been to slow the decline in production volumes.

Figure 2: Catfish, US acres taken out of production

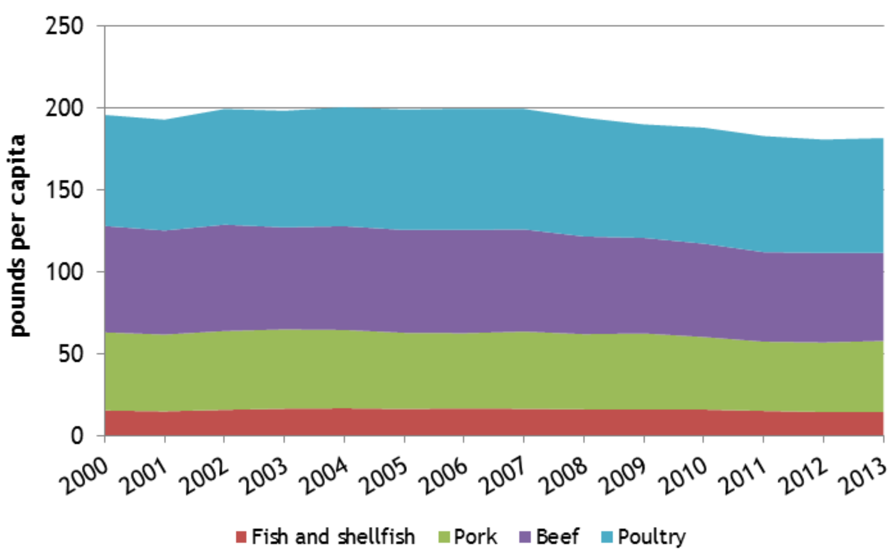


Source: USDA NASS

3.2.2. Domestic demand

Broadly speaking, catfish competes for the consumer protein dollar. In 2013, per capita availability was 97.9 pounds of red meat, 70.2 pounds of poultry, and 14.3 pounds of seafood, for total availability of 182.5 pounds. This represents a per capita decline of 9.4% from the peak per capita consumption of 201.5 pounds registered in 2004.

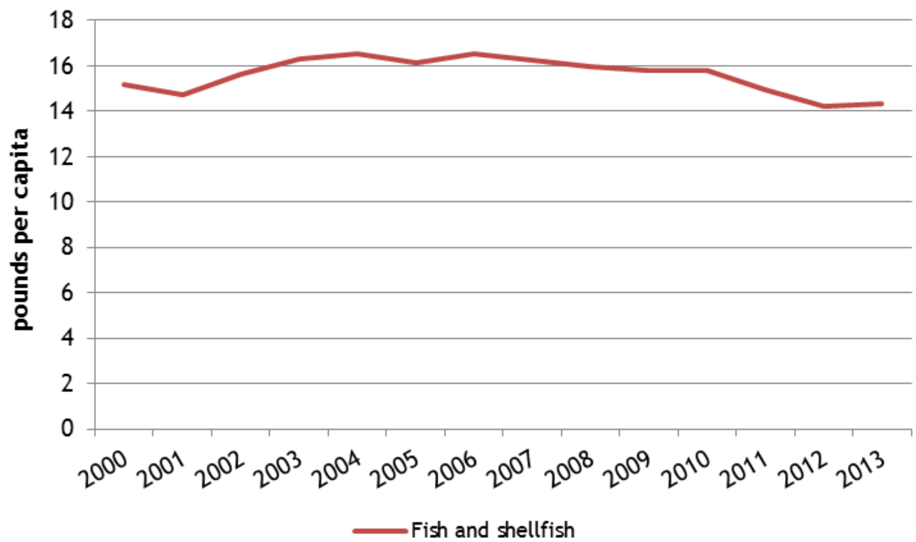
Figure 3: US meat, poultry, and seafood consumption per capita, 2000-2013



Source: Calculated by ERS/USDA based on data from various sources (see http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/food-availability-documentation.aspx)

Per capita seafood consumption has also declined slightly in recent years, though overall seafood consumption has risen overall due to the country's growing population.

Figure 4: US per capita seafood consumption, 2000-2013



Source: ERS/USDA, updated Feb 1, 2015.

Overall, domestic availability of fish was up 5.5% between 2000 and 2013. This growth is due to 12.2% growth in the population overall during that period. This growth in consumption has been increasingly fueled by imports.

Although it is the largest aquaculture product, catfish consumption represents only a modest share of fish and shellfish consumption. Of the 14.3 pounds available per person, 0.6 pounds are catfish. Consumption by seafood type is shown in the following table, which shows consumption in recent four-year intervals:

Table 1: Seafood consumption by fish and shellfish type, 2005-2009-2013

Type	2005	2009	2013
Shrimp	4.1	4.1	3.6
Salmon	2.4	2.0	2.7
Canned Tuna	3.1	2.5	2.3
Tilapia	***0.8***	***1.2***	***1.4***
Pollock	1.7	1.5	1.2
Pangasius	**--**	***0.4***	***0.8***
Cod	0.6	0.4	0.6
Catfish	***1.0***	***0.8***	***0.6***
Crab	0.6	0.6	0.5
Clams	0.4	0.4	0.4
Other	1.5	1.9	0.4
Total all species	16.2	15.8	14.5

Source: National Marine Fisheries Service (raw data)

One can see that not only did per capita seafood consumption drop overall, but that the decline in catfish consumption coincided with increasing tilapia consumption and the emergence and growth of pangasius sales.

Pangasius is a species of fish in the same genus as catfish and is native to Asia. Imported Pangasius first appeared in the list of US top ten species consumed in 2009, ranked at number 10. In that year, it was estimated that Americans consumed just over a third of a pound. Over the next two years, consumption doubled and pangasius now ranks 6th, two places above catfish.

3.2.3. US seafood trade

Seafood imports overall grew 6% between 2005 and 2013, though exports grew twice as fast over the same period. The net effect was a slight decline in net imports.

Table 2: Seafood trade, 2005-2009-2013

	VOLUME			VALUE		
	-------- Metric tons, millions --------			----------- $ billions -----------		
	2005	2009	2013	2005	2009	2013
Imports	2.320	2.341	2.459	12.1	13.1	18.0
Exports	1.290	1.120	1.456	3.8	3.7	5.2
Net imports (I-X)	1.030	1.221	1.003	8.3	9.4	12.8
Total trade (I+X)	3.610	3.461	3.915	15.9	16.8	23.2

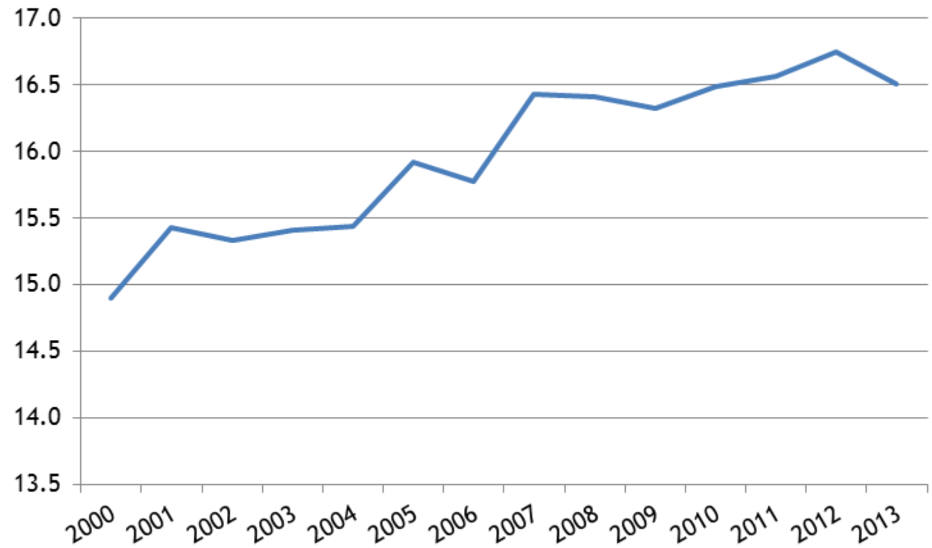
Source: NOAA, National Marine Fisheries Service

3.2.4. World situation

Global seafood demand

Globally, seafood consumption has risen roughly 10% since 2000, from just under 15 pounds per person to 16.5 pounds per person in 2013. This of course is compounded by global population growth. Americans eat less seafood than the global average.

Figure 5: Worldwide fish and seafood consumption, 2000-2013

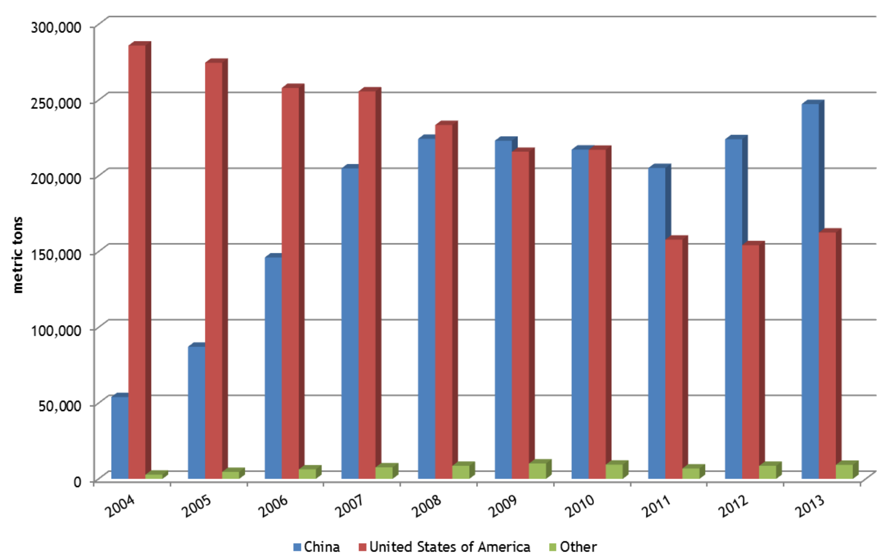


Source: FAO Stat

Catfish production

From 2004 to 2013, catfish production in China grew fourfold, while US production fell by more than 40%. Production of channel catfish is insignificant outside of the US and China.

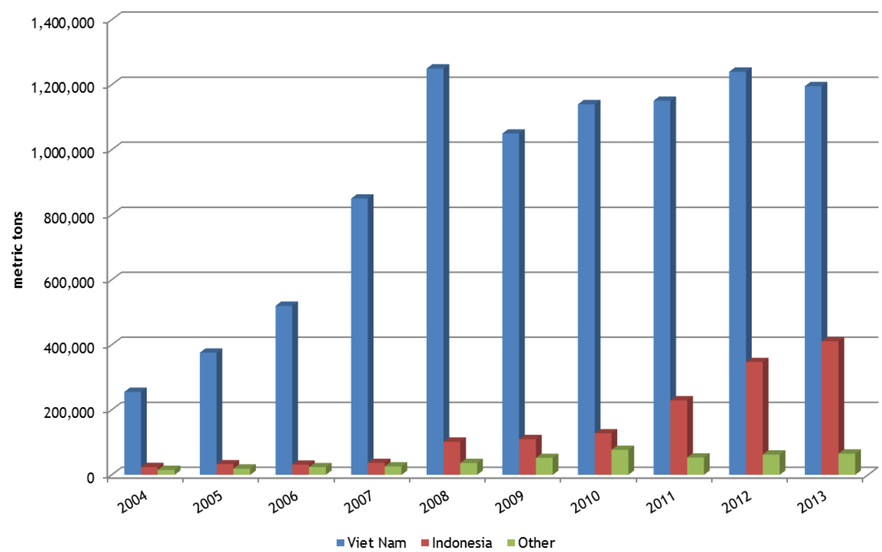
Figure 6: Channel catfish production, mt, 2004-2013



Source: FAO FishStat J

Channel catfish is not the only species of catfish produced, though. Pangasius production is massive in scale compared to channel catfish. Vietnam is by far the predominant Pangasius producer. From 2004 to 2008, pangasius production grew from 255,000 MT to 1.2 million MT and has remained near that level since.

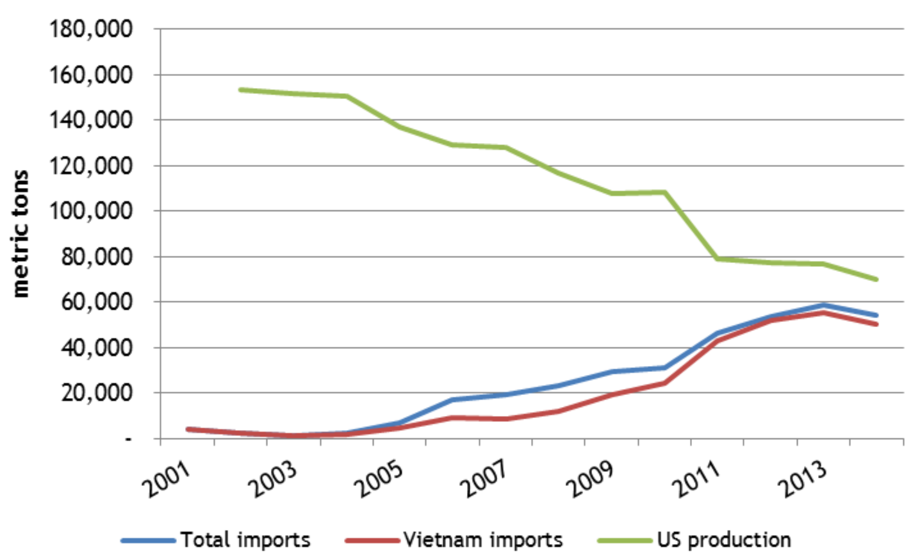
Figure 7: Pangasius catfish production, metric tons, 2004-2013



Source: FAO FIshStat J

Competition from Pangasius species from Southeast Asia has captured market share from domestic catfish. The imports are frozen, boneless fillets and these supply a large share of total US consumption. Imports serve to displace domestic production and pressure prices, but the extent of price pressure is not clear; domestic production retains a core niche market, particularly in the Southern US.

Figure 8: US domestic production vs. imports of all species of catfish, 2001-2014, metric tons



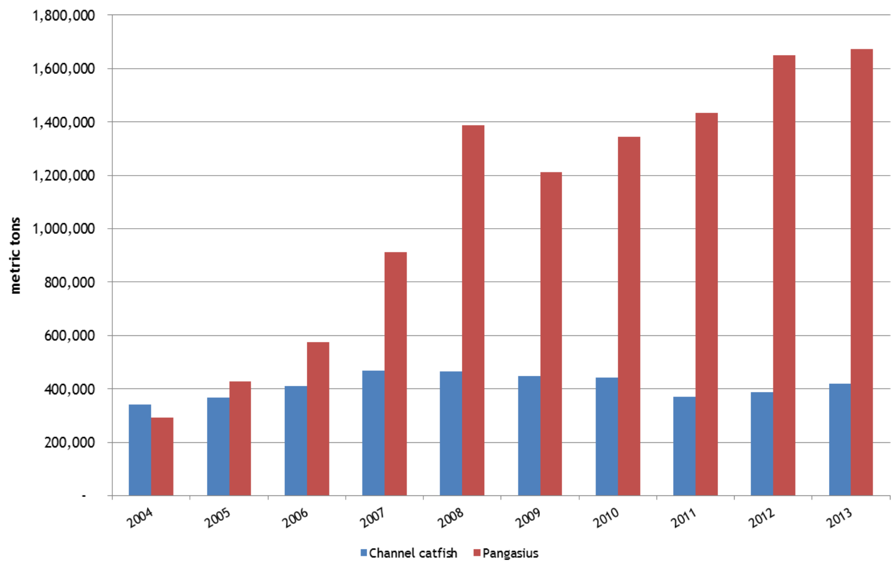
Source: US International Trade Commission (USITC), USDA NASS

In Figure 8 above, you can see that the decline of US catfish production is accompanied by an increase in imported catfish. Although the species are not the same, the taste and consistency seem to be close enough that consumers cannot discern between species. Other whitefish such as tilapia and swai may be substituted for catfish.

In 2005, the US-produced market share of frozen fillets sold in the US market was 80%; by 2012, this market share had fallen to 22%. The rate of change has accelerated in recent years; between 2011 and 2012, imports of frozen pangasius fillets increased by 34 million pounds (14%) to 237 million pounds, accounting for 78% of all US sales. Frozen tilapia shipments from China add to the competition.

The chart below shows global production of channel and pangasius catfish, in context. These two species represent virtually all the catfish produced in aquaculture worldwide. In 2004, the US produced 83%, about 285 million Kg of catfish, out of 342 million Kg total. By 2013, the US accounted for just 38% of world channel catfish production. Neither the US nor China export much channel catfish; virtually all production is consumed in each respective domestic market. Pangasius, on the other hand, is exported in large volumes.

Figure 9: World channel and Pangasius catfish production, metric tons, 2004-2013



Source FAO Stat

Catfish trade and inspection issues

Over the past fifteen years, imports of pangasius and other whitefish products have flooded the US market. Widespread, fraudulent seafood labeling contributes to a very low level of consumer understanding of fish species attributes and to price pressures on US catfish.

The US catfish industry prompted the US government to investigate the Vietnamese industry to assess whether the competition was fair. The government concluded that some companies were dumping product and penalty duties were imposed on a company-by-company basis.[1] Some Vietnamese exporters signed agreements with the US industry and they are excluded from anti-dumping retaliation. The impact of the penalties is anticipated to be marginal because the competitive difference is so great and the Vietnamese have the potential to adjust their export strategies. As a result, some of the major exporters will suffer no serious anti-dumping penalties. Nevertheless, the measures taken have been contested by the Vietnamese government.

[1] US International Trade Commission, Certain Frozen Fish Fillets From the Socialist Republic of Vietnam: Amended Final Results of Anti-dumping Duty Administrative Review; 2010-2011, Federal Register, 78 FR 29323 (May 20, 2013)

The US catfish industry advised US federal agencies that production conditions in Vietnam represent a threat to food safety. Provisions were consequently introduced into the Food, Conservation, and Energy Act of 2008 (Farm Bill) that would impose USDA food safety checks on Vietnamese production rather than Food and Drug Administration (FDA) checks. Some domestic catfish processors objected to such changes because of the implications for their own operations. The envisioned move was criticized by several government agencies including the Government Accountability Office (GAO) as it duplicated controls already in place and was not justified by evidence of food safety issues associated with Vietnamese imports[2].

Food inspection duties have now legally been passed to the USDA. The USDA, however, has not completed rule making for the introduction of regulations. Proposed guidelines have been presented, but as of this writing, a fish inspection program has not been implemented.

3.3. The production challenge - price/cost squeeze on margins

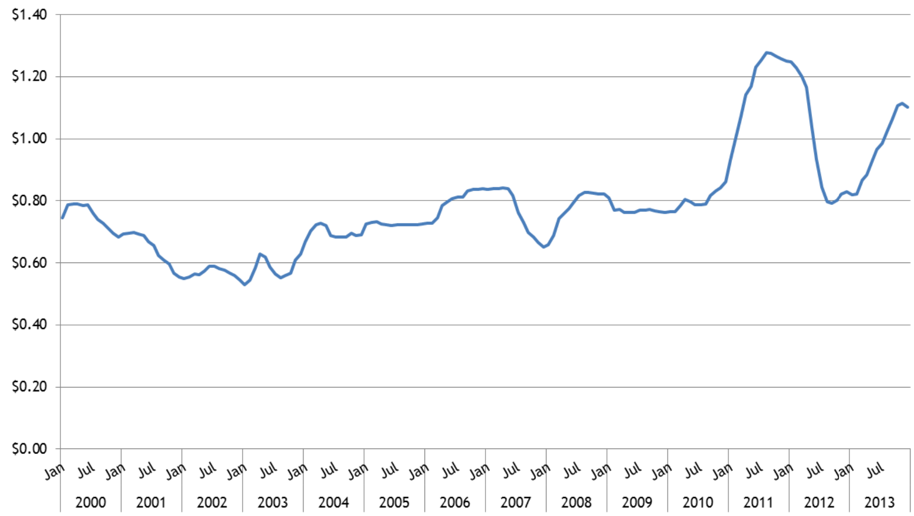
Catfish farmer incomes fell 25% in 2012, with few reporting profits in that year. Profitability has been declining as a whole for over a decade now. In addition to intense competition from imports, catfish farmers have recently faced higher feed and fuel costs as prices of corn, soybean, and energy increased. Catfish farmers have experienced price/cost squeezes, particularly in 2012 and 2013. Intense competition has lowered prices the same time production costs were higher. As a result, many farmers, particularly in Mississippi have removed their levees and switched to other crops such as soybeans. Although imports have continued to increase, input costs have moderated, lessening the price/cost squeeze.

3.3.1. Catfish prices

Catfish prices from 2000 through 2010 were generally at or below $0.80 per pound. In 2011, nominal fish prices paid to producers spiked to over $1.20/pound because of low inventories. However, in 2012 the price dropped dramatically.

[2] Government Accountability Office, Seafood safety - Responsibility for Inspecting Catfish Should Not Be Assigned to USDA, GAO-12-411, May 2012

Figure 10: US farmer price received for catfish, 2000-2013



Source: USDA NASS and T. Hanson

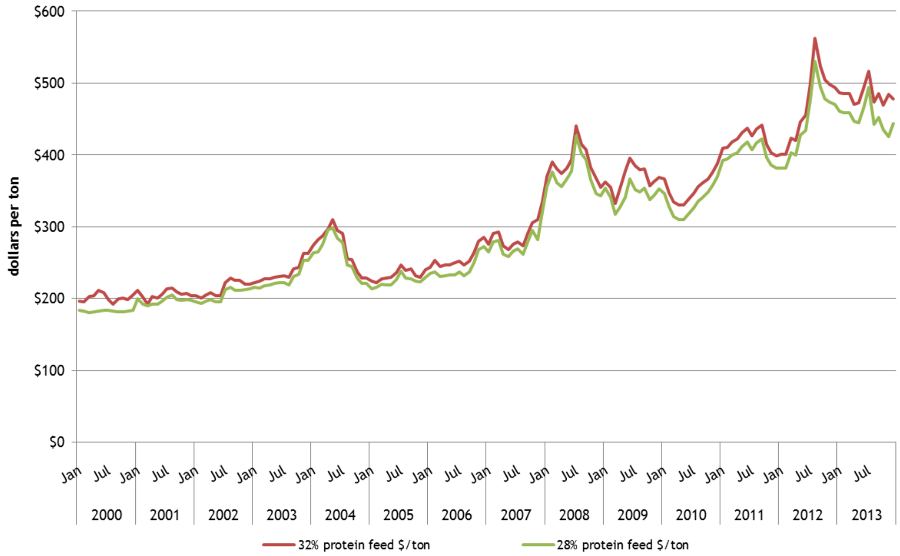
3.3.2. Feed consumption

Feed represents about 60% of farm production costs. Consequently, margins are very sensitive to feed costs changes. The price of feed has been very high in recent years as the price of the main components, soybeans and corn, hit record levels. The price of 32% crude protein floating feed reached record levels in 2012, with producers paying $469 per ton of feed on average, or $48 per ton (12%) higher than 2011. This followed a feed price increase of almost 20% between 2010 and 2011. More recently feed prices have moderated on lower corn and soybean prices.

3.3.3. Feed prices

In Figure 11, prices for 28% feed and 32% protein feed are shown. Feed prices are highly correlated but there are periods when they do not track tightly together. In addition, the price differential has increased slightly over the period shown.

Figure 11: Catfish feed price per ton, 32% and 28% protein



Source: USDA NASS & T. Hanson

3.3.4. Feed purchases

In order to hedge against feed price volatility, most catfish farmers use feed bookings to ensure a stable price and reliable supply. One feed manufacturer we spoke with said farmers can book feed six months to a year in advance at a contracted price and tonnage. Once he has all the bookings established for the year, he uses the futures market to hedge the amount of feed ingredients he will need to supply those contracts.

3.4. Catfish production

3.4.1. Domestic production and production systems

Between 1970 and 1990, catfish output grew rapidly to just over 350 million pounds. It then further expanded to almost 608 million pounds, according to the 2005 Census of Aquaculture. Over the past decade, however, production has declined. The 2013 Census of Aquaculture shows that 354 million pounds of foodsize catfish were sold, a drop of 42% since 2005.

According to the 1998, 2005, and 2013 Censuses of Aquaculture, there were 1,370 catfish operations in 1998, 1,160 in 2005 and only 695 in 2013. The decline in catfish production has accompanied a decline in the number of farms and consolidation of production.

Table 3: US catfish farms

	Farms		%	Number sold (1,000)		%
	2005	2013	Change	2005	2013	Change
Foodsize or market size	1,017	605	-41%	396,554	211,356	-47%
Stockers	102	67	-34%	33,637	73,997	120%
Fingerlings or fry	184	117	-36%	683,112	172,876	-75%
Broodfish	39	19	-51%	503	41	-92%
Catfish total	1,160	695	-40%	1,113,806	458,270	-59%

2013 Census of Agriculture, Table 2
Number of farms does not add due to simultaneous operations on the farms.

The table below also shows how the value of sales has changed. The value of the catfish sold has dropped below $400 million.

Table 4: Catfish operations

	Number of farms			Sales ($1,000)		
	1998	2005	2013	1998	2005	2013
Alabama	250	192	140	$58,222	$98,413	$107,248
Arkansas	156	142	49	$55,307	$77,852	$28,582
Mississippi	404	386	213	$285,366	$243,122	(D)
Other states*	560	440	293	$51,815	$42,498	$240,035
United States	1,370	1,160	695	$450,710	$461,885	$375,865

(D) data withheld
* Includes MS for 2013 sales
2013 Census of Aquaculture, Table 7

The catfish industry comprises many relatively small- and medium-sized operations. Though there are large producers, none holds a significant share of output.

Key characteristics of production

Channel catfish (Ictalurus punctatus) is the predominant species in US catfish aquaculture. Channel catfish do not naturally reproduce in ponds, which gives breeders great control over crossing. Another advantage of channel catfish is that sexually mature fish are easily spawned, which is essential for artificial reproduction. Unlike many other aquaculture species, catfish fry accept manufactured feeds and growth and feed conversion efficiencies are good at all stages of production. In addition, they tolerate relatively high levels of crowding and a wide range of environments. For all of these reasons, channel catfish are ideal for commercial aquaculture.

Catfish are warm water fish that grow best in a temperature of 85°F. Consequently, production is limited to the south and southeastern regions of the United States. In 2010, Mississippi, Alabama, Arkansas, and Texas accounted for 94% of US catfish production. The remainder is in California, Louisiana, and North Carolina. Almost all fingerlings are produced in Mississippi.

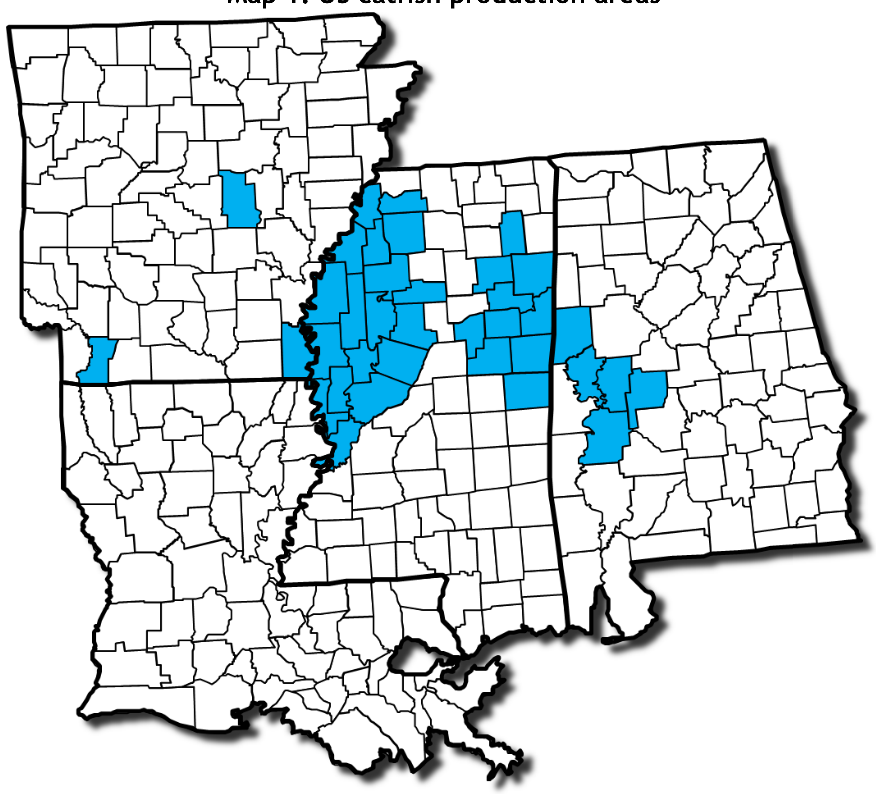
The recent NAHMS/APHIS study (2011) of production practices in the four leading states revealed significant differences between the scale of production in the east of the region (the rolling hills of Alabama and eastern Mississippi) and the west (Arkansas, Louisiana, and the Mississippi Delta). Farms located in the east are more than three times larger than those in the west.

According to the recent NAHMS/APHIS study (2011), 95% of catfish (in 2009) are sold for processing into fillets. Most commercial producers specialize in selling to this market. Direct sales to consumers or local retailers are a niche market that is largely serviced by smaller producers. Today, catfish are processed into a wide range of value-added products as well as fillets such as breaded strips, breaded nuggets, and breaded trim pieces.

Production Area

The majority of US catfish aquaculture is located in the delta region of Mississippi, eastern Mississippi, and western Alabama. The map below shows major production areas. Approximately 86% of production occurs in the counties highlighted.

Map 1: US catfish production areas



Source: Agralytica

Production system – channel catfish

It takes 18-36 months to produce a foodsize catfish. Catfish production involves several stages: reproduction, hatching, fry production, fingerling production, and grow-out. The hatching industry is very concentrated; there are state run and private hatcheries as well. Many of the fee-fishing operations have their own hatcheries to stock their ponds. According to the 2013 Census of Aquaculture, there were 67 farms that produced stockers, 117 farms that produced fingerlings and fry, and 19 farms that produced broodstock.

Spawning begins in the spring when water temperatures are consistently around 75˚F. Broodfish begin spawning when they are about 3 years of age and weigh at least 3 pounds. The prime spawning age is between 4-6 years of age with fish weighing 4-8 lbs. Older fish produce fewer eggs and larger fish cannot enter the containers used as nesting sites. Brood stocks are maintained at about 2,000 pounds per acre to provide good environmental conditions and minimize overcrowding that can cause spawn suppression. Brood fish typically lay 3,000-4,000 eggs per pound of body weight. The percentage of females spawning depends on the condition and age of the female broodfish. The percentage of females that spawn each year ranges between 30-80%. Females lay eggs over several hours in layers in the nesting containers. Containers are checked every 2-3 days for the presence of eggs.

Catfish eggs are collected and placed in insulated and aerated containers and transported to the hatchery. The eggs are hatched in indoor tanks or troughs holding 90-100 gallons of water. The most critical factor in egg hatching is high quality water supply. Egg hatching tanks have a series of paddles along the length of the tanks that rotate the water to provide aeration and circulation. Hanging wire baskets are placed in the tanks between the paddles. Each basket holds a mass of eggs. After roughly 5 to 8 days, the eggs hatch into sac-fry.

Sac-fry swim out of the wire basket and form tight schools. They are siphoned off into buckets and transferred to fry rearing tanks. Initially, the newborn sac-fry are not fed because they have an attached yolk sac they receive nourishment from (hence the name sac-fry). At 3-5 days after hatching, the sac-fry absorb the yolk sac and turn black. The fry (now called swim-up fry) swim up to the surface seeking food. Swim-up fry must be fed 6-12 times a day to survive and grow. Farmers feed the swim-up fry a nutritionally complete feed for 2-7 days before transferring them to the nursery pond.

In the nursery pond, the fry are not fed any manufactured feed. Instead, farmers rely on the naturally available foods in the pond. The fry spend the next 5-8 months growing out in the nursery ponds to 3-8 inches in length. They are now called fingerlings and are transferred to earthen grow-out ponds or they may be grown further in the nursery pond to stocker size (0.2-0.25 pounds) or foodsize (1.2–2.5 pounds).

Many catfish producers produce fry and fingerlings, as well as food-size fish production. Specialized fry and fingerling producers are more common in western Mississippi and Arkansas. Almost one-fifth of all operations produce all or some of their own fingerlings according to NAHMS/APHIS study (2011).

Fingerling production, like fry production, is also standardized. Fingerlings grow faster and bigger at lower stocking densities but more can be grown with higher stocking densities. The stocking density is a decision each farmer has to make depending on constraints and costs. The nursery pond is managed so that it has an abundance of natural foods for the small fry. After about a month, when the fingerlings are big enough and there are not enough natural foods, manufactured feeds are introduced. They are fed a small floating pelletized feed of 32-35% protein. As the fish grow, the pellet size is increased.

Fingerlings are particularly susceptible to infectious diseases. Careful management is critical to ensuring a high survival rate. Losses to predation and diseases vary greatly depending on management and water quality. Survival rates over 60% are considered excellent. The average survival rate is more like 45%. Once the fish are big enough, they are typically moved to a different pond. However, some farmers continue to use the same pond for the rest of the production cycle.

After the fingerling stage, grow out production can take many different forms depending on the farm, region, and farmer. In addition, there is an intermediate stage during growout when the fish reaches 0.2-0.25 pounds, called stocker size. Not every production system makes use of stockers, though.

There are 3 cropping systems in use: single batch, multiple batch, and modular.

- **Single batch** systems are usually stocked with large fingerlings. In the single batch system, larger fingerlings are stocked once a year into a growout pond. No additional fish are added during the growout phase; all the fish are grown to food size and are harvested at one time. Multiple ponds are often used so that a farmer may have one batch or more ready for harvest every year.
- **Multiple batch** systems are stocked with smaller fingerlings. In a multiple batch system, smaller fingerlings are stocked multiple times throughout the year so that there are several class sizes of fish all in the same pond. When they reach food size, farmers harvest only the larger fish using a grading device – usually specially designed seine nets. Shortly after harvest, the pond is stocked with new fingerlings. This method allows the farmer to have more harvests per year and space out sales. This can prevent a glut of fish being brought to the processor; however, it is less of an issue than it once was, given that farmers have increasing control over the timing of their stocking and harvests.
- In the **modular system**, different ponds are used at several life stages. Farmers usually move fish when they reach certain sizes, typically, fingerling size, stocker size, and growout size. The modular system uses more ponds and as such may be more capital intensive. Farmers initially stock fingerlings to a smaller pond and grow more for one season until they reach stocker size. They are then moved to a larger growout pond. Using the smaller pond reduces costs, management time, and may increase survival rates.

Each system has its advantages and disadvantages. In addition, regional variations make some systems better than others do. For example, in the Mississippi Delta, ponds must be drained every 5-7 years so the multiple batch system is very cumbersome to implement there. In western Alabama where the ponds rarely need to be drained, the multiple batch system is very popular.

According to the 2010 NAHMS Aquaculture survey, 81% of operations operated multibatch production systems. Those farms were responsible for 88% of the total fish production. Operations using the single batch system accounted for 14% of the operations and 11% of the fish. The remaining systems were unspecified. They accounted for 4% of operations but only 0.3% of the total fish produced.

Stocking densities vary widely from farm to farm and no consensus exists for the best stocking density. Farmers decide their stocking density based on experience, environmental conditions, farm resources, and management ability.

Production system – hybrid catfish

Hybrid catfish production is similar to channel catfish once hatched, but vastly different in the reproductive stage. Open pond and pen spawning systems used in channel catfish production do not work to produce hybrid catfish. Commercial production of hybrids relies on hormone induction and strip spawning of the channel catfish females. The female channel catfish are artificially inseminated with blue catfish sperm.

Despite the labor intensive and additional costs of producing hybrid fry, hybrid catfish have several distinct advantages over channel catfish. The production cycle to grow a foodsize fish is shorter, 266 days compared to 403, production is 30% higher, survival rates are 19% higher, and fillet yield is 25% higher. In addition, growth rates are more uniform in hybrids. Hybrids are much easier to catch than channel catfish reducing the time and labor cost of harvest. However, diseases, water quality, and off-flavors still present problems for hybrids.

Researchers continue to work on developing better blue catfish and channel catfish strains. Currently about 40% of catfish production is hybrid catfish.

3.4.2. Management practices

An important finding of the 2010 NAHMS/APHIS study is the significant variation in production practices. These differences highlight the challenges when considering crop insurance.

Pond systems

There is considerable variation in the average pond size and depth.

There are three types of ponds used in catfish farming, levee or embankment ponds, watershed ponds, and hybrid ponds. A fourth type of pond, the split pond or intensive management system, is discussed separately.

Levee ponds are built on flat lands by removing soil from the center of the pond and using that soil to create the levees. Levee ponds are made in uniform sizes and depths, and have square or rectangular shapes. Since levee ponds are manmade and located on flat land, they tend to be bigger on average than the other two types. Levee ponds are primarily located outside eastern Mississippi and Alabama. Watershed ponds are built using the natural terrain of hills and valleys, along with a dam to create a pond. Watershed ponds are common in western Alabama and some of eastern Mississippi. They have irregular shapes and depths. The third type of pond is a combination of the previous two types. Hybrid ponds make use of natural terrain but also have two or three artificially created embankments to enclose the remaining area. Hybrid ponds are built in regions with gently rolling topography like the Blackland Prairie of eastern Mississippi.

The average size of production ponds is 10.8 acres. Pond depths vary from three feet in the levee ponds of the Delta region to nine or more feet at the deepest point of the ponds in western Alabama. As noted earlier, the eastern farms were much larger than the ones to the west of the main production states. In addition, farms in the east were primarily supplied with surface water, while those in the west were almost exclusively supplied by underground sources.

Split ponds

A relatively new method of production has emerged in the last few years called intensive management or split pond system. This new system is both a pond and management system whereas other pond and management systems can be mixed and matched.

Existing ponds are converted into split ponds by the addition of a levee. The levee is placed so that the pond is split into an 80/20 ratio. Ducts and pumps are placed into the levee to facilitate water transfer between the two sections without allowing fish access to the other side. The fish are placed into the small 20% side of the pond. The larger side of the pond serves as the waste treatment section. Water is circulated from the section containing the fish into the larger section where it is naturally cleaned up before being pumped back to the fish side. This system allows for a much higher stocking densities ranging from 14,000 pounds per acre to 20,000 pounds per acre compared to the normal 4,000 to 7,000 pounds for the other systems. However, a loss of power to the aerators would result in almost immediate fish losses.

This system also makes catching the fish much easier since the area to be seined is so much smaller. Since the fish are concentrated, there is both an advantage and a disadvantage concerning dissolved oxygen. Since the fish are so concentrated, oxygen demand is very high compared to the surface area. Water aeration is far more critical than in any of the other systems. However, the fish are concentrated so as long as the aerators are operating it is virtually impossible for any fish to inadvertently swim into oxygen-depleted water.

Currently, this system is in the first stages of adoption. The first noted acreage of split ponds was in 2010, with less than 200 acres in production. In 2013, almost 1,600 acres were reported to be using the split pond, with about 1,400 of that in Mississippi.

Stocking density

Stocking densities vary considerably, with 22% of the surface area stocked at less than 4,000 fish per acre, 47% at 4,000 to 6,000 fish per acre, and 30% by more than 6,000 fish per acre. The average production is about 4,100 pounds of catfish per acre. The average size of fish sent to the processor is 1.7 pounds.

Channel catfish are raised primarily in operations located in Mississippi and Arkansas. Hybrid catfish (male channel catfish crossed with female blue catfish) are grown mostly by Alabama producers.

The hybrid lines were more likely to be grown by those culturing catfish on a larger scale. Hybrid catfish lines produce more fish per acre of water than do normal channel catfish. Consequently, they represent fewer acres of water but a higher portion of production.

The bulk of production is undertaken in continuous multi-batch production – 76% added fingerlings to ponds that were already populated with fish at various stages of growth. Single batch, 'all-in all-out' production systems allow for more precision with management decisions, although multi-batch systems do enable exploitation of available carrying capacity.

There are regional differences in which system of production is employed. Alabama farmers were early adopters of hybrid catfish. In addition, Hybrids tend to grow better in multibatch systems, again Alabama farmers were early adopters. That landscape has changed somewhat as more farmers in Mississippi are adopting hybrid lines and switching to multibatch systems. In addition, Mississippi ponds are ideally suited for conversion to split ponds or intensive production systems.

Almost 50% of food-size fish operations stocked at least one additional fish species in addition to catfish in the catfish production ponds. The most popular were (threadfin shad, a natural food item for catfish and a phytoplankton grazer, and grass carp, an herbivore used primarily to control aquatic weeds). There were few differences in this practice between different sized farms.

Length of production cycle

Depending on the species, environmental conditions, and pond system (channel or hybrid) it takes between 18-36 months to raise catfish, starting from an egg and growing all the way to a food-size fish. This holds regardless of the production system.

Seasonality

Catfish feed and grow the most when it is warmest, when water temperatures range from 70-85 degrees Fahrenheit. Below 70 degrees, they eat less and less frequently, and below water temperatures of 50 degrees, they stop feeding altogether.

Broadly speaking, feeding season picks up in April and May and peak feeding occurs in July and August. By December, feeding drops substantially. During the winter months (December-March), feeding is minimal, and takes place when the water temperatures rise above 50 degrees.

Feed conversion ratio

The feed conversion ratio for catfish ranges between 1.9 and 2.4, with an average ratio of about 2.2 according to the NAHMS 2010 Aquaculture survey. The feed conversion ratio (FCR) changes over the lifecycle of the fish. When the fish is at the fingerling stage the FCR is about 1.5, meaning it takes 1.5 pounds of feed to make one pound of fish. As the fish grows older the FCR moves up, meaning, it takes more feed to make one pound of fish. In addition, other factors such as stress, disease, and environmental conditions can cause the FCR to rise. Since catfish are grown to 1.5 to 2.5 pounds, the total feed required to grow each foodsize catfish ranges somewhere between 3.5 and 6 pounds. Several knowledgeable people indicated that an average of 5 pounds for each fish to be a reasonable estimate.

Feeding practices

During the catfish lifecycle, there are a number of feed formulations that may be used, depending on the age and size of the fish. Newly hatched fry are not always fed a manufactured feed. Fry feed is usually used as a supplement to the natural food available in a nursery pond. Fry feed is formulated to provide 50% protein and may be only fed to the young fry for only several weeks. Once the catfish reach the large fingerling stage, they may be fed a 36% protein feed. Again, this period is brief, only lasting a few weeks.

Apart from fry and fingerling feed, there are two primary types of feed farmers use to grow catfish, one is a 32% protein feed, and the other is a 28% protein feed. The choice of which feed to use is determined by the farmer. Many farmers use the cheaper 28% feed but some larger operations use 32% feed extensively. The choice of which feed to use is also dictated by the age and weight of the fish. Newly introduced fingerlings are often fed 32% feed for several months. The fingerlings grow faster on 32% feed than on 28% feed. However, as the fish grows bigger the advantage of 32% feed declines. Studies have shown that once a fish reaches a certain size it grows at very near the same rate whether fed 32% or 28% feed. Since 28% feed is cheaper farmers may switch to the cheaper feed. This is particularly relevant in single batch or modular production systems; however, in multibatch systems 32% feed may be used more since there are several age cohorts cohabitating.

There are different approaches to feeding catfish. Farmers may feed:

- every day to satiation (18%),
- every day but to a maximum limit (12%),
- on alternate days to satiation (38%),
- on alternate days to a maximum limit (21%).

According to the HAHMS 2010 Aquaculture survey, 57.3% of operations used 28% protein feed and 40.4% of farms used 32% protein feed. A small percentage, 0.8%, used 35% feed and the remaining 1.5% used an unspecified ration.

The exact feed composition depends of the price of each ingredient. Feed manufacturers use linear programs to determine the appropriate combination of ingredients that will produce the most nutritionally sound food for the lowest price. The range of possible ingredients includes plant proteins like soybean meal, cottonseed meal, DDGS, CGFM, and wheat middlings. Formulators also may include animal proteins such as meat and bone meal, porcine meal and poultry feather meal. Menhaden fishmeal is rarely used anymore due to high market prices. Feed manufacturers also add minute amounts (> 1%

total composition) of lysine, vitamin and mineral premixes, and phosphates. A very small amount of vegetable oil is sprayed on to the pellets in order to keep dust down which can reduce water quality.

Harvest

Farmers harvest the fish once they reach the size agreed to with the processor. This is usually between 1.5-2 pounds per fish. Prior to harvest farmers have to do several things. The first step is to check the health of the fish. Although no fish diseases can harm humans, a large proportion of severely infected fish may not survive the harvest and transport process. If a small proportion of fish have minor symptoms of a disease, the decision can be made to accelerate harvest to prevent the spread of the disease. This can minimize disease related losses to the farmer.

The next step is to schedule the delivery. Samples are sent to the processor to check flavor quality. If the fish are on-flavor, scheduling process can begin. In addition, farmers sometimes have to deal with off-flavors in their harvest due to algae, or off color due to too much corn or DDGS in the fish diet. Typically, during the summer farmers can simply delay harvest until the algae problem has been fixed, however during the winter fish do not feed much, if at all, so the off flavors do not pass out of the fish in a timely manner. Another issue is off-color. Corn and corn-byproducts tend to give the fish a yellow cast. Off-color issues cannot be ameliorated except by feeding a ration lower in corn.

The processors and farmers work together to schedule deliveries so that each batch of arriving fish can be processed within minutes of offloading. In order to schedule a delivery, processors must take into consideration, transportation distance, other deliveries, processing capacity, size of the delivery, and availability of the size fish required to meet client needs.

Certain conditions need to be met before harvest can begin. Water quality, dissolved oxygen, temperature, and other stressful conditions can cause mortality during the handling and transport. In order for the fish to arrive at the processor alive, farmers take extra care to maintain good water quality in the weeks leading up to harvest.

Farmers quit feeding the catfish 2 to 3 days before harvest. This allows the fish to fully digest any food and eliminate it. Fish with food still in their gut may grade poorly, regurgitate during transport, and do not handle transport stress as well. Processors will deduct a percentage off the price if fish have too much food in their belly.

Levee pond harvest

The basic harvest operation involves seining the pond with a sein net, a seine reel, a live car or sock net, a small motor boat, two tractors, and at least five people. An additional tractor with an aerator is also highly recommended to provide adequate oxygen once the fish are in the live car or sock.

While concept of seining is simple, it does require a great deal of coordination of a large number of moving pieces. Two people operate the tractors pulling the net, two are in the water keeping the net on the bottom, and one person operates the boat to detect problems with the net catching too much mud. One person may be operating the reel and a sixth person may be needed to operate the aerator. With a tractor and one person on the levee on either side of the pond, they start at one end of the pond and slowly pull the net the length of the pond. Once they reach the other end, the tractors converge to close the net so that the fish can be graded and loaded into the sock or live car. Harvest of all the foodsize fish in a pond usually involves the seining process several times. At best, the first seining operation will only capture about 70% of the catfish.

Watershed pond harvest

Watershed ponds with relatively flat bottoms can be harvested like levee ponds. However, deeper or steeply sloped watershed ponds must be harvested different ways. Because watershed ponds are more irregularly shaped, there is no standard method for harvest. Draining water is frequently employed to reduce the size of the pond in order to make seining easier. Due to the steep sides of many watershed ponds, it may not be possible to use mechanical equipment. Sometimes seining is done by hand. The particulars depend on the terrain, pond shape, pond depth, slope, ground firmness, and other factors. Each watershed pond has its own peculiarities and it is up to the farmer to decide the best harvest method.

Once the fish are harvested, they are immediately loaded onto trucks and transported to the processor. To maximize transportation efficiency, trucks are typically loaded at or near capacity, which is 20,000-25,000 pounds. Processing of the catfish occurs generally within several hours of harvest. Transportation to the processing facility accounts for almost all that time delay. Once the trucks arrive at the processing facility, the fish are processed immediately.

Key factors affecting success

Critical to success in catfish production is maintaining appropriate dissolved oxygen levels in the water and ensuring water quality. Disease management is also important; operator experience has been estimated to play a significant role in managing disease on catfish farms.

On the financial side, the industry has been repeatedly subject to cost squeezes, where there is a) market pressure on prices due to competition from imports and/or b) increases in feed costs. At times when both have occurred, even efficient, soundly managed catfish operations can become unprofitable.

3.5. Environmental Adaptation

Catfish are grown in hypertrophic ponds with dynamic environments, in depth of the pond and daily or seasonal variations. These variations can directly, and indirectly, affect catfish survival and growth rate. Some variations increase production. Some stress the catfish and decrease production, but are not necessarily detrimental to the fish. Some of the effects, such as prolonged high stress environments, are detrimental to the survival of the fish.

Stress on catfish negatively influences its ability to adapt to changing environmental conditions and can lead to disease and fish loss if prolonged. Contributors to stress include:

- Dissolved oxygen (see 3.7.2 Natural resource requirements)
- Water temperature (see Production system – channel catfish)
- Water pH changes (see Growing Requirements)
- Nutrition (see Production system – channel catfish)
- Feeding practices (see Production system – channel catfish)
- Handling (see Production system – channel catfish)
- Chemicals (see Chemical usage)
- Water quality (see 3.7.2 Natural resource requirements)

Physiological responses to stress are an adaptation that allows the fish to restore homeostasis, at least in the short term. Primary responses to stress serve to mobilize the energy reserves, fat deposits, and include increased heartrate, increased gill blood flow. The level of stress is important but the length of the cause of the stress is also important. Secondary stress responses occur with high stress levels over the short term and prolonged low levels of stress. Secondary responses to stress include immunosuppression and osmoregulatory imbalance. Secondary responses can be deleterious if left too long, eventually causing death.

The effects of stressors on catfish are temperature dependent; as the temperature falls, the slower and less intense the response. The recovery period from stress depends on water temperature, the particulars of the stressor, the level of stress, and physiology of the fish. Full recovery in the absence of the stressor generally takes 1 to 4 days.

In aquaculture ponds, catfish are routinely exposed for relatively brief periods to low dissolved oxygen. However, these frequent periods of low oxygen are unlikely to have any deleterious effects, although they do produce a primary response. Recovery is very rapid, measured in minutes, once oxygen levels are raised.

A major indirect effect of stress response is immunosuppression. Immunosuppression lowers the resistance to diseases. Disease outbreaks can severely affect the thin profit margin of a catfish farm. Disease outbreaks have occurred due to the indirect response to hypoxia, high nitrates, and net confinement.

3.6. Catfish species

3.6.1. Agronomic Classifications

Catfishes (order Siluriformes, family Ictaluridae) are named for their unmistakable barbels, which strongly resemble a cat's whiskers. Catfish have lived on all continents, except Antarctica, at one time or another. More than half of all catfish species live in the Americas but only one family is indigenous to the US, Ictalurus. There are 2 main types of food catfish grown in the US, channel catfish (Ictalurus Punctatus), and hybrid catfish, a crossbreed of blue catfish (Ictalurus Furcatus) and channel catfish.

3.6.2. Varieties

Channel catfish and hybrid catfish are the two types farmed in the US. Channel catfish is the most commonly farm raised catfish in the US. It grows fast, is easy to spawn, is tolerant to a wide range of temperature and water quality, and has a flavor consumers like. However, channel catfish have some traits that reduce production efficiency; non-uniform growth rates, they are adept at avoiding the seining nets, and they are susceptible to disease.

From the 1960s to the mid-2000s, virtually all US production was channel catfish. Recently however, the USDA Agricultural Research Service assisted farmers with the development of a hybrid variety of catfish in order to improve production efficiency. Female channel catfish were bred with male blue catfish to produce a hybrid with better farming characteristics. The resulting hybrid grows at a uniform rate, is more disease resistant, more tolerant of stressors, easier to catch, and has better processing yields. Commercial production of these hybrids began in the mid-2000s. Many farmers in Alabama have switched to producing hybrid catfish. Adoption has been much slower in the other major production regions. Hybrid production was about 20% of the total catfish production in 2011, though this has undoubtedly increased to about 40% presently.

3.7. Growing Requirements

Catfish can tolerate a wide variety of growing conditions. Optimum water temperature is 75° to 85°F but fish can survive from just above freezing and up to 100°F. For each 18° of temperature change from the optimum temperature, the metabolic rate halves or doubles. Catfish quit growing and feeding at about

50°F. Catfish can thrive in both fresh and mildly brackish water. Fully-grown catfish can tolerate water salinity from 0 to 11 parts per thousand (ppt). However, they prefer salinity below 4 ppt. Eggs will hatch in salinity at 8ppt or less but can survive in salinity as high as 16ppt.

The optimum pH for catfish ponds is a relatively neutral pH, 6.5 to 8.5, though catfish can handle a range of 6.0 to 9.5 without being unduly stressed. Although catfish can readily handle a 1-unit pH change, a 2-unit pH change should only take place over at least half an hour.

While catfish generally prefer clear water, they do just as well in muddy and turbid waters. In clear water, catfish use their eyes to locate food. In turbid and muddy waters, catfish locate food using their sense of taste. Catfish in the wild live off a variety of natural foods including plants and animals. Catfish generally feed near the bottom but may also feed near or on the surface. Catfish will eat aquatic insects, snails, crawfish, green algae, aquatic plants, seeds, and smaller fish. Catfish will also feed on terrestrial insects when they are available. There are also reports of catfish eating small birds. In an aquaculture farming operation, catfish are well adapted to eating many different feeds manufactured from a wide variety of feedstocks.

3.7.1. Rotation and isolation requirements

Water quality in nursery ponds

Nursery ponds where fry are grown to fingerling size are managed a little differently than growout ponds. The catfish fry are especially vulnerable to water quality, disease, predation etc. Nursery ponds are drained and refilled for each new batch of fry stocked. This ensures very high water quality when the fry are the most vulnerable. As time passes, the water quality degrades to the point that it is essentially the same as growout ponds by the time the fingerlings are ready to be switched to growout ponds. This ensures a relatively similar environment between the nursery pond and the growout pond and reduces the stress of entering a new environment.

Aeration is more important for fry and fingerlings than for larger fish. Fry and fingerlings consume more oxygen per pound of body weight than a larger fish. In addition, they are weak swimmers. They cannot swim through oxygen-depleted waters to reach the safe haven of oxygenated waters near an aerator. Nursery ponds have greater aeration needs than growout ponds. Farmers with nursery ponds use more ponds of smaller size with intensive aeration to ensure the greatest number of fry surviving to the fingerling stage.

Catfish fry are also extremely vulnerable to diseases. Infectious diseases can rapidly decimate a nursery pond. Smaller ponds also serve to break up the fry batches into smaller groups so that disease in one pond does not wipe out a large portion or the entire fry population in a nursery pond. Additionally, smaller ponds are easier to treat for infectious diseases.

3.7.2. Natural resource requirements

Of all the natural environmental conditions affecting catfish, water quality is the most important. Water quality depends on the amount of dissolved oxygen, ammonia, carbon dioxide, and nitrates in the water. When a pond is initially filled, the water quality is usually very good. However, over time, the quality deteriorates. A possible by-product of poor water quality is the presence of off-flavors in catfish.

Almost all water quality issues can be traced back to the feed. When the feed is spread on the water, some of it is not eaten and dissolves into the water and gets broken down by algae and plants. Feed that is dissolved into the water contributes to overgrowth of algae, which in turn causes an increase in nitrates and ammonia levels. Algae overgrowths also consume oxygen, further reducing water quality. In addition, some of the food that is eaten becomes waste.

Ammonia

Ammonia is the major byproduct produced in fish waste. Ammonia decays naturally. Higher accumulations cause a decrease in fish feeding activity, which in turn reduces ammonia buildup, thus the problem is self-correcting. Very few cases of ammonia intoxication have ever been recorded; however, ammonia levels can be used to predict the onset of nitrite accumulations as discussed later.

Carbon dioxide

The combined respiration of all the organisms living in a pond serve to deplete the oxygen levels while simultaneously increasing the carbon dioxide levels. Carbon dioxide levels are not usually measured by farmers.

Nitrites

Nitrite toxicosis or brown blood disease can be deadly to fish. Even low levels of nitrites can cause toxicosis. Ammonia from uneaten food, fish waste, and organic matter is oxidized into nitrites by bacteria called Nitrosomonas. Nitrites are further oxidized by bacteria called Nitrobacter into nitrates, which has a low toxicity for fish. The breakdown of nitrates occurs naturally by aquatic plant uptake. The rate of this final step depends on environmental conditions. The factors affecting the nitrification rates include ammonia concentration, temperature and dissolved oxygen. High levels of ammonia by themselves do not lead to excess nitrites; ammonia levels tend to self-correct quickly so that no problems ever present. The problem with excess nitrites occurs when excess ammonia and one or more factors that slow the rate of decay of nitrites into nitrates occur simultaneously.

Nitrite toxicosis in early aquaculture in the US caused severe losses; however, this occurrence is very rare now. A simple monitoring program can easily detect when levels get a high. Monitoring ammonia levels can predict the onset of excessive nitrites. Remedial action is accomplished by spreading common table salt on the pond. Fish losses due to nitrite toxicity are now the consequences of lax management.

Oxygen management

The last factor in water quality is dissolved oxygen. This is the single most important part of water quality especially during the summer nights when oxygen demand is high and absorption is very low.

Like all animals, fish need oxygen to survive. Aeration is the single most important management activity related to growing catfish. Ensuring that the catfish have enough dissolved oxygen in the pond is time consuming and labor intensive. The amount of dissolved oxygen becomes a limiting factor due to the respiration of fish, phytoplankton, and mud dwelling organisms. Combined, these can place a demand on oxygen greater than the water surface interaction can replace. Aeration is needed to increase the water-air interaction to facilitate greater oxygen absorption.

Chemical usage

Chemicals are discouraged unless there are no alternatives (lack of chemical contamination is one of the key selling points of aquaculture). Chemicals may ultimately be required for a number of reasons, however, from disease or algae control, to managing water quality, to eliminating undesirable fish, insects, or weeds, or even to sterilize a pond.

3.8. Diseases, pests, and mortality

Unlike most other agricultural products, it is virtually impossible to account for losses in aquaculture. Cattle, sheep, and pigs are easy to count, not so with catfish.

A farmer only knows approximately many fry he put into the pond the first time after it was filled. Additionally, there is no way to count losses, small fry may never appear on the surface, older fish may die and be eaten, cannibalism is known to occur, no one counts the dead fish, fish can evade nets, and loss to avian predation is impossible to count. Some farmers attempt to compensate for unobserved losses by adding fingerlings into their growout ponds. They restock the observed losses plus some unknown additional amount to offset the unobserved losses. This further exacerbates the inventory inaccuracies.

This inventory counting issue was one of the major obstacles identified to insuring several aquaculture species studied under the National Risk Management Feasibility Program for Aquaculture (NRMFPA). Although many hours were poured into finding a solution it was evident that the current technology and production practices could not account for pond inventory or losses Researchers in that program concluded that in order to develop an actuarially sound program, the ability to count inventory and losses would need to be solved along with several other issues.

Researchers continue to research disease controls, management systems, pond systems, and other technologies that may solve the inventory counting problem in the future.

Catfish can die or be lost for many reasons.

- Death due to a wide range of diseases, many factors including, poor water quality, inadequate nutrition, or what is sometimes called 'trade mortality'; in other words weaker fish just dying earlier in their life cycle than others in the population.
- Death may be due to predation from birds, terrestrial mammals, or reptiles, such as snakes. Where determined predators are present, only partial protection or deterrence is possible in some systems and predation is a significant problem.

  A few measures are available to deal with predatory birds. However, they are either insufficiently effective, or too expensive. Some ponds have lines across them to discourage birds from landing; in other cases, human teams have been used to scare the birds away. Nets are not used – they are simply not feasible from a management or economic standpoint due to pond operations and/or pond size - ponds in most cases are too large (several acres in size).
- Losses may result from severe weather and subsequent impacts. Severe weather and resulting floods may wash out all or part of a containment structure. Some larger fish are susceptible to death from lightning strikes.
- Cannibalism, which is not thought to occur in most farmed fish if they are all about the same size and well fed, may be more common than often assumed, especially if there are a wide variety of sizes. The latter can occur when a fish population has not been well graded, or where some pond systems are never fully fallowed between harvests, therefore allowing some larger fish to remain.
- Deliberate culling of weak or 'poor doing' fish' may also be part of the management strategy.

- Human error in operating the equipment and facilities may cause mortality e.g. failure to properly aerate the ponds.
- Handling stress

The most common diseases, rate of occurrence and treatment are shown in the following table.

Table 5: Percent of catfish operations that lost any food size fish to the following causes in 2009.

Disease name	Cause	Occurrence
ESC (Enteric Septicemia)	E. ictaluri	36.6%
Columnaris	F. columnaris	39.0%
Winter kill		20.6%
Anemia		7.9%
Proliferative Gill Disease (PGD)	H. ictaluri	13.6%
Visceral toxicosis (VCT)	Clostridium botulinum type E	5.2%
Trematodes	B. damnificus	3.7%
Ich (white spot disease)		4.9%
Predation (avian or other)		53.9%
Low dissolved oxygen		28.1%
Other		9.3%

Source: USDA APHIS National Animal Health Monitoring System

ESC is the disease that causes the most mortality in commercial catfish ponds. A vaccine was developed in 2008. The vaccine is currently undergoing dosage and efficacy trial verification.

3.8.1. Pests

Bird predation is identified as one of the more serious threats to catfish farms. The high density of fish on catfish farms makes them attractive to birds such as cormorants and pelicans. The impact on farms is varies significantly, but some producers can be heavily affected. Estimates in the 1990s suggested that bird control costs for the industry were $2 million, with losses around $5 million.

Insect predation is only a problem with recently hatched catfish fry for the first 3 to 6 weeks of age. Only two types of insects prey on catfish fry, though the newly hatched fry are extremely vulnerable to predation. Air-breathing insects such as backswimmers or gill breathing insects such as dragonfly naiads prey on fry.

3.8.2. Diseases

In the beginning of commercial catfish aquaculture, lower stocking densities impeded disease transmission. However as stocking densities rose so did the incidence of disease. The increased disease transmission rate in a densely stocked pond is the primary limiting factor in catfish production. Disease outbreaks are common, even on the best-managed farms.

About 45% of fingerling loss is attributable to disease. Numbers on losses in the growout ponds are harder to come by since it is impossible to accurately count inventory and because of poor record keeping and under reporting. Infectious diseases are estimated to cost farmers millions of dollars per year. Effective disease management consists of identifying a problem, diagnosis of the disease or diseases, and corrective treatment. Compounding the problem is that multiple infectious diseases can occur simultaneously. This complicates corrective actions.

3.8.3. Mortality

Fish losses happen throughout the production cycle; however, the majority of losses occur in hatching, and at the fry and fingerling stages. Smaller fish are more susceptible to diseases, predation, cannibalism, and water quality than larger fish. The overall survival rate from egg to foodsize catfish is about 45%. The Alabama Fish Farming Center suggests that fish losses in growout ponds are 10 to 20% annually. Some losses in current operations are beyond the farmers' control. Fish loss due to predation simply cannot be controlled using current technology. The majority of losses, other than the survival rate of small fish, come from oxygen depletion. Catastrophic losses are rare with the advent of oxygen management and aeration technology.

3.8.4. Perils

Most perils that result in losses can be influenced by management. The three most common perils reported by farmers in the NAHMS catfish survey are predation, low dissolved oxygen and disease. Low dissolved oxygen levels are frequently caused by other factors that are influenced by management (such as stocking intensity, feeding procedures, water quality treatment, etc.) and by natural conditions (weather, water source quality, etc.).

In 2009, 54% of catfish producers lost food-size fish to predation. The larger farmers experienced significantly more predation than the smaller operations. Low dissolved oxygen was identified by 28% of operations. Again, this peril was three times more common in the largest ponds compared to the smallest ponds. The three most common diseases were columnaris (affecting 39% of operations), enteric septicemia of catfish (ESC – resulting from eswardsiella ictaluri infection and affecting 37% of operations) and winter kill (a fungus affecting 21% of operations).

Farmers reported that roughly 12% of ponds had major mortality events (defined as 5% or more of mortality loss over a period of two weeks) in 2009. The average losses were roughly 4,500 pounds per acre on average. Ponds with no major losses produced 1,000 pounds more catfish per acre than those with losses.

Producers reported 43% of ponds suffered losses from predation, 14% from ESC, 14% from columnaris, 7% from winterkill, 3% from proliferative gill disease, 1.8% from anemia, 1.7% from visceral toxicosis of catfish, 1% from trematodes and 1% from ich. 4.5% of ponds suffered from losses classified as 'other' and 9.5% reported losses because of low dissolved oxygen. Each of these loss events were identified as, light, moderate, or severe. The causes of loss with the greatest proportion of severe losses were trematodes (27%) anemia (26%) columnaris and proliferative gill disease (both with 11%). However, 23% reported severe losses because of low dissolved oxygen and 53% because of other causes of loss. More than two thirds of these 'other' losses that were severe were reported to be because of Aeromonas bacteria.

Management action can reduce the incidence of predator damage, although this can be expensive for large ponds and is rarely entirely effective.

Sound management is the first line of defense. The less stress put on the fish the better. Stress and poor water quality greatly increase the risk of disease. To prevent disease on farms, producers have multiple tools. First, they can maintain ideal stocking densities and water conditions and second they can vaccinate or purchase vaccinated fingerlings (against columnaris and eswardsiella).

Dissolved oxygen levels can be monitored and in many cases are. In 2009, all operations with 50 acres or more monitored the levels of dissolved oxygen in their ponds. Methods varied, but included automated sensors and hand monitors. Only roughly 50% of the farms with less than 20 acres regularly tested the dissolved oxygen levels. However, the lower stocking density at smaller farms reduces the risks of low levels of dissolved oxygen. If the dissolved oxygen level does drop below recommended levels then aeration can be used to increase the levels of dissolved oxygen. Additionally,the NAHMS catfish survey reported that 17% of small operations had no aeration capability.

There were differences in water treatment to maintain quality. For example, 30% did not use salt to modify chloride levels and 67% did not add calcium to modify alkalinity. One third of producers used no algae control treatments. Those that did, used copper sulfate, Diuron, or biological control (algae eating fish). Only 13% use any form of control of snails (a host of trematodes). Of course, this may not imply poor management as those not applying treatment may have adequate water quality.

To avoid some leading diseases, producers can stock their pond with fingerlings that were vaccinated against columnaris and ESC (using FDA approved immersion vaccines at the fry stage). In 2009, 6.2% of food-size operations stocked ESC-vaccinated fish, which accounted for 4.9% of the total catfish, and only 3.9% of operations stocked columnaris vaccinated fingerlings, which accounted for 2.7% of the catfish.

Vaccinating fish does not completely remove the risk of infection. ESC outbreaks occurred on 47% of operations that contained food-size, vaccinated fish. Even though ESC still occurs on farms with vaccinated fish, 42% of producers believed the vaccinated fish had better survival rates than non-vaccinated fish, 21% thought they fared equally and 38% did not know. In addition, 13% thought that the vaccinated fish had a better growth rate; no one reported lower growth rates in vaccinated vs. non-vaccinated fish.

The results for columnaris-vaccinated fish are similar. There were outbreaks on 59% of farms that had vaccinated fish. Outbreaks were also treated with medicated feed. Almost 50% of farmers that stocked vaccinated fish thought they had better survival rates, and 40% did not know if it was better or worse. Over 13% thought that the growth rate in vaccinated fish was better and no one reported worse growth rates.

In addition to adjusting water quality, producers can use medicated feeds to fight bacterial infections. Only 8.2% of operations used any medicated feed as a treatment for bacterial diseases. The percentage was consistent for all operation sizes. There are three approved antibiotics: Romet, used by 50% of those using medicated feeds, Aquaflor used by 36% and Terramycin used by 26%. The larger operations used more Aquaflor.

4. MARKETING

a) Pre-harvest prices

The only information on preharvest prices comes from enterprise budgets last published in 2005. In addition, the most recent study conducted on the effects of quality and price correlations are more than ten years old.

b) Describe how prices are determined; if contracted, provide copies.

To determine the use of contracts we spoke with a couple of the larger processors. No one we spoke to reported using a standard contract. Instead, the only records are written agreements, and not all farmers and processors use them. In some cases, agreements were drafted by the farmers themselves.

As described, catfish sales arrangements are often made in advance based on relationships and handshakes. Where written agreements are used, they are considered legally unenforceable. Their value – as described by processors – is that they serve as a reminder / confirmation of the handshake agreement.

The processors we spoke with said they had never had to legally enforce an agreement. One large processor indicated that only about 10% of their processed volume was procured under a written agreement.

Where they are used, agreements sometimes stipulate prices, as well as a premium for delivering all promised volume, and discounts for under- or oversized fish.

Price discounts. During the listening session and phone conversations with processors, it was made clear that farmers suffer price reductions for things such as under- or oversized fish and off-flavors. Beyond that, no formal or standard price reductions are known. Since many of the processor and farmer agreements are conducted by handshakes and simple written agreements, it is likely that the price differentials are unique to each agreement. However, several people we have spoken with indicate the premium is about “a few cents” or “several cents per pound”.

c) Describe how catfish are utilized

Catfish are processed into several different products. By far the most popular form is fresh or frozen fillets. Catfish are commonly processed the following ways, according to uscatfish.com:

- Whole Dressed (fresh)
- Steaks (cross-section cuts from larger dressed fish, fresh or frozen)
- Fillets (boned sides of the fish, cut lengthwise away from the backbone, fresh or frozen)
- Regular and shank fillets (regular fillets have the belly section attached, shank fillets have the belly section removed, fresh or frozen)
- Nuggets (boneless pieces cut from the belly section of the fillet, fresh or frozen)
- Strips and fingers (smaller pieces of fish cut from fillets, fresh or frozen)

In addition to cutting the fish into the products described above, some processors also produce further value-added products, such as convenient or “heat and eat” food. The most common value added processing is breading the fillets, strips, and nuggets for quick frying in restaurants or in the home.

US catfish has a well-defined niche market that is mainly confined to the Southern United States. Almost all US Catfish consumption occurs in the states where catfish is produced. Catfish is sold in regional supermarkets or may be offered in national chains with stores located in the Southern US. Additionally, many regional restaurants buy catfish directly from the processor, especially the fillets and value added products.

Since it is a high quality, and relatively expensive, niche product, US farm-raised catfish may be offered at specialty food shops and mid- to high-end restaurants nationwide. However, most US residents outside the Southern states are unfamiliar with catfish. The decline of catfish production and its higher price than tilapia, swai, or pangasius limits the potential of targeting catfish to the average US consumer.

d) Establish insurable interest of producer. By region, describe critical time periods to market and/or sign contracts

Insurable interest. For regular crop insurance, a catfish farmer's fish would be the insurable interest. In this case, however, the insurable interest for the purposes of gross margin insurance would be the catfish farmer's own gross margin (i.e., the price received for catfish less the marginal costs of feeding and raising the fish). The assumption in this case is that the market gross margin (i.e., catfish market price less a standard market catfish feed price) is a reasonably proxy for the farmer's own gross margin, since feed represents the largest component of the farmer's marginal costs.

Critical time periods / contract signing. Timing of catfish sales is no longer "lumpy". In the early days of catfish aquaculture, farmers would stock ponds in a single batch, and then harvest all at the same time about 15-18 months later. Although farmers could stock half the ponds one year and the other half the next year, many farmers were harvesting in a narrow range of late fall around October and November. This created a glut in the market. Multiple batch systems allow greater freedom on timing since a new batch is ready every few weeks or months, and helps to prevent market gluts. In addition, processors can more efficiently use plant capacity by operating year round.

Since more than 80% of farms use a multiple batch productions system, it makes sense that market timing of contracts is not as standardized in catfish as in other agriculture species. However, there is increased activity as the growing season begins. Farmers begin feeding fish around April and will be looking to book their feed deliveries for the year as early as December or January. Most of the single batch farmers are getting ready to stock fingerlings. Some of the multiple batch farmers will be buying fingerlings as well.

The feed booking contract might be relevant as proof of intent to produce a certain amount of fish and could be required documentation as part of an insurance policy.

5. PROGRAM AVAILABILITY

a) Identify statute changes required for RMA to provide coverage

The type of catfish gross margin insurance program that the Farm Bill required be investigated appears to fit within RMA's existing programs and policies. It would be similar to the LGM-Cattle, LGM-Swine, and LGM-Dairy policies.

However, as it would be a new livestock policy, it would have to fit within the existing $20 million program cap. RMA has confirmed that all animals are included as livestock under the AGR, now the Whole Farm plan. Catfish margin would be included in the $20 million limit unless a legal review found otherwise.

Given this limitation, any catfish policies sales would reduce funds available to the other existing policies. Since dairy policy sales use the bulk of the funds, any catfish policy sales would likely reduce funds that would have otherwise been used by dairy policy sales.

We do not believe a change would need to be made in the statutory language to develop an LGM-Catfish policy.

b) Identify regional & USDA grading standards

Until recently, catfish processing has not been under the purview of the USDA like red meat and poultry processing. Recently Congress passed the requirements of fish inspection to the USDA. Draft rules have been published but no rules have been formalized or implemented yet.

Catfish production and processing were subject to oversight from various agencies prior to the recent change. Processing operations were under Good Manufacturing Practice Code of Federal Regulations title 21, Part 110 of the Food and Drug Administration (FDA). Other than that, no other regulatory framework existed. However, the catfish processing industry *voluntarily* contracted with the National Marine Fisheries Service (NMFS) under NOAA to have their plants inspected. The primary impetus was to ensure unbiased standard grading standards and to ensure a high quality product and facility. The inspectors issue certificates verifying quality and the condition of the processed products. In turn, the processors must pay to have their facilities, procedures, and products certified.

c) Identify grading agents and independence of agents

Although the primary contractor is NMFS, the actual inspection is subcontracted to a Department of Commerce (USDC) inspector, or a cross-licensed State or USDA inspector. The inspectors inspect the product to determine whether the product is clean, safe, and properly labelled. They also inspect the plant, equipment, and handling procedures to establish that it meets established sanitation and hygiene standards.

USDC also performs grading. Only products that have established grade standards can be graded. The processing industry, retailers, and consumers all rely on the grading standards. Contracted lots of product may be inspected to ensure it meets the contracted specifications of the buyer that requests the inspection. USDC also performs consultation services, assistance in specifications, development of labels and analytical tests.

In 1988, The Catfish Institute in combination with the USDC and NMFS began a voluntary third party certification process. The goal was to promote quality catfish products. Processors can voluntarily elect to meet the higher standards and receive certification and additional labelling stating it meets that standard. The catfish processing industry adopted Hazard Analysis Critical Control Point HACCP guidelines set forth by the FDA in 1994. The Catfish Institute requires these guidelines to be met by plants that elect certification in their program as a Certified Processor.

d) Provide a copy of grading standards

Grading standards are included with the appendices to this report.

e) Describe alternative uses of reduced quality fish

Off-flavor fish are particularly a problem in the mid to late summer months, although off-flavors can persist for 6 months. The presence of off-flavors in a crop typically means the farmer simply waits for the off-flavor to be eliminated before he harvests. A simple treatment can also be used to eliminate the off-flavor in several weeks. However, treatment costs money. Unless the need for harvest is imminent, farmers will generally wait for the off-flavors to be eliminated naturally.

Sometimes the processor needs fish to fill orders and the only fish available for harvest are off-flavor. In those cases, the processor may accept off-flavor fish. When off-flavor fish are accepted for processing, the farmer is paid a price, discounted several cents per pound. Off-flavor fish is processed normally into fresh and frozen products and value-added breaded products.

f) Determine impact of Federal Marketing Order, if any, on insurance plan

The catfish industry has considered, but not implemented, a federal marketing order under the Agricultural Marketing Agreement Act.

Though there is no federal catfish marketing order, there are a couple of state programs raising funds for research and promotion:

- The Arkansas Catfish Promotion Board collects a mandatory $1 fee per ton of catfish feed purchased by commercial Arkansas catfish producers. These funds are used for research and promotion.
- Alabama catfish farmers have their own voluntary commercial fee assessment for research and marketing purposes. This was raised in early 2015 from $0.50 to $1 per ton of catfish feed sold. The new rate is projected to raise about $120,000 per year. The additional funds will help fund disease research on aeromonas, a bacterial pathogen that has substantially affected production in Alabama in recent years.

Neither of these state assessments would impact an insurance plan, nor would we expect a federal marketing order to alter the viability of catfish insurance plans, as they would not alter operational nor market risks to producers.

6. A REVIEW OF LIVESTOCK PROTECTION PLANS

6.1. Statutory language

The Agricultural Risk Protect Act (ARPA) of 2000 instructed the Federal Crop Insurance Corporation (FCIC) to establish pilot livestock protection programs.

The statutory language is as follows:

> ''SEC. 523. PILOT PROGRAMS.
> ''(a) GENERAL PROVISIONS.—
> ''(1) AUTHORITY.—Except as otherwise provided in this section, the Corporation may conduct a pilot program submitted to and approved by the Board under section 508(h), or that is developed under subsection (b) or section 522, to evaluate whether a proposal or new risk management tool tested by the pilot program is suitable for the marketplace and addresses the needs of producers of agricultural commodities.
> …
> (b) LIVESTOCK PILOT PROGRAMS.—
> ''(1) DEFINITION OF LIVESTOCK.—In this subsection, the term 'livestock' includes, but is not limited to, cattle, sheep, swine, goats, and poultry.
> ''(2) PROGRAMS REQUIRED.—Subject to paragraph (7), the Corporation shall conduct two or more pilot programs to evaluate the effectiveness of risk management tools for livestock producers, including the use of futures and options contracts and policies and plans of insurance that protect the interests of livestock producers and that provide—
> ''(A) livestock producers with reasonable protection from the financial risks of price or income fluctuations inherent in the production and marketing of livestock; or
> ''(B) protection for production losses.
> …
> ''(10) LIMITATION ON EXPENDITURES.—The Corporation shall conduct all livestock programs under this title so that, to the maximum extent practicable, all costs associated with conducting the livestock programs (other than research and development costs covered by section 522) are not expected to exceed the following:
> ''(A) $10,000,000 for each of fiscal years 2001 and 2002.
> ''(B) $15,000,000 for fiscal year 2003.
> ''(C) $20,000,000 for fiscal year 2004 and each subsequent fiscal year.[3]

Subsequently, RMA established both Livestock Gross Margin (LGM) programs for beef cattle, swine, and milk producers, as well as Livestock Risk Protection (LRP) programs for cattle, feeder cattle, swine, and lambs.

[3] *Agricultural Risk Protection Act of 2000*, Public Law 206-224. June 20, 2000, Sec 523(b)(2).

Here, we review the LGM programs as well as LRP-Lamb, which although not margin programs, have elements that are instructive for the catfish case. Additionally, the privately offered Dairy Margin Protection Program (Dairy-MPP) provided the basis and model for the catfish ration we used.

6.2. Livestock gross margin (LGM) plans

Livestock Gross Margin plans help farmers manage risk by insuring that the prices they receive for their production is adequate to cover their input costs. Typically, margin programs insure against losses for the most volatile variable costs. In the case of, animal production, feed costs are the largest and most volatile of the variable costs.

6.2.1. LGM-Cattle

The Livestock Gross Margin-Cattle policy is available in select states and covers the gross margin difference between the market value of livestock minus feeder cattle and feed costs. It uses futures prices to calculate expected gross margin and actual gross margin.

Insurance sales are available 12 times per year and allow farmers to insure their targeted marketings (the maximum number of slaughter-ready cattle the producer will sell) for the 10-month period beginning one month after the sales closing date. Farmers can choose deductibles ranging from $0 dollars per head to $150 per head in $10 increments. The premium is due with the insurance application.

Indemnities are based on market prices and not on prices received by the producer. LGM-Cattle does not insure against death, damage, or other loss. LGM-Cattle policies have had unsubsidized premiums.

6.2.2. LGM-Swine

The LGM-Swine policy provides protection against the loss of gross margin (again, the difference between the value of livestock and feed costs). LGM-Swine uses futures prices to determine expected gross margin and the actual gross margin. It is available to cover farrow-to-finish, feeder pig-finishing operations, and segregated early-weaned operations. Swine are assumed to be marketed at 260 pounds. The policy coverage includes assumptions regarding proportions of feed inputs for each of the different insurable operations.

Insurance is available 12 times a year and covers the six-month period following sales closing, but coverage is only in effect beginning one month after sales closing, so five months are actually insured. The sales period begins as soon as RMA reviews data submitted by the developer after the close of markets on the last day of the price discovery period. The sales period ends at 8pm Central Time the following day (Saturday).

For LGM, a producer may insure as many as 30,000 hogs per year with up to 15,000 hogs for any 6-month insurance period. There is a 3% surcharge added to the producer's premium. The premium for LGM-swine is due at the end of the insurance period.

Indemnities are based on market prices and not on prices received for animals. Farmers can choose deductibles ranging from $0 dollars per head to $20 per head into dollar increments. The premium subsidy is negligible — under 1% for 2014.

6.2.3. LGM-Dairy

The LGM-Dairy policy provides protection against the loss of the margin between milk market value and feed costs. It uses futures prices for corn, soybean meal, and class III milk to calculate the expected gross margin and the actual gross margin.

Insurance sales are available 12 times per year and allow a farmer to insure all the milk they expect to sell over the 11-month insurance period, which includes the 11 months following sales closing. Coverage does not include the first month following sales closing, just the 10 months afterwards.

Indemnities are based on market prices and not on actual milk prices received. Policies are capped at 24,000,000 pounds of milk per year. The level of subsidy provided depends on the deductible amount chosen.

LGM-Dairy does not insure against cattle death, production losses, changes in feed use, or multiple-year milk price declines or multiple year changes in feed costs. The policy premiums on average were subsidized 42.8% in 2014. This higher subsidy likely accounts for its much higher participatione.

6.2.4. Usage of the LGM plans

The cattle and swine LGM programs have had very limited participation to date. From 2012 to 2014, they sold approximately 30 and 140 policies per year, respectively. By contrast, the dairy LGM program has led to the full use of the LGM program funds for the last several years.

Table 6: LGM insurance plans - policies, loss ratio, and subsidy by plan, 2012-2014

	Year		
	2012	**2013**	**2014**
Cattle			
Policies	29	33	39
Loss ratio	2.25	0.88	0.00
Subsidy (%)	0.0	0.0	0.0
Dairy cattle			
Policies	1,769	1,697	1,621
Loss ratio	0.07	0.16	0.23
Subsidy (%)	46.3	45.4	42.8
Swine			
Policies	140	142	142
Loss ratio	1.34	0.46	0.46
Subsidy (%)	3.9	1.0	0.7

Source: RMA

6.3. Other related plans

In addition to the three LGM plans, we reviewed a couple of other insurance plans of interest to this particular investigation: Livestock Risk Protection policy for lamb (LRP-Lamb), and the Margin Protection

Program (MPP) for milk. The LRP policy is provided by RMA; the MPP program is administered by the Farm Services Agency (FSA).

6.3.1. Lamb Livestock Risk Protection

The lamb Livestock Risk Protection program (LRP-Lamb) offered by RMA, available in select states, is designed to protect producers against market price declines. It can cover feeder or slaughter lambs that weigh between 50 and 150 pounds by the ending period. There is an annual limit of 28,000 head per producer per year (July 1 to June 30).

The insurance period can be 13, 26, or 39 weeks in length. Coverage prices range from 80% to 95% of expected ending value. The premium is due when a specific coverage endorsement is applied for. Coverage begins when RMA approves the coverage endorsement purchase.

LRP-Lamb was of interest and included in our analysis because it shares a similarity with catfish: lamb markets also lack a publically traded futures. The program instead uses a complex model to forecast future prices. The actual ending value is derived from data published by Agricultural Marketing Services.

A formal evaluation of LRP-Lamb concluded that

> *"… the model did not perform well in predicting prices, particularly in a market experiencing unusual changes in value. There is evidence that the model should not be expected to perform well out of sample over a sustained period, even with regular recalibrations. No model is likely to have access to the same volume of information about the lamb market that the potential insured growers will have on any given week and this information asymmetry gives rise to the potential for adverse selection. There is substantial evidence of adverse selection throughout the life of the program to date and there is no actuarially sound approach to adjusting rates for adverse selection… it is the overall finding of the contractor that the program should be terminated based on deficiencies and model approach and evidence of historical abuse the cannot be adequately addressed within the current construct.*[4]

It is our understanding the LRP-Lamb policy was suspended during the evaluation but has been reestablished after program changes were made following the evaluation.

The LRP-Lamb insurance policy summary for 2012-2014 is shown in the following table.

Table 7: Lamb LRP insurance plan - policies, loss ratio, and subsidy %, 2012-2014

	Year		
	2012	**2013**	**2014**
Lamb			
Policies	362	394	284
Loss ratio	6.12	6.40	4.06
Subsidy (%)	13.0	25.3	34.9

Source: RMA

[4] "Evaluation of the LRP Lamb Insurance Program". RMA Order No. D12PD01589 (2012), pp. 84-85.

For 2012-2014, loss ratios were high (6.12, 6.40, and 4.06) and the subsidy percentage has been increasing, reaching 34.9% in 2014. Following a formal evaluation of the program, LRP-Lamb sales were suspended on February 5, 2014. Changes were then made to the plan - including the adoption of a new price prediction model – and sales were allowed to resume on May 4, 2015. RMA shows sales of 30 LRP-Lamb policies for FY 2015.

6.3.2. Dairy Margin Protection Program (MPP)

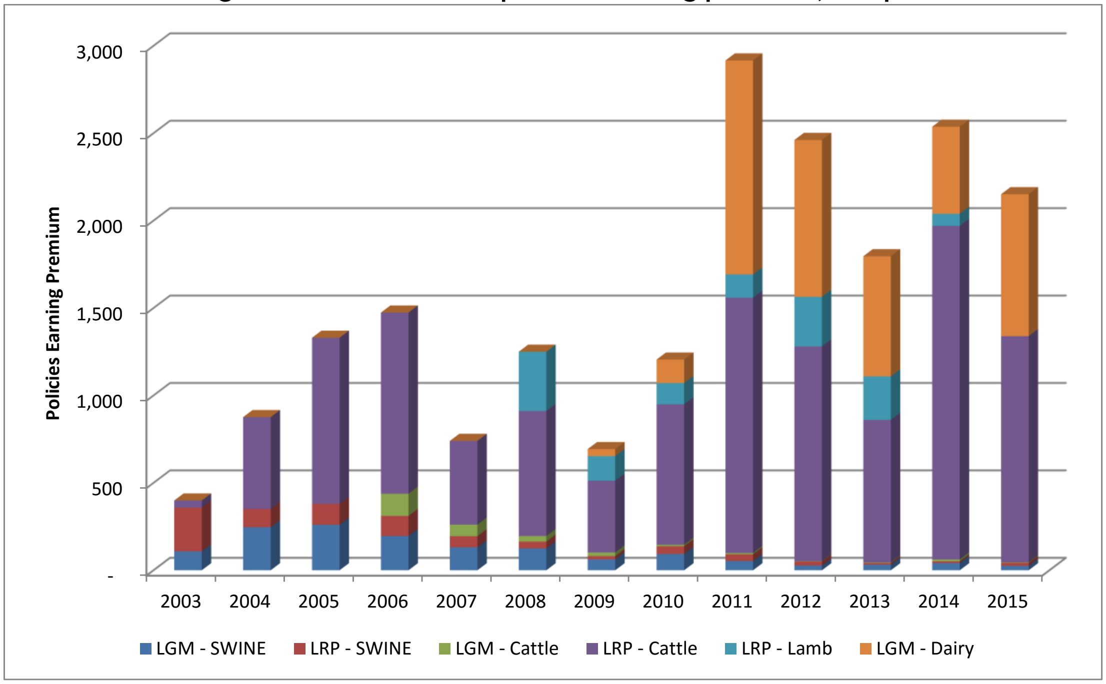
The Dairy MPP plan, administered by the Farm Service Agency (FSA), offers catastrophic coverage for a $100 fee. It is not rated using actuarial standards and consequently has the character of a revenue support policy rather than a crop insurance plan. It provides coverage of a $4 per hundredweight (cwt) margin at 90 percent of the largest production year out of the producer's previous three-year history. It also offers different levels of buy-up coverage to guarantee margins up to $8 per hundredweight.

We included the Dairy-MPP because it has some characteristics that can be adapted to a catfish margin program. One of the specific margin plans for animals called an "Income Over Feed Costs" plan. IOFC plans insure that feed costs are covered by the revenue generated. The other costs associated with catfish farming are relatively stable, while feed costs are highly volatile. RMA has identified the IOFC model as way to insure catfish farmers and stipulated so in the statement of work for this project. The feed ration methodology in the Dairy-MPP serves as the basis of the feed ration model for catfish in this report.

6.4. Comparison of current LGM and LRP products

This section discusses the insurance experience for both the LGM and LRP programs. A major change to the program was the addition of a 28% premium subsidy for Dairy Cattle in 2011. As mentioned previously the LRP program has a 13% premium subsidy and LGM (excluding Dairy Cattle) has a 3% premium surcharge. Since 2011, Cattle-Dairy has comprised most of the insured liability for the program, and it is our understanding that it depletes the $20 million administrative cap on an annual basis.

Figure 12: LGM and LRP policies earning premium, all species

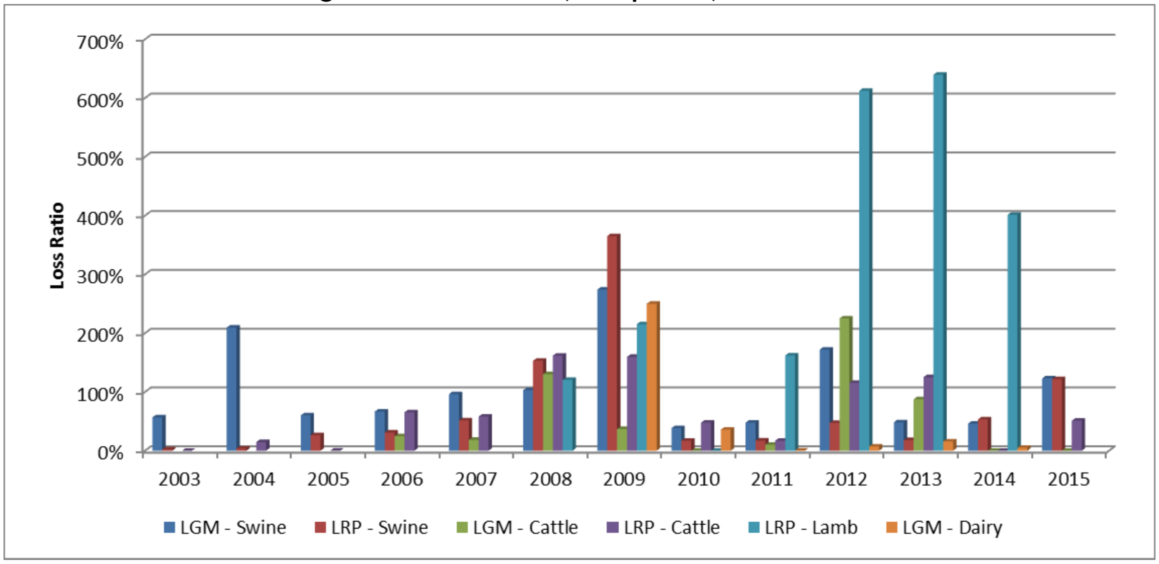


Source: USDA RMA

Policies earning premium for LGM – Dairy increased significantly in 2011 when the 28% subsidy was added. Policies earning premium for LRP-Cattle have fluctuated between roughly 500 and 2,000 annually throughout the history of the program. The LRP-Lamb product was withdrawn during 2014 following an RMA commissioned study, but it is now available again.

The next chart displays the loss ratio (Indemnity divided by Premium) for the LGM and LRP plans by year. Overall, the loss ratio is 62% for the 2003-2015 years (although more indemnities may be payable in 2015). The LRP-Lamb product had very high loss ratios in most years. The recent evaluation of the Lamb LRP explains the higher participation and loss ratios for LRP-Lamb are due to asymmetrical market knowledge by the producer. The higher participation is due to the fact that, unlike the other commodities insured under LRP and LGM there is no futures market for lamb. This creates a situation where the producer has greater market knowledge and the poor ability of the forecast model to predict prices creates an imbalance producers can exploit. The overall loss ratio for LGM-Dairy has been only 6%; however, it has been the most popular product by far.

Figure 13: Loss ratios, all species, LRP & LGM



Source: USDA RMA

6.5. A summary of plans, needs, and data sources

We reviewed existing livestock policies to help determine the most appropriate approach to developing a catfish margin program. The following table identifies the basic characteristics, information requirements and sources, and approach used for the existing LGM and related animal policies - and how a potential one for catfish fits by comparison.

Table 8: Summary of livestock insurance plans

	Information needed	Data and source	Challenges	Time horizon to rate	Lessons from the model
Cattle LGM	Income Over Feed Cost (IOFC) margin determined by • Beef futures market • Feed futures market	• CME Group (Chicago Mercantile Exchange and Chicago Board of Trade) futures markets for live cattle, feeder cattle, and feed	• Futures markets have minor errors that grow over the time horizon	11 months rolling 1 month periods	Futures markets are more accurate in the short term and less so long term, but still accurate enough to rate out to a year.
Swine LGM	IOFC margin determined by • Swine futures market • Feed futures market	• CME futures markets for swine and feed	• Futures markets have minor errors that grow over the time horizon	6 month rolling periods, 12 periods/year	Futures markets are more accurate in the short term and less so long term, but still accurate enough to rate out to a year.
Dairy MPP	• Farm production history • US average All Milk Price • US average feed ingredient prices	• USDA all milk price • USDA US average corn price received • Central/Decatur IL Soybean meal (SBM)price • USDA Agricultural Marketing Service (AMS) average alfalfa price received	• Forecast of MPP margin to rate	11 months, rolling 2 month insured cycles	Not comparable, but forecasting has been developed.
Dairy LGM	IOFC margin determined by • Milk futures market • Feed futures market	• CME futures markets for milk and feed	• Futures markets have minor errors that grow too large over long time horizon	2-11 months, rolling	Futures markets are more accurate in the short term and less so long term, but still accurate enough to rate short periods.
Lamb LRP	• Future lamb prices • Actual lamb prices	• Econometrically modeled • USDA AMS	• Future lamb price is forecast using econometric model	12 months, cumulative	Evaluation of econometric model indicated it is insufficient to forecast lamb prices accurately.
Catfish LGM	• Current and future catfish price • Current and future feed price	• No source for future catfish price • CME futures markets for feed ingredients • Current prices for feed and catfish	• Future catfish price forecast requires an econometric model • Feed and catfish price informally reported by Dr. Hanson.	TBD but in order to accommodate catfish growout period - 15 months, rolling Apr-Oct, cumulative	Predicted results: • Model to forecast future fish price will be very inaccurate

In the following table, we summarize the information needs and availability for catfish, in comparison with the existing LGM and LRP-Lamb programs.

Table 9: Information needed to develop a ratable insurance product to protect gross margin - sector summary

Sector	Product prices		Feed prices		Measurable production
	Current	Future	Current	Future[1]	
Cattle	✓	✓	✓	✓	Yes
Swine	✓	✓	✓	✓	Yes
Dairy	✓	✓	✓	✓	Yes
Lamb	✓	X	N/A[2]		Yes
Catfish	[3]	X	[3]	✓[5]	No[4]

[1] Future feed prices can be forecast using weighted futures for individual feed ingredients
[2] LRP-Lamb is not a gross margin program
[3] Could be collected and reported but are not currently produced in the public domain. Limited data is collected by Auburn University Professor Terry Hanson.[4] Inventory could in theory be implied/tracked by feed purchases; however, practically speaking, catfish losses are not measureable..
[5] Technically, it may be possible to develop a future feed price beyond 1 year; however, futures markets that far out are highly volatile and thinly traded.

6.6. Existing catfish risk protection programs

a) List and summarize provisions and benefits of all state and federal programs that support or subsidize producers

There are currently no active insurance plans, either commercial or government funded, that insure catfish production losses or protect against changes in market prices. Several times in the past, government catastrophic payments have been made to catfish farmers to cover losses (see Disaster programs below).

Arkansas and Alabama each have modest research and promotion programs for catfish, funded by a $1 fee per ton of catfish feed purchased.

b) Research and describe any private insurance program

During the listening sessions, attendees indicated that they recalled only a single private offerer of catfish insurance; this took place years ago and lasted only a year or so. During the listening sessions, farmers explained that claims were so high that the program was discontinued.

There are no known private insurance programs currently operating.

c) Note any gaps in coverage or constraints of private insurance programs, if applicable

Not applicable – there are no known private programs insuring catfish.

d) Disaster programs

Catfish farmers have been recipients of emergency relief funds on several occasions over the last fifteen years. Ideally, an insurance program would eliminate the need for ad-hoc emergency relief. During the listening sessions, farmers compared the potential benefit of a margin insurance program to payments they had received in the past.

The following relief programs have been made available to catfish farmers since 2000:

- In 2010, up to $12,000 per eligible catfish farmer was made available under the USDA's Trade Adjustment Assistance (TAA) for Farmers Program. The program provided free technical training, then payments of up to $4,000 toward developing a business plan or long-term business adjustment plan, and up to an additional $8,000 towards implementing a long-term plan.
- In 2009, US aquaculture producers were allocated $20 million in for feed assistance under the 2009 Aquaculture Grant Program (AGP). Payments were limited to $100,000 and to farms whose average AGI did not exceed $500,000 from 2005-2007. Payments were made by multiplying a producer's feed deliveries by the difference between the 2009 feed price and the states' 2003-07 five-year average feed price.
- Southeast and Mid-South catfish farmers were eligible for $11 million in assistance for catfish feed losses due to declared federal disasters between January 2005 and February 2007. Mississippi received $8.12 million and Alabama $3.12 million. Losses eligible for payments included loss or damage of feed, increased feed costs, and costs associated with lost feeding days. Individual payments were capped at $80,000. The payments were authorized under the "U.S. Troop Readiness, Veterans' Care, Katrina Recovery, and Iraq Accountability Appropriations Act, 2007".
- Under the Agricultural Assistance Act of 2003, in August of that year catfish producers began receiving credits of $34 per ton of feed based invoices for purchase in 2002; feed mills certified their customers and volumes, and the credits were provided for purchases of feed. In all, $34 million were allocated to the eleven catfish producing states; Mississippi was allocated $20 million.

6.7. The cap on livestock program expenditures

There is currently a cap of $20 million – fully used in the past few years - on RMA's LGM and LRP program expenditures. Any new livestock plans would be subject to the following program requirements identified earlier:

> (10) LIMITATION ON EXPENDITURES.—The Corporation shall conduct all livestock programs under this subtitle so that, to the maximum extent practicable, all costs associated with conducting the livestock programs (other than research and development costs covered by section 522) are not expected to exceed the following:
> (A) $10,000,000 for each of fiscal years 2001 and 2002.
> (B) $15,000,000 for fiscal year 2003.
> (C) $20,000,000 for fiscal year 2004 and each subsequent fiscal year.

The current LGM $20 million cap would suffice only to cover 2-3% of US milk production.

In recent years, the cap has been reached, mostly through LGM-Dairy sales. Once money for subsidies runs out in a given year, LGM policies are no longer offered until the next fiscal year. During several of the years, LGM-Dairy policy sales have been suspended at various times to allow funds to remain available to other LGM programs; in several of these cases, LGM-Dairy policy sales were later resumed and the full $20 million allocation was used.

For instance, for the 2015 (current) fiscal year, LGM-Dairy had used $11.2 million through the first semester, and RMA announced a suspension of LGM-Dairy policies. Other livestock policies had used $2.5 million, leaving $4.6 million in subsidies still available to the other policies (cattle, lamb, and swine). Later this fiscal year, RMA made available $1 million for the LGM-Dairy program to cover the months of August and September.

Policy premiums are due the first business day of the month following the last month that a producer reported insured marketings.

7. DATA AVAILABILITY AND PRICE METHODOLOGIES

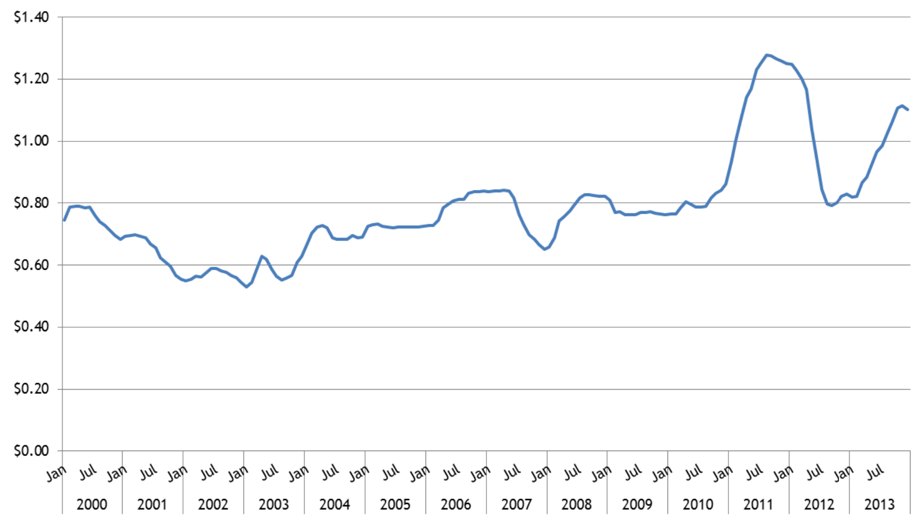
In order to produce a gross margin insurance product, i.e., "income over feed costs" (IOFC), we need estimated future market prices for both catfish feed and catfish. This section provides details on what data are available, what are not, and how data gaps might be filled.

7.1. Search for price data at regional and national level and yield data for each region

To produce the time series we needed for our analysis we appended Dr. Hanson's data discussed in section 3.1 on to the end of the USDA NASS catfish data series. The following two graphs show the time series from NASS and the data collected by Terry Hanson.

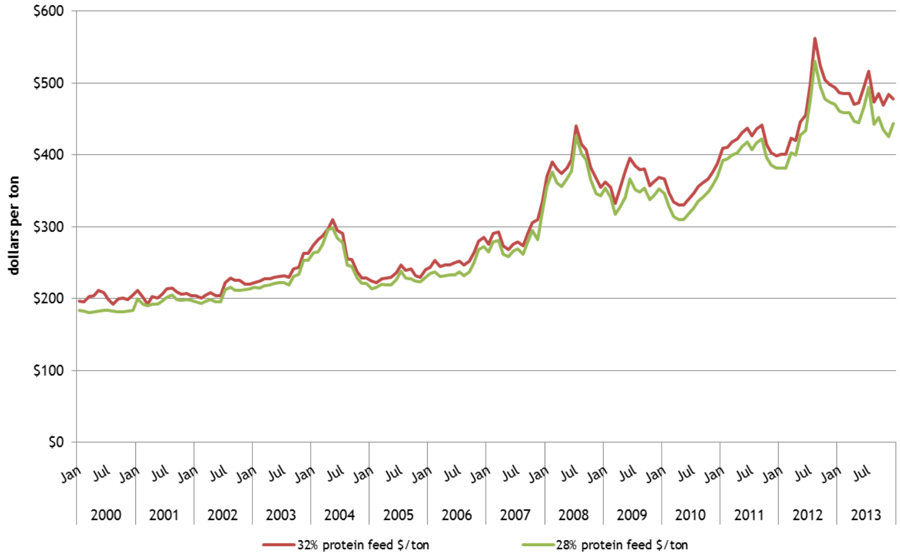
The following two data series will be needed to produce an LGM-Catfish insurance program. As Dr. Hanson's data is currently the only source, RMA will have to decide how and whether it wants to procurethis data. Dr. Hanson has indicated he is amenable to discussion with RMA to produce the data for the purposes of insuring catfish.

Figure 14: Average monthly catfish price paid to farmers, $/pound, 2000-2014



Source: USDA NASS, T. Hanson, Auburn University

Figure 15: Average monthly catfish feed price, $/ton, 2000-2014



Source: USDA NASS, T. Hanson, Auburn University.

RMA specified it wanted regional and national level price data and yield data. However, apart from the data and source listed above, there are no other price data. Moreover, no regional data exist. In addition, catfish yield data do not exist in any form. The greatest challenge to producing this feasibility analysis has been collecting sufficient data.

In order to estimate future industry margins, we need estimates of both future prices and future costs. However, there are no good data for catfish production costs, so there is not simple way to calculate the share of production costs that feed represent.

7.2. Catfish feed price forecasting

We developed a model to estimate the future price of catfish feed involving the following steps:

- Calculating a historical least cost formulation (LCF) for catfish feed based on historical ingredient prices;
- Checking the fit of this LCF series with actual reported catfish prices; and
- Adjusting the formula to include other manufacturer costs and margins and yield a manufactured catfish feed price series; and
- Testing the manufactured catfish feed price formula.

7.2.1. Calculating a least cost formulation (LCF) for catfish feed

Feed manufacturers use linear programming models to construct a least cost formulation to minimize feed costs. As the price of each ingredient varies, formulators change the recipe so that it maintains the same nutritional value but keeps costs to a minimum. In principle, if a least cost formulation fits well against historical prices, it is likely to be a useful in estimates of future prices, if it uses as key inputs the futures values for key ingredients.

Catfish feed ingredients

Catfish feed is complex. The following table provides details on the most commonly used feed ingredients used in catfish feed. Over the very long term the feed composition has changed – for instance, feed mills no longer use menhaden fishmeal. However, in recent years, feed composition has not changed substantially.

Table 10: Common catfish feed ingredients & nutrient profiles

	Dry matter	Crude protein	Crude fat	Crude fiber	Ash	Digest energy	Avail lysine	Avail methionine & cystine	Total phos	Avail phos	Yellow pigment
Ingredient	%	%	%	%	%	*kcal/kg*	%	%	%	%	*ppm*
Soybean meal	88	47.8	1.0	3.0	6.0	3163	2.83	1.27	0.67	0.24	0
Cottonseed meal	90	41.0	1.5	12.7	6.4	2614	1.09	0.84	1.00	0.22	0
Canola meal	91	38.0	3.8	11.1	7.2	2214	1.59	1.41	1.17	0.35	15
Penut meal	90	47.0	2.5	8.4	5.0	3190	1.31	0.93	0.57	0.16	0
Distillers grains w/solubles	92	27.0	9.0	8.5	4.5	2786	0.58	0.84	0.89	0.69	30
Menhaden fish meal	92	62.0	9.2	1.0	19.0	4129	3.88	1.78	3.00	1.28	0
Porcine meat & bone meal	96	55.0	10.5	2.3	26.5	3716	2.60	0.86	4.00	2.10	0
Porcine meal w/blood	92	65.0	10.3	1.8	19.0	3716	3.40	1.02	3.50	1.84	0
Poultry by-product meal	94	53.0	14.0	2.5	19.0	4143	1.38	1.09	2.70	1.42	0
Corn gluten feed	88	21.0	2.0	10.0	7.8	2106	0.40	0.71	0.90	0.67	13
Corn germ meal	90	20.0	1.0	12.0	3.8	2334	0.70	0.79	0.50	0.22	3.4
Corn grain	86	7.5	3.5	1.9	1.1	2516	0.17	0.22	0.23	0.06	13
Wheat grain	86	13.5	1.9	3.0	2.0	2339	0.34	0.42	0.41	0.08	0
Wheat middlings	89	15.0	3.6	8.5	5.5	2267	0.60	0.24	0.91	0.18	0
Fat/oil	99	0.0	99.0	0.0	0.0	8730	0.00	0.00	0.00	0.00	0
Lysine HCl	100	0.0	0.0	0.0	0.0	0	78.00	0.00	0.00	0.00	0
Vitamin premix	100	0.0	0.0	0.0	0.0	0	0.00	0.00	0.00	0.00	0
Dicalcium phosphate	100	0.0	0.0	0.0	85.6	0	0.00	0.00	18.50	12.93	0
Trace mineral premix	100	0.0	0.0	0.0	90.0	0	0.00	0.00	0.00	0.00	0

Source: Menghe Li, Mississippi State University

Although there are a number of viable ingredients for catfish feed, cost is the limiting factor. Both the ingredients and their percentages in the recipe can change as prices change. The typical feed ration is usually made from only about five or six key ingredients.

We considered all the currently used ingredients in manufactured feed. Almost all the plant-based commodities have futures prices. However, several ingredients such as porcine meal and poultry byproduct meal do not.

Following the advice of Dr. Menghe Li, a catfish nutrition expert, we built a ration out of the ingredients in the table below. We have also included the exact time series and data source we used for the historical prices.

Table 11: Commodity feed ingredient price sources

SBM Hi Pro	U.S. - Central IL	Prices, wholesale
CtsdM	Memphis, TN	41% solvent,Table 16 By product feeds
DDGS	Central IL	Table 16 By product feeds
Fish Meal	U.S. - Domestic, East Coast	Prices, wholesale
MBM	U.S. - Central US	Prices, wholesale
PFM	U.S. - AR points	Prices, wholesale
CGF	Midwest	21% protein, Table 16 By product feeds
CGM	Midwest	60% protein, Table 16 By product feeds
Corn	United States	Prices received by farmers
Wheat grain	United States	Prices received by farmers
Wheat Mid	U.S. - Kansas City, MO	Prices, wholesale

Sources: USDA NASS, USDA ERS, USDA AMS

These commodities represent the most commonly used ingredients for which there are also futures prices. These commodities account for about 97% of the total feed ingredients. In addition to major ingredients, manufacturers also mix fat and vitamin premixes into the recipe. Feed manufacturers may also tweak their particular recipes in some way. The base cost of the catfish feed recipe is well represented by the commodities we have chosen.

The linear program we used to compute the least cost formula is WinFeed 2.8.4. The exact software needed to replicate the results is not critical; any least cost feed formulation software should give similar results.

Using this least-cost formulation, we used the historical feed ingredient prices (spot market prices from NASS) to calculate a time-series for the ingredient costs within a catfish feed formulation. The NASS data is a monthly time series, however we learned that feed manufacturers do not change the actual formulation very often – generally only once or twice per year and at most 3 times. Given this information we decided that it would not be necessary to compute the monthly least cost ration. Instead, we calculated the least cost ration based on the average monthly spot price for four months per year, March, June, September and December. We computed the least cost ration for feed ingredients for each of these quarters from 2000 to the first quarter of 2015.

7.2.2. Checking the fit of this LCF series with actual reported catfish prices

We can then test the fit of this series against actual reported feed prices.

The catfish industry uses both 28% protein and 32% protein feeds. However, Farmers may switch between the different feeds through the growth cycle or when prices are high or low. In short the practical administration of an insurance policy with two feed rations would be more complex than required. For these reasons we chose to develop a time series of reported feed prices based on an average of the two, a 30% ration. A quick check of the differential between 32% feed prices and 28% feed prices showed a very tight correlation of 0.998097. This indicates that a 30% ration would serve as a good proxy to estimate an average feed price. SMEs agreed with this, adding that some farmers used both types of feed, depending on the growth stage of the fish.

Agralytica

Testing the model

After running the least cost ration using the historical spot market prices, we tested the fit with the actual feed prices. We tested this to see whether the least cost formula was capable of matching the volatility of the actual feed prices.

The correlation between the LCF and actual catfish feed prices is 0.981712%. Since the correlation is so high, we conclude that the LCF is a valid basis from which to calculate a manufactured catfish feed price series. However, this LCF model only gives us about half the total feed price. We have no data for several feed ingredient costs such as the vitamins, Lysine, methionine, and others. In addition, feed manufacturers have other costs such as electricity and milling (and profit to account for). The next step involves estimating these uncounted costs to arrive at the price farmers actually pay for feed.

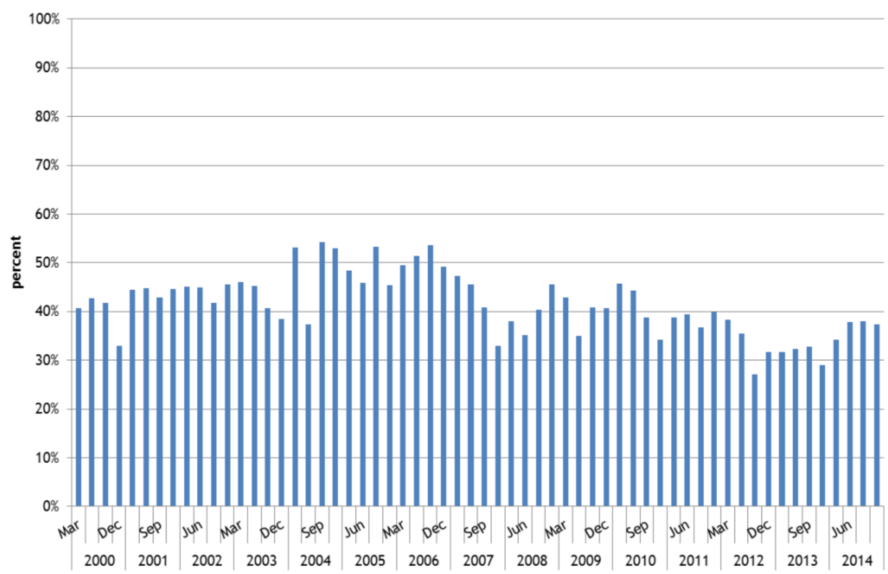
7.2.3. Adjusting the formula to yield a manufactured catfish feed price series

In order to get the estimates of manufactured feed prices, we need not only an estimate of the key feed ingredient components of catfish feed, but an estimate of the overall catfish feed cost – which must include manufacturers' other costs plus their profit margin. This is the price paid by farmers.

Feed manufacturer margins

Next, we calculated the difference between the actual feed prices and the raw ingredient LCF price and obtained an average difference of 0.41. This indicates that over the period evaluated, key raw ingredient costs represented 59% of the feed prices, with the remaining 41% accounting for other factors, such as the marginal feed ingredients not already included (fats, oils, vitamin premixes, Lysine, mineral premix), plus manufacturing costs and the feed miller's profit.

Figure 16: Estimated non-key ingredient costs as a percentage of total cost, 2000- 2014



Source: Agralytica

As can be seen in Figure 16, there is a change over time between the non-key feed ingredient costs and the actual feed prices. During the period from 2000 to 2003 the difference is pretty tight around 42%, however beginning in 2004 we see the percentage jump over 50% for most quarters, to as high as about

55%. It begins to fall back down in 2007. Since 2011, the percentage has bounced between 27% and 40%. The average of all periods is 41%.

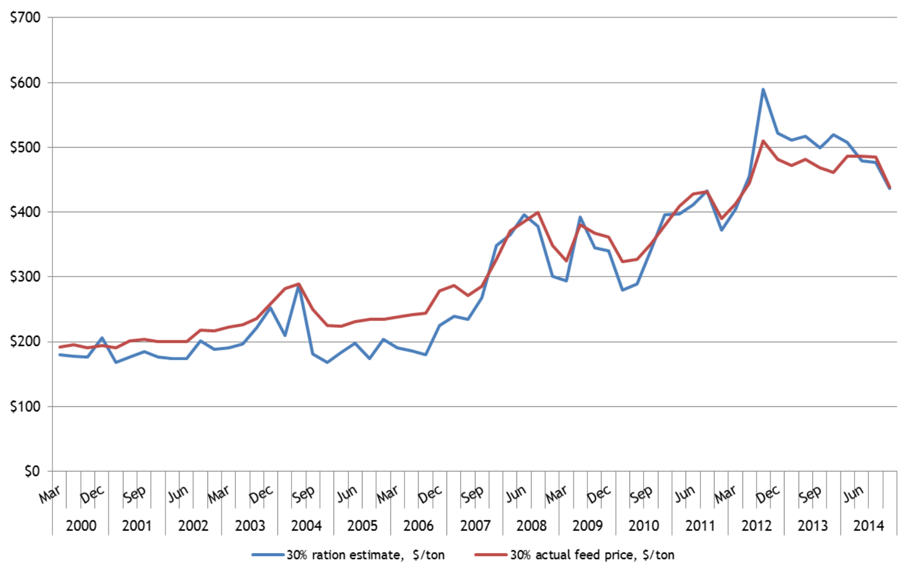
We are unsure the mechanism that has caused these variations. Although some of the variations may simply be random noise it is also likely that there are other variables that are likely impossible to fully capture in any model. However, this model represents the most viable option to predict feed prices.

We thus add this margin of 41% to the computed LCF feed price to arrive at the price a catfish farmer pays for feed.

7.2.4. Testing the catfish feed price formula

The next step is testing the fit of the estimated prices to the actual feed prices. The graph below compares the two series for the period 2000-2014.

Figure 17: Estimated feed ration cost and actual feed prices, 2000 - 2014

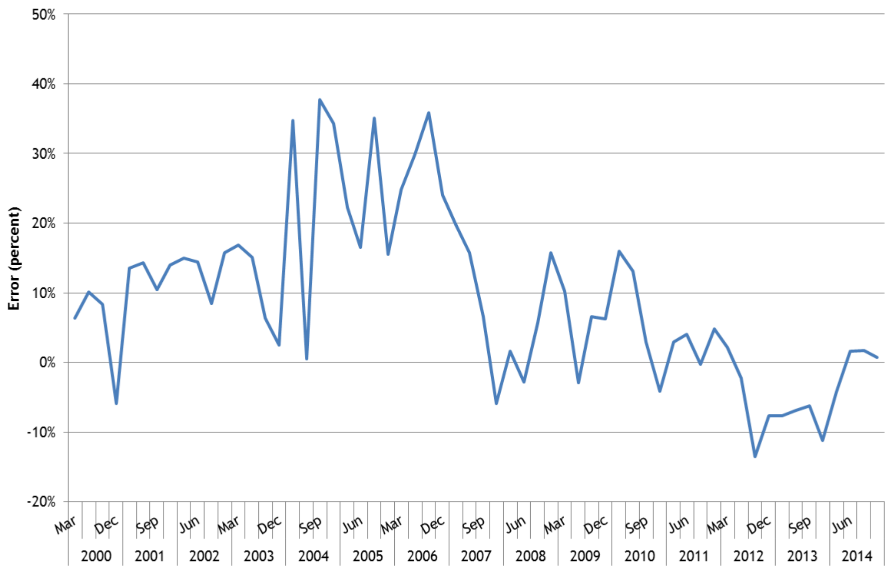


Source: Agralytica

The correlation of the two series (estimated feed prices vs. actual feed prices) is 0.982. The LCF model, adjusted to reflect manufacturers' additional costs and margin yield a series that very closely matches the volatility of the actual catfish feed prices, see Figure 17 above. However, the period from 2004 through 2006 shows a good deal of divergence from the actual feed prices. In addition, the period from 2012 through 2013 shows a larger inverse relationship where the estimated feed prices are greater than the actual feed prices.

We computed the error for the estimated price and the actual price. See the following graph. Again, the error is much higher from 2004 through 2006. While the error is typically between 0.2 and -0.1, from 2004 through 2006 it went over 0.2 nine times, only three estimates from that period exhibit an error less than 0.2. In all, these outliers account for 15% of the 60 total price estimates.

Figure 18: Error of the estimated feed ration vs. actual prices



Source: Agralytica

The error is calculated as:

$$Error = \left(\frac{(Actual\ Price - Estimated\ Price)}{Estimated\ Price}\right)$$

The average of the difference between the actual feed prices and the estimated prices using the least cost formula is $15.51 in dollar terms. However, the maximum difference is $72.51 and the minimum is -$79.58. This represents quite a large error. There appears to be a shift in the uncounted costs that make up the difference between the feed ingredient costs and the final price of feed.

Conclusion

Although the model does a decent job of predicting prices, it could be better with the addition of some of the unaccounted for variables. Additional prices of the minor feed ingredients might help to eliminate some of the error.

Given the power of this model to backward predict prices, we believe this methodology may work to forecast short-term (<1 year) future feed prices if it can be improved. However, at this point there is no available data about the additional feed ingredient prices and feed mill production costs to improve the model.

In addition, there is also the problem of predicting a future feed price using any model. The availability of futures beyond one year varies by feed ingredient. More importantly, the farther out the delivery date is, the greater the volatility in those prices. Futures beyond one-year are very thinly traded, if at all, so the price data is unreliable for accurately predicting the actual settlement price. Therefore, feed price predictions farther than a year out based on this, or any, model are not likely to be very useful.

7.3. Identify viable data series and formulate all reasonable alternative methods other than contract price to develop expected prices for catfish

As noted earlier, formal contracts are not used in the catfish industry so there is no expectation of the price farmers will receive for their catfish at the time of sale. Unlike the sectors that already have LGM plans (cattle, swine, dairy), there is no futures market for catfish. Another approach is thus needed to develop expected future catfish prices. This is why we reviewed the LRP-Lamb approach – it uses an econometric model to predict future lamb prices. Using LRP-Lamb as a guide, we evaluated the possibility of using a similar approach to forecast catfish prices.

An econometric model for catfish was published by Muhammad et al in 2007. Here we compare the two approaches and test whether an econometric approach to catfish would work for insurance purposes.

a) Model comparison

In the following table, we show the input data used for the LRP-Lamb model, the catfish econometric model, and whether or not the data required for the catfish model are available.

Table 12: Insurance model comparison

<table>
<tr><th>LRP-Lamb</th><th>Catfish (Muhammad et. al., 2007)[1]</th><th>Catfish data availability?</th></tr>
<tr><td rowspan="8">Lamb slaughter price for week (t+x) where x =13, 26, 39, or 52

Lamb slaughter price for week (t-1)

Actual slaughter under Fed Inspection Lambs and Yearlings reported in week (t-2)

Actual Live weight of sheep Slaughtered Under Federal Inspection reported in week (t-2)

No. 1 pelt price reported for week (t-1)

Index, 5 yr, 52 week centered moving avge seasonal index for week (t+x)

Trend for week (t+x)

Dummy variable to adjust for effects of Mandatory price reporting (farmers show asymmetrical knowledge of market and time sales accordingly, not an issue with the Catfish Gross Margin)

Easter variable to account for Easter sales</td><td>Processor quantity</td><td>Data not available any more from USDA; no other source</td></tr>
<tr><td>Processor price</td><td>Data not available any more from USDA; no other source</td></tr>
<tr><td>Farm price – Historical</td><td>USDA, Hanson only source now</td></tr>
<tr><td>Seafood retail index price</td><td>USDA Economic Research Service</td></tr>
<tr><td>Catfish import price</td><td>US International Trade Commission (USITC) spotty and infrequent, various Harmonized Tariff System codes, not enough long term consistency to be useful</td></tr>
<tr><td>Tilapia import price</td><td>Data for other white fish would likely also be needed.
USITC spotty and infrequent, various HTS codes, not enough long-term consistency to be useful.</td></tr>
<tr><td>Energy price index</td><td>US Bureau of Economic Analysis</td></tr>
<tr><td>Catfish feed price – Historical</td><td>USDA, Hanson only source now. However, feed price might be forecast short term (<1 year) using a model.</td></tr>
</table>

[1]Catfish model source: "The Impact of Catfish Imports on the U.S. Wholesale and Farm Sectors." Andrew Muhammad, Sammy J. Neal, Terrill R. Hanson, and Keithly G. Jones. Agricultural and Resource Economics Review 39/3 (October 2010) 429-441.

b) Catfish model data issues

The Catfish econometric model has multiple data shortcomings. Some data series are simply not available. Processor quantity and price are no longer regularly published by the USDA or any other source. As noted, both catfish farm price and catfish feed prices are now collected and occasionally reported by a private source, Dr. Terry Hanson of Auburn University..

A key shortcoming of the model is that the market price for catfish is impacted by low-priced imports. The model above includes two terms related to fish imports. Unfortunately, import fish data from USITC are incomplete and spotty, and are unlikely to be a reliable source for updating an econometric model on a monthly basis.

In addition, multiple types of imported white fish compete with catfish in the marketplace. Though consumers in catfish production areas may express a distinct preference for US farm-raised catfish, many do not distinguish between catfish varieties and/or between catfish and other types of white fish.

Another major obstacle is that the Harmonized Tariff System codes have not remained consistent; they change over time as particular products gain in relevance and begin to be tracked separately. This makes tracking competitor imports comprehensively over time near impossible, as it is difficult to piece back together disaggregated codes to get a historical price series.

Consider the fact, for example, that the model above does not include pangasius, a fish whose imports have grown substantially in recent years as the product has entered the product as a direct rival to US farm-raised catfish. It is widely accepted that pangasius imports have adversely affected catfish prices.

Another consideration omitted from the model is the potential impact on prices resulting from government regulation of trade. For instance, potential quotas, penalty tariffs, or other measures that result in limiting or raising the costs of imports represent an additional exogenous factor that could impact catfish prices.

7.3.2. Evaluating the catfish price prediction model

The LRP-Lamb econometric model has already been evaluated and found to have significant shortcomings. It used accurate and consistent data but ultimately did a poor job of predicting prices and created opportunities for moral hazard.

By comparison, the catfish econometric model requires some data sources that are unreliable or nonexistent.

The time horizons for the lamb policies are 13, 26, or 39 weeks (i.e., 3, 6, or 9 months); for catfish the time horizon required to cover a production cycle would have to be *15+ months*.

We do not believe it would be possible to produce an accurate catfish price forecast with this type of model. Poor predictions of future prices could result in poor loss ratios, a product considered too expensive by farmers, or it could allow for adverse selection.

7.4. Formulate methods to construct Yields and/or revenue for prospective insureds without APH or ARH

In order to construct a history for prospective insureds in the absence of a full 4-year production history, one could use the following method for the purposes of assigning target marketings:

1. With no history, there would be no basis for assigning marketings.
2. With one year of history, take 50% of that one year's production and assign it to the other three years.
3. With two years of history, take the average of those two years and assign the other two years 75% of their average.
4. With three years of history, use 90% of the average of those three years for the fourth year.

8. RISK ANALYSIS

Many of the risks faced by catfish farmers so far are on-farm perils (operational risks). As such, they are outside the scope of what could be addressed by a margin insurance program. However, they are of relevance in understanding the risks faced by catfish farmers, and may be of assistance in the development of an insurance program.

In addition to operational risk, farmers face economic risks as well, both stemming from the market and financial issues related to their own operations.

a) Define economic risks

The following table presents some key economic risks faced by catfish farmers, as well as their ability to influence that risk.

Table 13: Key economic risks

Risk	Farmer's ability to influence
Falling / low catfish prices	Limited. Unenforceable agreements with processors.
Increasing input prices	Short term – hedge feed inputs / book feed. In the long term – No influence; might be able to switch to a more profitable crop.
Rising interest rates	None
Reduced consumer demand	Short term – None Long term - Switch to more profitable crop, if viable.
Regulatory pressure & costs	None except through group lobbying.
Import competition	None except through group lobbying and marketing efforts.
Low prices for substitute products	None

Most of these economic risks are beyond the influence of any given catfish farmer, although some in the long run may have the option to shift away from catfish production. Some of the risks might be counteracted by catfish farmers united as a group.

However, for the most part, catfish farmers are price takers and are exposed to market risk.

b) Collect data to identify and quantify risks

There is limited up-to-date, published information quantifying the risks faced by catfish farmers. The Economic Research Service publishes the Census of Aquaculture every five years (the year after it releases the Census of Agriculture), though the Census of Aquaculture is chiefly concerned with operation sizes, operators, inventory, and total sales.

As noted previously, most data related to catfish production and the market are no longer officially collected and reported by the USDA. y However, Dr. Terry Hanson of Auburn University continues to collect catfish prices to the processor and catfish feed prices.
No on-farm risks are currently insured. The most significant threats, generally related to maintenance of water oxygen levels and quality, are largely preventable through sound management techniques.

The following table identifies key catfish perils, along with its relative frequency, severity, a farmer's ability to mitigate the threat, and past evaluation of the peril's insurability.

Table 14: Catfish events: frequency, severity, ability to mitigate, insurability

Events	Frequency	Severity	Ability to mitigate	Insurability
Price pressure from imports, low prices paid to farmers	Ongoing	Severe - substantial price gap	Very limited - difficult to expand niche market for US catfish	Uninsurable - No data
High feed costs	Episodic	Can be severe	Limited. Can book feed or hedge	Insurable - enough data exists
Demand shock	Infrequent	Moderate	None	Uninsurable - no way to predict catfish prices or resulting demand
Growth of imports	Ongoing	Severe	Very limited: lobbying	Uninsurable
Supply shock	Occasional	Can be severe	Limited; avoid policies encouraging marginal producers	Uninsurable - no way to count inventory
Predation, pest, or disease losses	Common	Limited to severe	Variable, depending on peril. Overall, management practices will have a substantial impact.	Uninsurable - no way to count inventory
Fish death due to mismanagement	Rare	Can be severe	Preventable	Uninsurable
Power outages/Loss of aeration	Rare	Severe	Preventable	Uninsurable - no way to count inventory
Equipment failures	Rare	Can be severe	Preventable	Uninsurable

Price pressure from imports, low prices paid to farmers

Farmers have no ability to mitigate low catfish prices. This has been a significant problem over the past decade – industry production has dropped in half since its peak in the early 2000s.

High feed costs

Catfish farmers have faced periods of very high feed costs in recent years. Booking feed is the simplest and for many farmers the most effective option to deal with feed price volatility. Many catfish farmers contract their feed purchases 3 to 12 months in advance, depending on feed price levels and market volatility. Feed mills allow them to book feed then hedge their exposed positions using futures contracts for the feed ingredients needed to meet their contracts with producers.

Catfish producers with the expertise and financial ability also have the option of hedging inputs on their own, and/or diversifying the activities on their farms to include crop production.

Demand shock

Demand shocks, a rapid reduction in consumer demand, is not a frequent problem for the catfish market. Individual farmers have no ability to mitigate demand shocks.

Growth of imports

This is a primary threat to catfish producers – imports of competing white fish such as pangasius, swai, and tilapia put pressure on catfish prices. Even relatively modest pressure – e.g., 5 to 10 cents per pound - can make the difference between industry profitability and losses.

Individual catfish farmers have no way to mitigate the price dampening effect of competing imports. Even as a group, the power of the catfish industry to affect import competition is limited.

Supply shocks

Supply shocks occur with overproduction. Periods of high prices may induce overproduction, resulting in a glut of product in the market. This in turn can depress prices. Individual farmers have little control in these situations, other than try to avoid overproducing during times when margins are negative.

Predation, pest, or disease losses

Predation is a significant peril, and will impact catfish farmers disproportionately. Efforts to prevent bird predation are expensive – estimated at $2 million in the 1990s, with estimated industry losses at $5 million – figures that are likely to be higher today.

Disease is also a very real concern and in any given year, about 70% of farmers will experience a disease condition in their ponds. It is a common occurrence, however major losses are rare as most of the time it is caught in time and treated.

Fish death due to mismanagement

The most common manmade peril is simple mismanagement, whether from a lack of knowledge or some oversight. Mismanagement can hurt production, though some problems can be corrected before losses mount significantly. An experienced catfish farmer will have routines and procedures in place that will detect potential problems early. Inexperienced farmers can avail themselves of help available through extension services, universities, and catfish aquaculture groups to learn how to develop routines and procedures to prevent losses.

Catfish research, understanding of aquatic diseases, modern technology, and understanding of nutritional requirements have dramatically changed the catfish industry. In the early days of the industry, catastrophic losses were common due to an incomplete understanding of catfish biology and its effects. Modern technology allows farmers to spend less time testing ponds and while maintaining continuous real-time monitoring.

Manmade perils and failures in aquaculture that result in catfish losses are the consequence of poor management, equipment, or mechanical failures. Fortunately, these are significantly less common that natural perils such as disease or predation. Several can cause significant losses very quickly though.

Power outages/Loss of aeration

Fish losses due to the loss of aeration are uncommon as well. Using modern technology, farmers can monitor several critical conditions in real-time. Alerts of low oxygen can be sent automatically to cell phones, giving farmers a crucial warning. Electrical power loss (to aerators) is a substantial concern for farmers. A farmer may not have enough tractor-powered aerators to adequately supply ponds at key moments, such as the early pre-dawn period when oxygen levels are most critical. Although this is a relatively rare occurrence, when power failure does occur it may devastate the entire pond.

Equipment failures

Mechanical or technological breakdown of machinery is potentially disastrous. In the event of mechanical or technological failures, an entire pond may be wiped out in a matter of hours or even minutes.

Most farmers currently use internet, Wi-Fi, or cell, enabled oxygen sensors that automatically alert the farmer when the oxygen levels begin to get low. One producer who has wireless enabled oxygen sensors on his ponds recounted a major loss of fish due to a simple failure. A worker had forgotten to plug the network cable back into the transmitting unit on the oxygen sensor. The unit was working properly; however, the signal that oxygen levels were low was unable to reach the farmer and he lost the entire crop in that pond. While that is a unique case, it illustrates the idea that technology can greatly reduce losses when implemented. However, is still vulnerable to different kinds of failures. Cell tower signal loss, router failures, cable failures, connection issues, or transmitter or sensor failures can still lead to losses. However, those kinds of failures are rare. A particular farmer will likely never experience losses due to those kinds of breakdowns.

9. EVALUATING THE FEASIBILITY OF CATFISH MARGIN INSURANCE

In this section, we detail our findings regarding the feasibility of establishing a gross margin insurance program for catfish farmers.

We cover the following:

- Previous catfish insurance research
- A summary of relevant FCIC sponsored livestock insurance plans
- What a catfish gross margin insurance plan might look like
- What would be necessary to establish a catfish margin insurance plan
- Other obstacles to developing LGM-Catfish
- A review of alternative approaches and solutions
- Actuarial and rating issues
- Conclusions and recommendation

9.1. Previous catfish insurance research

In 2001, RMA entered into a five-year partnership with Mississippi State University (MSU) to conduct a National Risk Management Feasibility Program for Aquaculture (NRMFPA). The research eventually extended over seven years and involved many aquaculture research institutions and researchers. That study reviewed information on markets, production systems, and data for four major aquaculture sectors in the United States. The results of the NRMFPA were presented to a meeting of the Board of Directors of the Federal Crop Insurance Corporation (FCIC) in March 2009. Ultimately, RMA staff informed the Board of Directors that RMA was withdrawing the programs from consideration in the light of issues raised by expert reviewers, but would continue to build upon the research. Key concerns surrounded issues associated with identifying pond inventories and objections to insuring perils that could be avoided by good management and prudent investment (e.g. investment in generators to run aeration and oxidation pumps during power outages).

We had the opportunity to review the various outcomes from the NRMFPA as part of a review of the feasibility of crop insurance for fresh and salt water aquaculture in 2011 (the freshwater volume can be found at: http://www.rma.usda.gov/pubs/2012/freshwateraquaculture.pdf). This report also underlined the challenges developing crop insurance for aquaculture. Catfish had the most promising industry structure (it was the largest sector and production systems varied less than for other species), although several factors led to the conclusion that insurance plans meeting FCIC standards were not feasible. In particular, that report confirmed issues measuring inventory and losses in pond production systems used for catfish. Issues arose because of continuous stocking of grow-out ponds; the use of other species for under-stocking; the movement of stock between ponds and/or facilities and lack of clear evidence of mortality; cannibalism because of uneven stocking sizes or poor feeding; and the mixing of different batches.

However, these efforts did not review specifically the role of a margin protection policy.

9.2. A summary of relevant FCIC-sponsored livestock insurance plans

The Agricultural Risk Protection Act of 2000 first instructed the FCIC to establish livestock programs to protect producers against price and income fluctuations or protect them from production losses. A program cap of $20 million per year was set for Fiscal Year 2004 and beyond.

In Section 6, A Review of livestock protection plans, we reviewed the LGM programs for cattle, swine, and dairy, in addition to the Livestock Risk Protection program for Lamb (LRP-Lamb) and the Margin Protection Program for dairy (MPP-Dairy) administered by the Farm Services Agency.

The LGM plans are similar in that they rely on futures prices for production and key feed inputs to set gross margin guarantees. The LRP-Lamb policy, though it protects producers purely against price risk rather than gross margin, is relevant to our analysis due to the model it uses to forecast future prices. MPP-Dairy, though more of a price support rather than an actuarially sound insurance program, was also of interest because it uses an income over feed costs (IOFC) model.

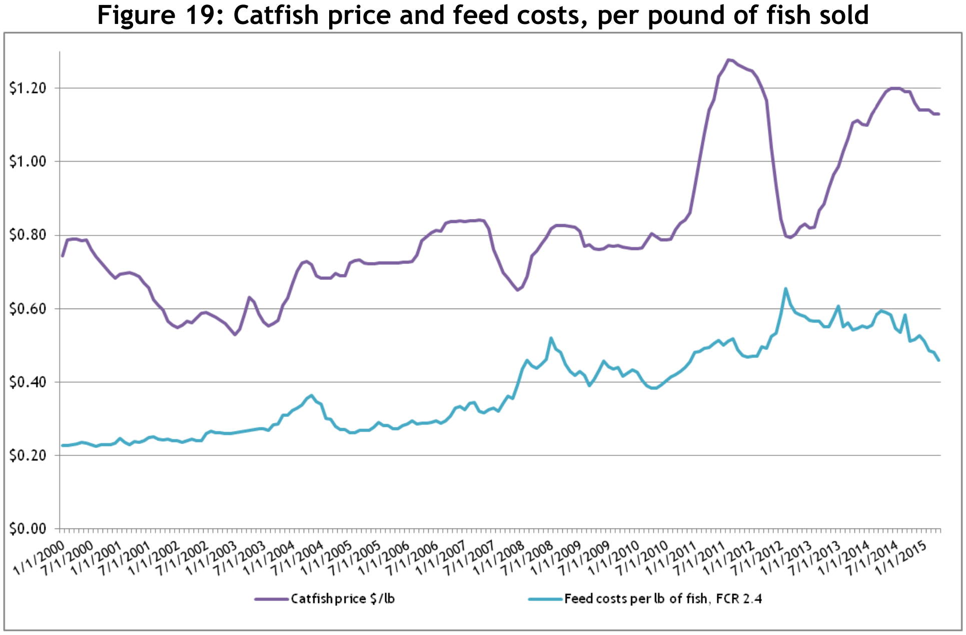
These plans were reviewed so that they could inform the development of a catfish margin plan.

9.3. What a catfish gross margin insurance plan might look like

Based on the reviewed plans, the building blocks of a catfish margin insurance program are clear. As with the other LGM plans, by definition a catfish margin policy would need to cover the difference between catfish market prices and key catfish inputs – namely feed. Based on the listening sessions and other materials, it does not appear that other costs are significant and variable enough to warrant inclusion in a policy.

There are published historical data that provide an indication of what catfish gross margins have been over time. Both catfish prices and feed costs per pound of catfish sold are shown in the following graph.

Figure 19: Catfish price and feed costs, per pound of fish sold

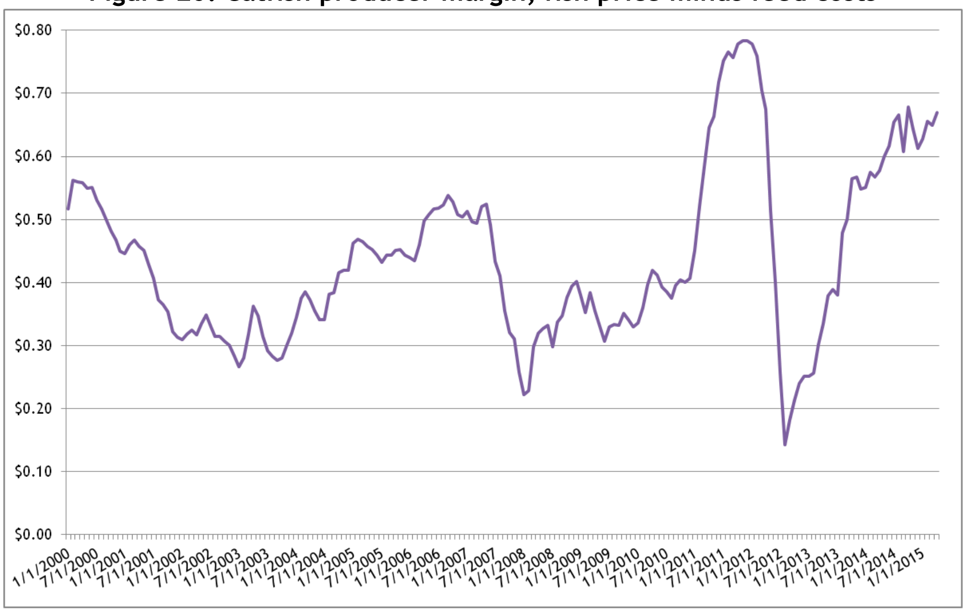


Source: USDA NASS, T. Hanson, Auburn University.

Since 2000, the gross margin, though highly variable, has averaged approximately $0.50 per pound of live catfish sold (a decade ago, the margin was approximately $0.40/pound). In our engagement with producers and others in the industry, and during the listening sessions, we shared a discrete example using these historical data.

Over the entire 15 year period shown, the catfish producer's gross margin has averaged $0.41 per pound. However, there is considerable variability around that figure. Periods of low margins include 2002-2003, 2008-2011, and very low margins in late 2012 to early 2013.

Figure 20: Catfish producer margin, fish price minus feed costs



Source: Agralytica

In line with other insurance programs, a gross margin policy might need to insure up to 80% or more of a substantial percentage of this margin — say, 40 cents out of the recent 50 cent average margin — to be attractive to catfish producers.

9.4. What would be necessary to establish a catfish margin insurance plan

In order to produce a gross margin insurance product, i.e., "income over feed costs", we need two vital pieces of information:

- The future market price of feed and
- The future market price of fish.

The difference between these two provides the expected margin.

Using the other livestock plans as a guide, we detail here a possible IOFC solution to developing a gross margin data series.

9.4.1. Available data

Catfish and catfish feed prices were shown in Figure 14 and Figure 15; Dr. Hanson's data extended each time series after NASS stopped collecting those prices.

However, in order to estimate future industry margins, we also need estimates of both future prices and future costs. There are no data collected that would indicate average catfish production costs, so there is no way to calculate the share of production costs that feed represents.

9.4.2. Catfish feed price forecasting

We developed a model to estimate the future price of catfish feed. The steps were detailed in Section 7.2, Catfish feed price forecasting, and included:

- Calculating a historical least cost formulation (LCF) for catfish feed based on historical ingredient prices;
- Checking the fit of this LCF series with actual reported catfish prices; and
- Adjusting the formula to include other manufacturer costs and margins and yield a manufactured catfish feed price series; and
- Testing the manufactured catfish feed price formula.

Conclusion

Although the model does a decent job of predicting prices, it could be better with the addition of some of the unaccounted variables. What these are we do not know and cannot accurately say at this point. Additional prices of the minor feed ingredients would help to eliminate some of the error.

Given the power of this model to backward predict prices, we believe this methodology may work to forecast short-term (<1 year) future feed prices if it can be improved. However, at this point there is no available data about the additional feed ingredient prices and feed mill production costs to improve the model.

In addition, there is also the problem of predicting a future feed price using any model. The availability of futures beyond one year varies by feed ingredient. More importantly, the farther out the delivery date is, the greater the volatility in those prices. Futures beyond one-year are very thinly traded, if at all so the price data is unreliable for accurately predicting the actual settlement price. Therefore, feed price predictions farther than a year out based on this, or any, model are not likely to be very useful.

9.4.3. Future catfish prices

Unlike the sectors that already have LGM plans (cattle, swine, dairy), there is no futures market for catfish. Another approach is thus needed to develop expected future catfish prices. This is why we reviewed the LRP-Lamb approach – it uses an econometric model to predict future lamb prices. Using LRP-Lamb as a guide, we evaluated the possibility of using a similar approach to forecast catfish prices.

An econometric model for catfish was published by Muhammad et al in 2007. Here we compare the two approaches and test whether an econometric approach to catfish would work for insurance purposes.

a) Model comparison

In the following table, we show the input data used for the LRP-Lamb model, the catfish econometric model, and whether or not the data required for the catfish model are available. The lamb and catfish models are not directly comparable; their components are provided to show the types of variables included in the models.

Table 15: Insurance model comparison

<table>
<tr><th>LRP-Lamb</th><th>Catfish (Muhammad et. al., 2007)[1]</th><th>Catfish data availability?</th></tr>
<tr><td rowspan="8">Lamb slaughter price for week (t+x) where x =13, 26, 39, or 52

Lamb slaughter price for week (t-1)

Actual slaughter under Fed Inspection Lambs and Yearlings reported in week (t-2)

Actual Live weight of sheep Slaughtered Under Federal Inspection reported in week (t-2)

No. 1 pelt price reported for week (t-1)

Index, 5 yr, 52 week centered moving avge seasonal index for week (t+x)

Trend for week (t+x)

Dummy variable to adjust for effects of Mandatory price reporting (farmers show asymmetrical knowledge of market and time sales accordingly, not an issue with the Catfish Gross Margin)

Easter variable to account for Easter sales</td><td>Processor quantity</td><td>Data not available any more from USDA; no other source</td></tr>
<tr><td>Processor price</td><td>Data not available any more from USDA; no other source</td></tr>
<tr><td>Farm price - Historical</td><td>USDA, Hanson only source now</td></tr>
<tr><td>Seafood retail index price</td><td>USDA Economic Research Service</td></tr>
<tr><td>Catfish import price</td><td>US International Trade Commission spotty and infrequent, various Harmonized Tariff System codes, not enough long term consistency to be useful</td></tr>
<tr><td>Tilapia import price</td><td>Data for other white fish would likely also be needed.
USITC spotty and infrequent, various HTS codes, not enough long term consistency to be useful.</td></tr>
<tr><td>Energy price index</td><td>US Bureau of Economic Analysis</td></tr>
<tr><td>Catfish feed price - Historical</td><td>USDA, Hanson only source now. However, feed price might be forecast short term (<1 year) using a model.</td></tr>
</table>

[1]Catfish model source: "The Impact of Catfish Imports on the U.S. Wholesale and Farm Sectors." Andrew Muhammad, Sammy J. Neal, Terrill R. Hanson, and Keithly G. Jones. Agricultural and Resource Economics Review 39/3 (October 2010) 429-441.

b) Catfish model data issues

The Catfish econometric model has multiple data shortcomings. Some data series are simply not available. Processor quantity and price are no longer regularly published.

A key shortcoming of the model is that the market price for catfish is impacted by low-priced imports. The model above includes two terms related to fish imports. Unfortunately, fish import data from the Commerce Department are incomplete and spotty, and are unlikely to be a reliable source for updating an econometric model on a monthly basis. Moreover, the Harmonized Tariff System codes have not remained consistent; they change over time as particular products gain in relevance and begin to get tracked separately. This makes tracking competitor imports comprehensively over time near impossible as it is difficult to piece back together disaggregated codes to get a historical price series.

Also, multiple types of imported white fish compete with catfish in the marketplace. Though consumers in catfish production areas may express a distinct preference for US farm-raised catfish, many do not distinguish between catfish varieties and/or between catfish and other types of white fish.

Consider the fact, for example, that the model above does not include pangasius, a fish whose imports have grown substantially in recent years as the product has entered as a direct rival to US farm-raised catfish. It is widely accepted that pangasius imports have adversely affected catfish prices.

Another consideration omitted from the model is the potential impact on prices resulting from government regulation of trade. For instance, potential quotas, penalty tariffs, or other measures that result in limiting or raising the costs of imports represent an additional exogenous factor that could impact catfish prices.

9.4.4. Evaluating the catfish price prediction model

The LRP-Lamb econometric model has already been evaluated and found to have significant shortcomings. It used accurate and consistent data but ultimately did a poor job of predicting prices.

By comparison, the catfish econometric model has some data sources that are unreliable or nonexistent.

The time horizons for the lamb policies are 13, 26, or 39 weeks (i.e., 3, 6, or 9 months); for catfish the time horizon required to cover a production cycle would have to be *15+ months*.

We do not believe it would be possible to produce an accurate catfish price forecast with this type of model. Poor predictions of future prices could result in poor loss ratios, a product considered too expensive by farmers, or it could allow for adverse selection.

9.5. Other obstacles to developing LGM-Catfish

In addition to challenges developing usable price forecasts for catfish and long-term forecasts for feed, there are other obstacles to developing a catfish gross margin policy. Catfish margin insurance poses several unique problems other margin insurance policies do not have to contend with.

a) Length of the catfish growth cycle

Catfish grows (typically) over two seasons. The time horizon for catfish growout is 15 months or more. The values of crop futures beyond the current market year may be very speculative, may not accurately predict future prices, and may be too expensive and thus are unlikely to be an accurate indicator of the actual costs a catfish feed processor incurs.

b) Timing of growth and expenditures

Catfish growout is different from other species. During the warm months, April through November, the fish grow and consume feed. However, from December through March, the fish consume very little due to the cool temperatures and therefore stop growing.

c) Variety of production systems

Unlike cattle, swine, and dairy production, catfish are raised and harvested in significantly different ways. There are two major catfish production systems in place, multiple batch and single batch. In the single batch system, a farmer usually adds fingerlings at the very beginning of the growing season, usually around April and harvests 15 or more months later. In the multi batch system, farmers will add fingerlings to a pond multiple times per year, with several generations of fish coexisting in the same pond. In such systems, fish may also be harvested multiple times per year. It is also important to note the retail market for catfish requires the fish to be neither too small nor too big. The farmer has only some control over sales timing, given that fish that are too small or large receive a price payment penalty.

d) Off-flavors can affect harvesting dates

Ponds can frequently develop algae or other issues that lead to off-flavors in the catfish. These off-flavors can be remedied, but delays harvest since the solution takes time to work the off-flavor out of the fish. In the winter, however, off-flavors are much more problematic, as catfish are not feeding or active, and thus do not shed the off-flavor quickly. To the extent that harvesting dates shift, it reduces the usefulness of insurance policies relying on specific timed forecasts.

9.6. A review of alternative approaches and solutions

After detailed consideration and review of other livestock plans and previous efforts regarding catfish, we have found no good method to calculate future catfish prices, which are a necessary component of a viable gross margin insurance plan. We do not believe the methods presented below would solve this problem, but include them here for completeness and in the event that future data availability make them viable.

9.6.1. Alternative 1 - Use an econometric model anyway

The first alternative is one where an acceptable econometric model is developed. In this case, future prices for catfish and futures prices for feed could be used to provide "short" (<12 month) policies to guarantee some percentage of the expected gross margin.

Under this scenario, farmers would buy policies for the upcoming year, indicating a total volume to insure, and assign percentage weights of this total to the months in which they expect to market their fish. By using feed as a proxy for fish volume to determine how much to insure, farmers could effectively customize the policy to reflect their own expected feed conversion factor.

There are multiple challenges with this approach:

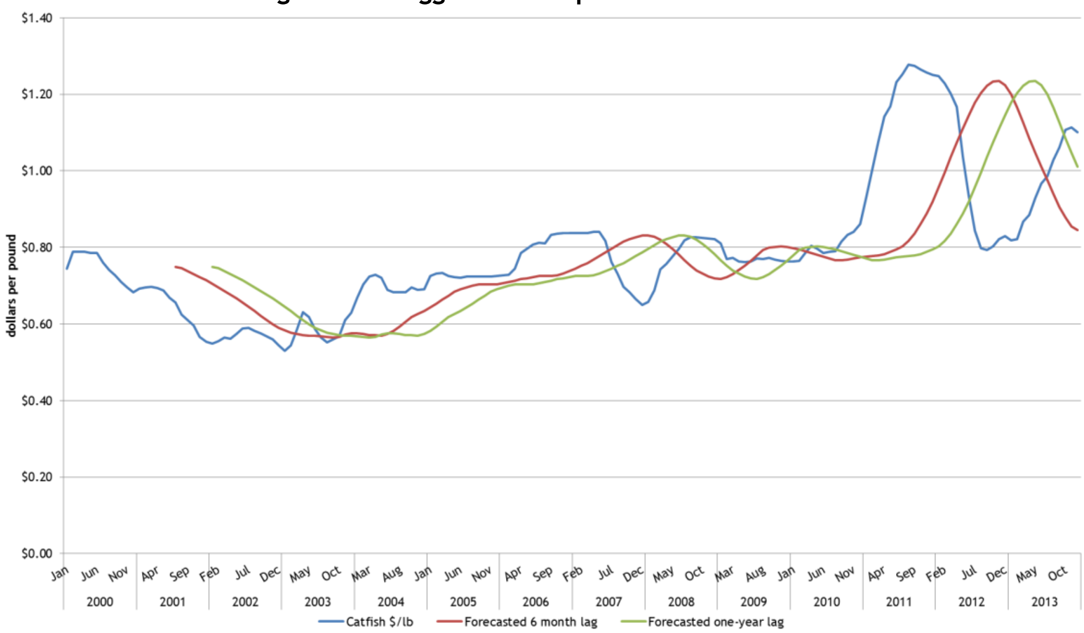
- The timing of feed purchases and catfish sales will not match up, i.e., farmers will be feeding fish for many months prior to marketing them. This may not matter much to producers who sell a consistent volume year-round, but could be a problem for those harvesting during shorter, concentrated periods.
- The insurance would not cover the full growout cycle of the fish, i.e. fingerling to harvest or stocker to harvest, just one season.
- It is not clear what basis one would use to assign target marketings. Though there may be receipts for fingerlings and/or stockers, and for feed, the insurance would be providing a policy based on an unknown quantity of fish. If a penalty were to apply to unexpectedly low production (say due to disease or predation losses), then a farmer would have a reduced incentive to buy insurance in the first place. This is because under pressured market margins, if insured:
    - If the farmer produces less than expected, the farmer would likely be penalized for low operational performance under the policy, and
    - If the farmer exceeds the target marketings, the farmer would face greater losses in the market (i.e., by selling more catfish at a loss).

9.6.2. Alternative 2 – Use prior prices to forecast future prices

A second alternative is using prior prices to predict future prices. The LRP-Lamb evaluation included two models – one was using the current price and the other a rolling-average price. The evaluators found the simple current price method to forecast future prices better than any other model. For this alternative, for catfish, we simply selected the future price as the average of the last twelve months with a lag of either six months or a year (to account for the lag time of prices reported by Terry Hanson). These are displayed in Figure 21.

As the chart in Figure 21 shows, lagged forecasts can differ dramatically between the forecast and actual price. Consider prices at the end of 2012: the model would predict catfish prices of $1.20/pound, but actual prices were $0.80/pound.

Figure 21: Lagged catfish price forecast models



Source : Milliman, based on data from T. Hanson.

We then calculate the error in the following chart. Note the dramatic recent differences between the forecasts and actual catfish prices.

Figure 22: Errors of the lagged catfish price models

Source: Milliman, based on data from T. Hanson

The error is calculated as:

$$Error = \left(\frac{(Actual\ Price - Forecasted\ Price)}{Forecasted\ Price}\right)$$

Any model to forecast future prices is not expected to be perfect (otherwise, there may be no need for insurance). However if the model over-projects the price (and hence the gross margin) it would encourage growers to over supply the market.

9.6.3. Alternative 3 - Feed spike insurance

The third alternative would not fall under a gross margin approach. It would not use catfish prices. Rather than protect against loss in margin, it would simply hedge on producers' behalf against sharp feed price increases.

Short-term (<1 year) forecasts for feed prices could be developed using futures prices for key ingredients. A synthetic "feed bundle" could be constructed using feed ingredient prices and allow RMA to insure the price of feed in the current or upcoming growing season. For example, a farmer would select how many tons of feed to insure for each month of the April-November period, plus a coverage level.

- This would be little different from catfish farmers hedging their feed costs themselves, or hedging by booking feed in advance, as many already do. However, it would be customizable based on an individual producer's feed needs (rather than using standard commodity contracts), and it would provide a means of protection for producers without the means or know-how to hedge for themselves.

The downsides of this approach:

- Farmers already have the ability to book feed; many do so, up to a year in advance. In this situation, feed producers are hedging for the farmers. As farmers book feed, feed producers hedge those positions.
- Farmers can hedge on their own; some already do.
- A margin insurance program would therefore be using a subsidy to support a mechanism already available to and used by some producers.
- This approach would tend to benefit those that cannot hedge on their own (for lack of knowledge or financial reasons); if offered, however, larger, more knowledgeable producers may have little interest in the product.

9.7. Actuarial and rating issues

As stated in the RFP, any possible insurance program should be "ratable and operable in an actuarially sound manner". In the statement of work describing this project, RMA provided the following definition: "Actuarially sound – For the purpose of the Federal Crop Insurance Program, a classification and premium rate determination system, where risk premium collected is sufficient to cover expected future losses and to build a reasonable amount of reserve."

The Casualty Actuarial Society provides the following principles with respect to insurance rates:[5]

- A rate is an estimate of the expected value of future costs;
- A rate provides for all costs associated with the transfer of risk;
- A rate provides for the costs associated with an individual risk transfer; and
- A rate is reasonable and not excessive, inadequate, or unfairly discriminatory if it is an actuarially sound estimate of the expected value of all future costs associated with an individual risk transfer.

Under RMA sponsored programs, the expenses are provided under the Administrative and Operating (A&O) subsidy, which is out of the scope of this project. The RMA definition of actuarially sound as discussed above implies that the long-term loss ratio should be close to but less than 100%.

9.7.1. Current LGM rating methodology

The current Livestock Gross Margin premium is calculated via a determinant Monte Carlo simulation procedure using 5,000 random draws per month of the gross margin. These draws are stored in the RMA Actuarial Data Master (ADM) tables and updated for the upcoming sales date using current values for the parameters. The draws include values for inputs such as corn, soybean meal, and feeder cattle and for outputs such as cattle, milk, and lean hogs. The expected value of these random draws is calculated and any subsidy is considered in the premium.

The basis for the random draws is outlined in "Livestock Revenue Insurance"[6]. Volatilities of commodity futures as well as correlations between inputs and outputs are used to develop the random draws.

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[5] Casualty Actuarial Society, *Statement of Principles Regarding Property and Casualty Insurance Ratemaking* (1988).

[6] "Livestock Revenue Insurance" – Working Paper 99-WP 224; November 2000, Revised; Center for Agricultural and Rural Development – Iowa State University

9.7.2. Possible LGM-Catfish rating methodology

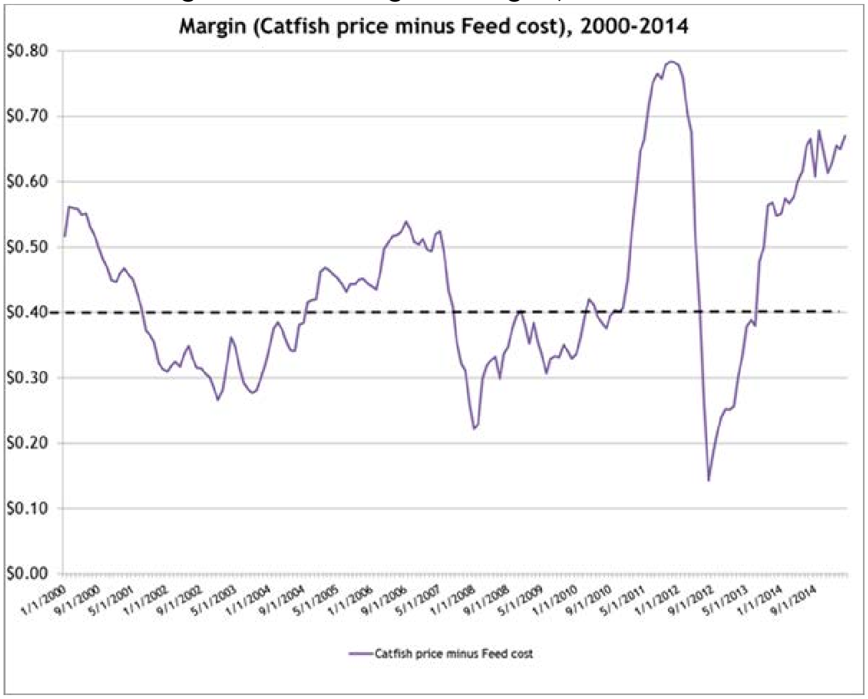
One could build a rating methodology for LGM-Catfish similar to the current LGM structure. The largest obstacle, as has been indicated, is the lack of a futures market for catfish. Although one could try to overcome this by developing an expected future price model and back testing – which would provide the variability of the expected price and could be used to develop the random draws used in the current LGM rating methodology – the concern with this approach is that there may not be enough data to develop credible variability. For example, if we look at the price chart from Alternative 2 (Figure 21) there is much less variability in price for 2000 to 2010 than for 2011 to 2013.

9.7.3. Actuarial soundness issues

For any insurance program to be actuarially sound, the long-term outlays must be lower than the long-term inlays. From a rating perspective, one typically assumes the pool of insureds remains constant. The current LGM plans allow signup twelve times a year – a producer can choose whether to participate or not. If the insureds have the ability to enter the insurance when it is favorable to them (or exit when unfavorable) this causes adverse selection. Adverse selection causes insurance programs to become unsound whereby either the loss ratios increase well beyond permissible levels or the rates increase after each evaluation causing fewer insured to stay within the program which creates a spiral.

We calculated the historical margins using actual data since 2000. While the average gross margin was close to $0.40/pound, the actual gross margin varied significantly over time: see Figure 23. The gross margin varied more due to the change in catfish prices rather than feed price. This was true in 2012, which was a major drought year and caused the price of corn and soybeans to increase substantially. The insurance guarantee (e.g. the gross margin) could be either set as a long-term average or vary significantly, as the actual gross margin does. There are significant problems with either method; however, it may be possible to introduce mechanisms into the policy, such as requiring multi-year participation that would mitigate these concerns.

Figure 23: Catfish gross margins, 2000-2014



Source: Agralytica based on data from USDA NASS and T. Hanson

If the gross margin was set at a certain amount that changed little year-to-year (say $0.40) then the pool of insureds may remain relatively constant. However, this may cause two problems:

- It would be difficult to accurately price this program since there would be a difference between the current gross margin and the guaranteed margin. Therefore, the premiums would vary significantly due to this difference.
- A gross margin set too high (or premiums set too low) may increase supply and therefore cause a significant decrease in future prices, - which would be difficult to accurately price, or
- The gross margin set too low (or premiums set too high) and participation would be low.

Alternatively, if the gross margin was allowed to fluctuate significantly, growers would only purchase when the guarantee was relatively high and premiums were relatively low.

If it were possible to offer multi-year type policies, how would these be rated? If the rates for the next year were not set at the initial sign-up this may lead to low participation or confusion when/if the rates substantially increase for the next year. If the rates for the next year were offered at the initial sales date it would be extremely difficult to accurately measure the required premium two years out.

We note that the evaluators of the LRP-Lamb program found evidence of adverse selection although they could not explain how the insureds could predict the actual prices better than the models. Regardless this helped cause the LRP-Lamb loss ratio to be 331% over the evaluation period.

If the rates were simply set using a formulaic approach, certain distortions in the rating parameters could cause the plan to become overly attractive or non-attractive: for example, if the gross margin guarantee was high and premiums low or conversely if the gross margin guarantee was near zero. If either of these were the case there would need to be adjustments and someone at RMA would either need to judgmentally make changes or well-defined procedures would need to be created in order to address these issues.

9.7.4. Producers' willingness to pay

There are four criteria from the RFP that we discuss in this section:

- Cost effective from the perspective of insured producers;
- Charge a premium that the insureds must be willing to pay for the insurance;
- Produce enough interest for the risk to be spread over an acceptable pool of insureds; and,
- Not allow a change in market behavior or market distortions that change the quantity supplied or shift the supply curve.

In order to gauge the interest of catfish farmers in an LGM policy we asked what they were willing to pay for a $0.50 per pound gross margin program at the listening session. We received many responses but no definitive amount – most producers thought there were too many variables to make a decision at this point. Many of the catfish producers we spoke with at the listening sessions grew other crops and were aware of crop insurance, including the premium subsidy. They understood that if there were no subsidy in the program then their premium would be the long-term average of the cost. Because of this, they did not seem interested in the program since they could self-insure or spend the money on capital improvements.

Some growers were concerned about the effect of an insurance program that guarantees margins would have on the overall supply. They were concerned that marginal growers would stay in business longer or new entrants would flood the market, lowering the price. These concerns are mitigated to some degree by the barriers to entry, although current growers could expand more rapidly.

This creates offsetting issues: on one hand if there is no or little subsidy the participation would be low and on the other hand if subsidy was too high it may distort the market.

9.8. Conclusions and recommendation

The key goal of this report was to identify ways to offer an insurance program that can help catfish farmers protect their margins. Here we revisit the objectives and scope enumerated in Section 1, providing conclusions and recommendations.

9.8.1. Conclusions regarding objectives and scope

Below we return to the objectives and scope identified in section 1 and required of an acceptable insurance program.

Table 16: Objectives: Review and conclusions

Objective	Conclusions
1) Provides meaningful and timely risk management benefits to producers without distorting markets;	A margin product that compensated producers in times when gross margins narrowed would likely provide a benefit to the average producer. However, there are significant concerns that a (subsidized) margin product may distort the catfish market as the availability of insurance may lead growers to oversupply the market. (On the other hand, an unsubsidized product did not appear attractive to producers.)
2) Is cost effective from the perspective of insured producers;	Based on feedback from the listening sessions, a margin product would need to include a significant subsidy to offer an option better than self-insuring (i.e., saving in order to manage periods of loss).
3) Is actuarially sound so that premium rates will cover expected losses plus a reasonable reserve;	We conclude that it is not possible to determine actuarially sound rates for a margin program for catfish.
4) Is able to be administered given the structure and resources of RMA and approved insurance providers; and	We found no structural impediment that would prevent RMA and approved insurance providers from offering margin insurance to catfish producers: • If a catfish program were feasible, RMA could create one within the current LGM program; and • Insurance providers voiced no objections or challenges to providing catfish insurance – though they did indicate to be successful, a program would need to engage farmers early in its development. • However, there remains the current $20 million limit on livestock programs. Providing insurance to catfish producers would have to come at the expense of another livestock group unless the cap were raised.
5) Demonstrates sound program integrity.	There are several reasons to believe a gross margin program would not be sound: 1. Lack of sufficient data to develop credible variability 2. Lack of subsidies would lead to poor acceptance and too costly a program for RMA to administer.

A discussion of the listed scope / requirements for an insurance program are given in the following table.

Table 17: Scope: Review and conclusions

Requirement	Conclusions
1) Conform to RMA's enabling legislation, regulations, and procedures that cannot be changed;	No issues
2) Charge a premium that the insureds must be willing to pay for the insurance;	It is not clear that a program could be offered at a rate deemed attractive by catfish farmers.
3) Be effective, meaningful and reflect the actual risks of producers;	A margin program would in principle reflect the (market) margin risk faced by farmers. However, in practice, matching farmer's risks would be highly imprecise, as market instruments do not exist to adequately cover the life cycle of catfish.
4) Have best management practices that can be defined, required of an insured and be monitored;	Given that the insurance under discussion concerns market margins rather than on-farm perils, best management practices would be relevant only insofar as they would impact a producer's target marketings.
5) Identify and appropriately categorize perils affecting production and/or revenue as insurable and non-insurable;	Not relevant in the context of margin insurance.
6) Be ratable and operable in an actuarially sound manner;	A margin insurance program for catfish would not be ratable and could not be operable in an actuarially sound manner.
7) Contain underwriting, rating, pricing, loss measurement, and insurance contract terms and conditions;	Applicable only if/when developing a program.
8) Be an appropriate geographic distribution of production to ensure a sound financial insurance program;	There was a clear distinction in interest levels between MS and AL catfish farmers. MS farmers were more vocally in favor of a program, AL farmers more skeptical there would be benefit. Nevertheless, a pilot program could cover only one region (e.g., Mississippi Delta).
9) Produce enough interest for the risk to be spread over an acceptable pool of insureds;	It is not clear that even if approved, a program would draw sufficient participation. Much catfish production is already partially hedged and/or diversified against market risk: • Many producers are also engaged in crop production; when feed prices are high, so are the prices they get for their crops. • Some of the larger catfish producers also own processing operations, hence are vertically integrated and better able to survive thinner catfish production margins.

Requirement	Conclusions
	Also, a margin insurance program doesn't work primarily by spreading risk over a pool of insureds facing different operating outcomes; it primarily spreads the risk of unfavorable costs / prices to the insured pool as a whole over time.
10) Not allow insureds to select insurance only when conditions are adverse;	This is a key and valid concern with setting up a Catfish margin program. LRP-Lamb program evaluators believed that adverse selection was taking place; they attributed it to producers having superior, asymmetric information. If gross margins are allowed to fluctuate, producers may choose to buy insurance only when margins are high.
11) Avoid or mitigate moral hazards; and,	There are potential moral hazards involved with a margin program: 1. If gross margins are allowed to fluctuate, producers may choose to buy insurance only when margins are high (conversely, there may be little participation when margins are low). 2. A subsidized program may distort the market by encouraging overproduction.
12) Not allow a change in market behavior or market distortions that change the quantity supplied or shift the supply curve.	This is a valid concern. It is likely that insurance would encourage marginal producers to remain in the market or increase production in response to the availability of insurance. This may in turn then exacerbate supply, driving prices down and magnifying the compression on market margins.

9.8.2. Recommendation

After careful review, we conclude that there are key data challenges and actuarial concerns that cannot be overcome. We are also concerned that a program could distort the catfish market and be vulnerable to adverse selection and moral hazard.

In order to develop an effective program that can be administered by RMA there needs to be a clear methodology and data available. While a model using feed ingredient futures could generate short-term feed price forecasts, there is no viable source of future prices for catfish. While alternative future prices could be defined, the actuarial rating, if set formulaically, may cause adverse selection in the program.

The challenges of creating a program for which insureds would be willing to pay, but that would not distort the market supply are significant. The current LGM programs without subsidy have almost no participation while the LGM-Dairy program sells out quickly. We do not believe there would be significant participation in the program without a large subsidy (or only in scenarios advantageous to the growers). If the participation were low the cost to RMA of maintaining a program would be too high in relation to the benefits provided. If the subsidy was too high this may distort the supply curve.

We recommend that RMA not try to develop a margin protection plan for catfish.

10. APPENDICES AND SUPPLEMENTS LIST

Appendix A: Listening session announcement

Appendix B: Catfish listening sessions handout

Appendix C: Hanson data, Excel file

Appendix D: Catfish price forecasting model

Appendix E: Part 5, US catfish grading standards, pdf file

Appendix F: Feedstuffs for catfish feeds, Excel file

SECTION 508 DATA

These are the data for Figure 1: US catfish sales, million pounds:

Catfish sales, million pounds

2010	2011	2012	2013	2014
257,400,000	173,900,000	174,800,000	175,300,000	161,500,000
137,700,000	119,200,000	122,600,000	109,300,000	105,300,000
49,400,000	25,500,000	20,000,000	25,300,000	17,200,000
16,000,000	16,900,000	12,700,000	15,800,000	14,300,000
5,850,000	5,200,000	5,200,000	4,000,000	3,400,000
2,000,000	2,200,000	1,960,000	3,500,000	3,248,000
3,100,000	2,850,000	2,150,000	2,800,000	2,550,000
7,400,000	2,250,000	756,000	1,130,000	-
478,850,000	348,000,000	340,166,000	337,130,000	307,498,000

These are the data for Figure 2: Catfish, US acres taken out of production:

Catfish acres taken out of production

	2010	2011	2012	2013	2014	2015
MS	5600	3400	4900	4200	1830	1500
AR	3000	2700	1170	1600	700	570
AL	870	540	940	165	1010	200
CA		0	0	0	0	
LA	400	480	0	0	0	
NC	70	15	0	0	0	
TX	290	210	170	250	500	
Other	20	150	370	310	570	
US	10250	7495	7550	6525	4610	2270

These are the data for Figure 3: US meat, poultry, and seafood consumption per capita, 2000-2013

	Fish and shellfish	Pork	Beef	Poultry
2000	15.2	47.8	65.1	67.9
2001	14.7	47.0	63.6	67.8
2002	15.6	48.2	65.0	70.8
2003	16.3	48.5	62.4	71.3
2004	16.5	47.9	63.4	72.8
2005	16.2	46.6	62.9	73.7
2006	16.5	46.0	63.1	74.2
2007	16.3	47.2	62.4	73.7
2008	15.9	45.9	59.7	72.6
2009	15.8	46.6	58.4	69.4

2010	15.8	44.4	57.1	70.9
2011	14.9	42.4	54.7	71.0
2012	14.2	42.6	54.8	69.2
2013	14.3	43.4	53.8	70.2

These are the data for Figure 4: US per capita seafood consumption, 2000-2013:

	Fish and shellfish
2000	15.2
2001	14.7
2002	15.6
2003	16.3
2004	16.5
2005	16.2
2006	16.5
2007	16.3
2008	15.9
2009	15.8
2010	15.8
2011	14.9
2012	14.2
2013	14.3

These are the data for Figure 5: Worldwide fish and seafood consumption, 2000-2013.

lbs per capita/yr	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fish, Seafood	14.9	15.4	15.3	15.4	15.4	15.9	15.8	16.4	16.4	16.3	16.5	16.6	16.7	16.5

These are the data for Figure 6: Channel catfish production, mt, 2004-2013:

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
China	54061	87254	146146	204929	224471	223233	217303	205177	224132	247399
United States of America	285970	274664	258049	255781	233564	215887	217204	157942	154297	162558
Other	2769	4619	6301	7637.3	8595	10149.18	9406.99	6901.5	8605.3	9257.68

These are the data for Figure 7: Pangasius catfish production, metric tons, 2004-2013:

Viet Nam	255,000	376,000	520,000	850,000	1,250,000	1,050,000	1,140,000	1,151,000	1,240,000	1,195,688
Indonesia	23,962	32,575	31,488	36,755	102,021	109,685	127,668	229,267	347,000	410,883
Other	15,325	19,202	23,754	25,884	36,525	52,148	77,054	53,259	62,547	65,254

These are the data for Figure 8: US domestic production vs. imports of all species of catfish, 2001-2014, metric tons:

	Total imports	Vietnam imports	US production
2001	4,100.71	3,882.66	
2002	2,313.61	2,180.70	153,271.69
2003	1,231.46	964.69	151,556.43
2004	2,092.10	1,504.90	150,751.30
2005	6,827.84	4,311.39	137,331.78
2006	17,001.08	8,999.15	129,024.24
2007	19,188.45	8,709.97	127,890.26
2008	23,244.50	12,143.78	116,781.80

	Total imports	Vietnam imports	US production
2009	29,342.76	19,363.52	107,943.56
2010	31,166.99	24,552.13	108,601.26
2011	46,187.32	42,778.14	78,925.01
2012	53,842.02	51,645.12	77,148.29
2013	58,900.51	55,259.69	76,459.74
2014	53,941.76	50,028.65	69,739.32
2015	29,084.90	27,204.10	

These are the data for Figure 9: World channel and Pangasius catfish production, metric tons, 2004-2013:

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Channel catfish	342,800	366,537	410,496	468,347	466,630	449,269	443,914	370,021	387,034	419,215
Pangasius	294,287	427,777	575,242	912,639	1,388,546	1,211,833	1,344,722	1,433,526	1,649,547	1,671,825
Total	637,087	794,314	985,738	1,380,986	1,855,176	1,661,102	1,788,636	1,803,547	2,036,582	2,091,039

These are the data for Figure 10: US farmer price received for catfish, 2000-2013:

Year	Month	Catfish $/lb
2000	Jan	$0.74
	Feb	$0.79
	Mar	$0.79
	Apr	$0.79
	May	$0.79
	Jun	$0.79
	Jul	$0.76
	Aug	$0.74
	Sep	$0.73
	Oct	$0.71
	Nov	$0.70
	Dec	$0.68
2001	Jan	$0.69
	Feb	$0.70
	Mar	$0.70
	Apr	$0.69
	May	$0.69
	Jun	$0.67
	Jul	$0.66
	Aug	$0.62
	Sep	$0.61
	Oct	$0.60
	Nov	$0.57
	Dec	$0.55
2002	Jan	$0.55
	Feb	$0.56
	Mar	$0.57
	Apr	$0.56
	May	$0.57
	Jun	$0.59
	Jul	$0.59
	Aug	$0.58
	Sep	$0.58
	Oct	$0.57
	Nov	$0.56
	Dec	$0.54
2003	Jan	$0.53
	Feb	$0.54

Year	Month	Catfish $/lb
	Mar	$0.59
	Apr	$0.63
	May	$0.62
	Jun	$0.59
	Jul	$0.56
	Aug	$0.55
	Sep	$0.56
	Oct	$0.57
	Nov	$0.61
	Dec	$0.63
2004	Jan	$0.67
	Feb	$0.70
	Mar	$0.72
	Apr	$0.73
	May	$0.72
	Jun	$0.69
	Jul	$0.68
	Aug	$0.68
	Sep	$0.68
	Oct	$0.70
	Nov	$0.69
	Dec	$0.69
2005	Jan	$0.73
	Feb	$0.73
	Mar	$0.73
	Apr	$0.73
	May	$0.72
	Jun	$0.72
	Jul	$0.72
	Aug	$0.72
	Sep	$0.72
	Oct	$0.72
	Nov	$0.72
	Dec	$0.73
2006	Jan	$0.73
	Feb	$0.73
	Mar	$0.75
	Apr	$0.79
	May	$0.80
	Jun	$0.81
	Jul	$0.81

Year	Month	Catfish $/lb
	Aug	$0.81
	Sep	$0.83
	Oct	$0.84
	Nov	$0.84
	Dec	$0.84
2007	Jan	$0.84
	Feb	$0.84
	Mar	$0.84
	Apr	$0.84
	May	$0.84
	Jun	$0.82
	Jul	$0.76
	Aug	$0.73
	Sep	$0.70
	Oct	$0.68
	Nov	$0.67
	Dec	$0.65
2008	Jan	$0.66
	Feb	$0.69
	Mar	$0.74
	Apr	$0.76
	May	$0.78
	Jun	$0.79
	Jul	$0.82
	Aug	$0.83
	Sep	$0.83
	Oct	$0.83
	Nov	$0.82
	Dec	$0.82
2009	Jan	$0.81
	Feb	$0.77
	Mar	$0.77
	Apr	$0.76
	May	$0.76
	Jun	$0.76
	Jul	$0.77
	Aug	$0.77
	Sep	$0.77
	Oct	$0.77
	Nov	$0.77
	Dec	$0.76

Year	Month	Catfish $/lb
2010	Jan	$0.76
	Feb	$0.77
	Mar	$0.79
	Apr	$0.80
	May	$0.80
	Jun	$0.79
	Jul	$0.79
	Aug	$0.79
	Sep	$0.82
	Oct	$0.83
	Nov	$0.84
	Dec	$0.86
2011	Jan	$0.93
	Feb	$1.00
	Mar	$1.08
	Apr	$1.14
	May	$1.17
	Jun	$1.23
	Jul	$1.25
	Aug	$1.28
	Sep	$1.28
	Oct	$1.27
	Nov	$1.26
	Dec	$1.25
2012	Jan	$1.25
	Feb	$1.23
	Mar	$1.20
	Apr	$1.17
	May	$1.04
	Jun	$0.93
	Jul	$0.84
	Aug	$0.80
	Sep	$0.79
	Oct	$0.80
	Nov	$0.82
	Dec	$0.83
2013	Jan	$0.82
	Feb	$0.82
	Mar	$0.87
	Apr	$0.89
	May	$0.93

Year	Month	Catfish $/lb
	Jun	$0.97
	Jul	$0.99
	Aug	$1.03
	Sep	$1.06
	Oct	$1.11
	Nov	$1.11
	Dec	$1.10
2014	Jan	
	Feb	
	Mar	
	Apr	
	May	
	Jun	
	Jul	
	Aug	
	Sep	
	Oct	
	Nov	
	Dec	
2015	Jan	
	Feb	
	Mar	
	Apr	
	May	
	Jun	
	Jul	

These are the data for Figure 11: Catfish feed price per ton, 32% and 28% protein:

Year	Month	32% protein feed $/ton	28% protein feed $/ton
2000	Jan	$196.00	$183.00
	Feb	$195.00	$182.00
	Mar	$203.00	$180.00
	Apr	$204.00	$181.00

Year	Month	32% protein feed $/ton	28% protein feed $/ton
	May	$211.00	$182.00
	Jun	$208.00	$183.00
	Jul	$199.00	$184.00
	Aug	$192.00	$182.00
	Sep	$200.00	$181.00
	Oct	$201.00	$181.00
	Nov	$199.00	$182.00
	Dec	$205.00	$183.00
2001	Jan	$211.00	$200.00
	Feb	$202.00	$192.00
	Mar	$192.00	$190.00
	Apr	$203.00	$192.00
	May	$201.00	$192.00
	Jun	$206.00	$196.00
	Jul	$213.00	$202.00
	Aug	$215.00	$205.00
	Sep	$209.00	$199.00
	Oct	$206.00	$197.00
	Nov	$207.00	$199.00
	Dec	$204.00	$197.00
2002	Jan	$204.00	$195.00
	Feb	$201.00	$193.00
	Mar	$205.00	$196.00
	Apr	$208.00	$198.00
	May	$204.00	$195.00
	Jun	$204.00	$195.00
	Jul	$222.00	$212.00
	Aug	$229.00	$216.00
	Sep	$225.00	$211.00
	Oct	$225.00	$211.00
	Nov	$220.00	$212.00
	Dec	$220.00	$214.00
2003	Jan	$222.00	$216.00
	Feb	$224.00	$215.00
	Mar	$227.00	$218.00
	Apr	$227.00	$219.00
	May	$230.00	$221.00
	Jun	$231.00	$222.00
	Jul	$232.00	$222.00

Year	Month	32% protein feed $/ton	28% protein feed $/ton
	Aug	$230.00	$219.00
	Sep	$241.00	$231.00
	Oct	$243.00	$234.00
	Nov	$263.00	$253.00
	Dec	$263.00	$253.00
2004	Jan	$275.00	$264.00
	Feb	$282.00	$265.00
	Mar	$287.00	$276.00
	Apr	$297.00	$296.00
	May	$310.00	$298.00
	Jun	$295.00	$284.00
	Jul	$290.00	$278.00
	Aug	$255.00	$247.00
	Sep	$254.00	$245.00
	Oct	$237.00	$229.00
	Nov	$229.00	$221.00
	Dec	$229.00	$221.00
2005	Jan	$224.00	$214.00
	Feb	$222.00	$216.00
	Mar	$227.00	$220.00
	Apr	$228.00	$219.00
	May	$230.00	$219.00
	Jun	$236.00	$226.00
	Jul	$247.00	$238.00
	Aug	$239.00	$229.00
	Sep	$241.00	$227.00
	Oct	$232.00	$224.00
	Nov	$230.00	$223.00
	Dec	$240.00	$230.00
2006	Jan	$243.00	$235.00
	Feb	$253.00	$237.00
	Mar	$244.00	$231.00
	Apr	$247.00	$232.00
	May	$247.00	$233.00
	Jun	$250.00	$233.00
	Jul	$252.00	$237.00
	Aug	$247.00	$232.00
	Sep	$252.00	$237.00
	Oct	$264.00	$250.00

Year	Month	32% protein feed $/ton	28% protein feed $/ton
	Nov	$280.00	$268.00
	Dec	$285.00	$272.00
2007	Jan	$276.00	$265.00
	Feb	$291.00	$279.00
	Mar	$293.00	$281.00
	Apr	$273.00	$262.00
	May	$268.00	$258.00
	Jun	$276.00	$266.00
	Jul	$279.00	$269.00
	Aug	$273.00	$262.00
	Sep	$291.00	$279.00
	Oct	$306.00	$295.00
	Nov	$310.00	$282.00
	Dec	$334.00	$321.00
2008	Jan	$370.00	$356.00
	Feb	$390.00	$376.00
	Mar	$380.00	$361.00
	Apr	$374.00	$356.00
	May	$382.00	$367.00
	Jun	$393.00	$377.00
	Jul	$440.00	$426.00
	Aug	$415.00	$402.00
	Sep	$407.00	$393.00
	Oct	$383.00	$365.00
	Nov	$368.00	$346.00
	Dec	$355.00	$343.00
2009	Jan	$362.00	$354.00
	Feb	$355.00	$341.00
	Mar	$332.00	$317.00
	Apr	$353.00	$327.00
	May	$377.00	$341.00
	Jun	$395.00	$366.00
	Jul	$385.00	$351.00
	Aug	$379.00	$348.00
	Sep	$380.00	$354.00
	Oct	$357.00	$338.00
	Nov	$363.00	$344.00
	Dec	$369.00	$353.00
2010	Jan	$367.00	$346.00

Year	Month	32% protein feed $/ton	28% protein feed $/ton
	Feb	$347.00	$328.00
	Mar	$334.00	$314.00
	Apr	$330.00	$310.00
	May	$330.00	$310.00
	Jun	$338.00	$317.00
	Jul	$346.00	$326.00
	Aug	$356.00	$335.00
	Sep	$361.00	$341.00
	Oct	$366.00	$348.00
	Nov	$376.00	$358.00
	Dec	$388.00	$370.00
2011	Jan	$409.00	$392.00
	Feb	$410.00	$394.00
	Mar	$418.00	$400.00
	Apr	$422.00	$403.00
	May	$431.00	$411.00
	Jun	$437.00	$418.00
	Jul	$426.00	$407.00
	Aug	$436.00	$417.00
	Sep	$441.00	$422.00
	Oct	$415.00	$396.00
	Nov	$403.00	$386.00
	Dec	$399.00	$381.00
2012	Jan	$401.00	$382.00
	Feb	$401.00	$382.00
	Mar	$423.00	$403.00
	Apr	$420.00	$400.00
	May	$446.00	$428.00
	Jun	$455.00	$434.00
	Jul	$499.00	$477.00
	Aug	$562.00	$530.00
	Sep	$524.00	$495.00
	Oct	$505.00	$478.00
	Nov	$498.00	$473.00
	Dec	$494.00	$470.00
2013	Jan	$486.00	$461.00
	Feb	$485.00	$458.00
	Mar	$485.00	$458.00
	Apr	$470.00	$447.00

Year	Month	32% protein feed $/ton	28% protein feed $/ton
	May	$472.00	$445.00
	Jun	$495.00	$467.00
	Jul	$516.00	$494.00
	Aug	$474.00	$442.00
	Sep	$485.00	$452.00
	Oct	$469.00	$435.00
	Nov	$484.00	$425.00
	Dec	$478.00	$444.00
2014	Jan	$474.00	$441.00
	Feb	$479.00	$447.00
	Mar	$505.00	$467.00
	Apr	$515.00	$473.00
	May	$509.00	$474.00
	Jun	$501.00	$471.00
	Jul	$474.00	$435.00
	Aug	$465.00	$426.00
	Sep	$506.00	$464.00
	Oct	$448.00	$405.00
	Nov	$450.00	$411.00
	Dec	$457.00	$421.00
2015	Jan	$446.00	$408.00
	Feb	$420.00	$388.00
	Mar	$416.00	$384.00
	Apr	$399.00	$368.00
	May	$384.00	$354.00
	Jun		
	Jul		

These are the counties for Map 1:

In Arkansas:
Lafayette
Lonoke
Chicot

In Mississippi:
Warren
Issaquena
Yazoo
Sharkey
Washington
Humphreys
Holmes
Bolivar
Sunflower
Leflore
Carroll
Coahoma
Tallahatchie
Grenada
Quitman
Tunica
Panola
Tate
Kemper
Noxubee
Winston
Choctaw
Oktibbeha
Lowndes
Clay
Chickasaw
Monroe
Lee

In Alabama
Pickens
Greene
Hale
Perry
Marengo

These are the data for Figure 12: LGM and LRP policies earning premium, all species:

	LGM - SWINE	LRP - SWINE	LGM - Cattle	LRP - Cattle	LRP - Lamb	LGM - Dairy
2003	108	250	-	41	-	-
2004	246	105	-	525	-	-
2005	260	120	-	950	-	-
2006	196	115	127	1,036	-	-
2007	131	64	66	479	-	-
2008	125	39	32	715	339	-
2009	62	19	21	410	141	40
2010	93	44	9	803	122	134
2011	53	38	8	1,460	133	1,224

	LGM - SWINE	LRP - SWINE	LGM - Cattle	LRP - Cattle	LRP - Lamb	LGM - Dairy
2012	27	23	2	1,228	284	897
2013	32	10	3	815	249	687
2014	41	10	11	1,908	69	498
2015	25	18	3	1,293	-	812

These are the data for Figure 13: Loss ratios, all species, LRP & LGM

Year	LGM - Swine	LRP - Swine	LGM - Cattle	LRP - Cattle	LRP - Lamb	LGM - Dairy
2003	57%	3%		0%		
2004	209%	4%		15%		
2005	60%	27%		0%		
2006	67%	31%	25%	65%		
2007	96%	52%	19%	58%		
2008	103%	153%	130%	162%	121%	
2009	274%	365%	37%	160%	215%	250%
2010	38%	17%	0%	48%	0%	36%
2011	48%	17%	10%	17%	162%	0%
2012	172%	47%	225%	115%	612%	7%
2013	48%	18%	88%	125%	640%	16%
2014	46%	53%	0%	0%	401%	5%
2015	123%	122%	0%	51%		

These are the data for Figure 14: Average monthly catfish price paid to farmers, $/pound, 2000-2014:

Year	Month	Catfish $/lb
2000	Jan	$0.74
	Feb	$0.79
	Mar	$0.79
	Apr	$0.79
	May	$0.79
	Jun	$0.79
	Jul	$0.76
	Aug	$0.74
	Sep	$0.73
	Oct	$0.71
	Nov	$0.70
	Dec	$0.68
2001	Jan	$0.69
	Feb	$0.70
	Mar	$0.70
	Apr	$0.69
	May	$0.69
	Jun	$0.67

Year	Month	Catfish $/lb
2002	Jul	$0.66
	Aug	$0.62
	Sep	$0.61
	Oct	$0.60
	Nov	$0.57
	Dec	$0.55
	Jan	$0.55
	Feb	$0.56
	Mar	$0.57
	Apr	$0.56
	May	$0.57
	Jun	$0.59
2003	Jul	$0.59
	Aug	$0.58
	Sep	$0.58
	Oct	$0.57
	Nov	$0.56
	Dec	$0.54
	Jan	$0.53
	Feb	$0.54
	Mar	$0.59
	Apr	$0.63
	May	$0.62
	Jun	$0.59
2004	Jul	$0.56
	Aug	$0.55
	Sep	$0.56
	Oct	$0.57
	Nov	$0.61
	Dec	$0.63
	Jan	$0.67
	Feb	$0.70
	Mar	$0.72
	Apr	$0.73
	May	$0.72
	Jun	$0.69
	Jul	$0.68
	Aug	$0.68
	Sep	$0.68
	Oct	$0.70
	Nov	$0.69

Year	Month	Catfish $/lb
	Dec	$0.69
2005	Jan	$0.73
	Feb	$0.73
	Mar	$0.73
	Apr	$0.73
	May	$0.72
	Jun	$0.72
	Jul	$0.72
	Aug	$0.72
	Sep	$0.72
	Oct	$0.72
	Nov	$0.72
	Dec	$0.73
2006	Jan	$0.73
	Feb	$0.73
	Mar	$0.75
	Apr	$0.79
	May	$0.80
	Jun	$0.81
	Jul	$0.81
	Aug	$0.81
	Sep	$0.83
	Oct	$0.84
	Nov	$0.84
	Dec	$0.84
2007	Jan	$0.84
	Feb	$0.84
	Mar	$0.84
	Apr	$0.84
	May	$0.84
	Jun	$0.82
	Jul	$0.76
	Aug	$0.73
	Sep	$0.70
	Oct	$0.68
	Nov	$0.67
	Dec	$0.65
2008	Jan	$0.66
	Feb	$0.69
	Mar	$0.74
	Apr	$0.76

Year	Month	Catfish $/lb
	May	$0.78
	Jun	$0.79
	Jul	$0.82
	Aug	$0.83
	Sep	$0.83
	Oct	$0.83
	Nov	$0.82
	Dec	$0.82
2009	Jan	$0.81
	Feb	$0.77
	Mar	$0.77
	Apr	$0.76
	May	$0.76
	Jun	$0.76
	Jul	$0.77
	Aug	$0.77
	Sep	$0.77
	Oct	$0.77
	Nov	$0.77
	Dec	$0.76
2010	Jan	$0.76
	Feb	$0.77
	Mar	$0.79
	Apr	$0.80
	May	$0.80
	Jun	$0.79
	Jul	$0.79
	Aug	$0.79
	Sep	$0.82
	Oct	$0.83
	Nov	$0.84
	Dec	$0.86
2011	Jan	$0.93
	Feb	$1.00
	Mar	$1.08
	Apr	$1.14
	May	$1.17
	Jun	$1.23
	Jul	$1.25
	Aug	$1.28
	Sep	$1.28

Year	Month	Catfish $/lb
	Oct	$1.27
	Nov	$1.26
	Dec	$1.25
2012	Jan	$1.25
	Feb	$1.23
	Mar	$1.20
	Apr	$1.17
	May	$1.04
	Jun	$0.93
	Jul	$0.84
	Aug	$0.80
	Sep	$0.79
	Oct	$0.80
	Nov	$0.82
	Dec	$0.83
2013	Jan	$0.82
	Feb	$0.82
	Mar	$0.87
	Apr	$0.89
	May	$0.93
	Jun	$0.97
	Jul	$0.99
	Aug	$1.03
	Sep	$1.06
	Oct	$1.11
	Nov	$1.11
	Dec	$1.10
2014	Jan	
	Feb	
	Mar	
	Apr	
	May	
	Jun	
	Jul	
	Aug	
	Sep	
	Oct	
	Nov	
	Dec	
2015	Jan	
	Feb	

Year	Month	Catfish $/lb
	Mar	
	Apr	
	May	
	Jun	
	Jul	

These are the data for Figure 15: Average monthly catfish feed price, $/ton, 2000-2014:

Year	Month	32% protein feed $/ton	28% protein feed $/ton
2000	Jan	$196.00	$183.00
	Feb	$195.00	$182.00
	Mar	$203.00	$180.00
	Apr	$204.00	$181.00
	May	$211.00	$182.00
	Jun	$208.00	$183.00
	Jul	$199.00	$184.00
	Aug	$192.00	$182.00
	Sep	$200.00	$181.00
	Oct	$201.00	$181.00
	Nov	$199.00	$182.00
	Dec	$205.00	$183.00
2001	Jan	$211.00	$200.00
	Feb	$202.00	$192.00
	Mar	$192.00	$190.00
	Apr	$203.00	$192.00
	May	$201.00	$192.00
	Jun	$206.00	$196.00
	Jul	$213.00	$202.00
	Aug	$215.00	$205.00
	Sep	$209.00	$199.00
	Oct	$206.00	$197.00
	Nov	$207.00	$199.00
	Dec	$204.00	$197.00
2002	Jan	$204.00	$195.00

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Year	Month	32% protein feed $/ton	28% protein feed $/ton
	Feb	$201.00	$193.00
	Mar	$205.00	$196.00
	Apr	$208.00	$198.00
	May	$204.00	$195.00
	Jun	$204.00	$195.00
	Jul	$222.00	$212.00
	Aug	$229.00	$216.00
	Sep	$225.00	$211.00
	Oct	$225.00	$211.00
	Nov	$220.00	$212.00
	Dec	$220.00	$214.00
2003	Jan	$222.00	$216.00
	Feb	$224.00	$215.00
	Mar	$227.00	$218.00
	Apr	$227.00	$219.00
	May	$230.00	$221.00
	Jun	$231.00	$222.00
	Jul	$232.00	$222.00
	Aug	$230.00	$219.00
	Sep	$241.00	$231.00
	Oct	$243.00	$234.00
	Nov	$263.00	$253.00
	Dec	$263.00	$253.00
2004	Jan	$275.00	$264.00
	Feb	$282.00	$265.00
	Mar	$287.00	$276.00
	Apr	$297.00	$296.00
	May	$310.00	$298.00
	Jun	$295.00	$284.00
	Jul	$290.00	$278.00
	Aug	$255.00	$247.00
	Sep	$254.00	$245.00
	Oct	$237.00	$229.00
	Nov	$229.00	$221.00
	Dec	$229.00	$221.00
2005	Jan	$224.00	$214.00
	Feb	$222.00	$216.00
	Mar	$227.00	$220.00
	Apr	$228.00	$219.00

Year	Month	32% protein feed $/ton	28% protein feed $/ton
	May	$230.00	$219.00
	Jun	$236.00	$226.00
	Jul	$247.00	$238.00
	Aug	$239.00	$229.00
	Sep	$241.00	$227.00
	Oct	$232.00	$224.00
	Nov	$230.00	$223.00
	Dec	$240.00	$230.00
2006	Jan	$243.00	$235.00
	Feb	$253.00	$237.00
	Mar	$244.00	$231.00
	Apr	$247.00	$232.00
	May	$247.00	$233.00
	Jun	$250.00	$233.00
	Jul	$252.00	$237.00
	Aug	$247.00	$232.00
	Sep	$252.00	$237.00
	Oct	$264.00	$250.00
	Nov	$280.00	$268.00
	Dec	$285.00	$272.00
2007	Jan	$276.00	$265.00
	Feb	$291.00	$279.00
	Mar	$293.00	$281.00
	Apr	$273.00	$262.00
	May	$268.00	$258.00
	Jun	$276.00	$266.00
	Jul	$279.00	$269.00
	Aug	$273.00	$262.00
	Sep	$291.00	$279.00
	Oct	$306.00	$295.00
	Nov	$310.00	$282.00
	Dec	$334.00	$321.00
2008	Jan	$370.00	$356.00
	Feb	$390.00	$376.00
	Mar	$380.00	$361.00
	Apr	$374.00	$356.00
	May	$382.00	$367.00
	Jun	$393.00	$377.00
	Jul	$440.00	$426.00

Year	Month	32% protein feed $/ton	28% protein feed $/ton
	Aug	$415.00	$402.00
	Sep	$407.00	$393.00
	Oct	$383.00	$365.00
	Nov	$368.00	$346.00
	Dec	$355.00	$343.00
2009	Jan	$362.00	$354.00
	Feb	$355.00	$341.00
	Mar	$332.00	$317.00
	Apr	$353.00	$327.00
	May	$377.00	$341.00
	Jun	$395.00	$366.00
	Jul	$385.00	$351.00
	Aug	$379.00	$348.00
	Sep	$380.00	$354.00
	Oct	$357.00	$338.00
	Nov	$363.00	$344.00
	Dec	$369.00	$353.00
2010	Jan	$367.00	$346.00
	Feb	$347.00	$328.00
	Mar	$334.00	$314.00
	Apr	$330.00	$310.00
	May	$330.00	$310.00
	Jun	$338.00	$317.00
	Jul	$346.00	$326.00
	Aug	$356.00	$335.00
	Sep	$361.00	$341.00
	Oct	$366.00	$348.00
	Nov	$376.00	$358.00
	Dec	$388.00	$370.00
2011	Jan	$409.00	$392.00
	Feb	$410.00	$394.00
	Mar	$418.00	$400.00
	Apr	$422.00	$403.00
	May	$431.00	$411.00
	Jun	$437.00	$418.00
	Jul	$426.00	$407.00
	Aug	$436.00	$417.00
	Sep	$441.00	$422.00
	Oct	$415.00	$396.00

Year	Month	32% protein feed $/ton	28% protein feed $/ton
	Nov	$403.00	$386.00
	Dec	$399.00	$381.00
2012	Jan	$401.00	$382.00
	Feb	$401.00	$382.00
	Mar	$423.00	$403.00
	Apr	$420.00	$400.00
	May	$446.00	$428.00
	Jun	$455.00	$434.00
	Jul	$499.00	$477.00
	Aug	$562.00	$530.00
	Sep	$524.00	$495.00
	Oct	$505.00	$478.00
	Nov	$498.00	$473.00
	Dec	$494.00	$470.00
2013	Jan	$486.00	$461.00
	Feb	$485.00	$458.00
	Mar	$485.00	$458.00
	Apr	$470.00	$447.00
	May	$472.00	$445.00
	Jun	$495.00	$467.00
	Jul	$516.00	$494.00
	Aug	$474.00	$442.00
	Sep	$485.00	$452.00
	Oct	$469.00	$435.00
	Nov	$484.00	$425.00
	Dec	$478.00	$444.00
2014	Jan	$474.00	$441.00
	Feb	$479.00	$447.00
	Mar	$505.00	$467.00
	Apr	$515.00	$473.00
	May	$509.00	$474.00
	Jun	$501.00	$471.00
	Jul	$474.00	$435.00
	Aug	$465.00	$426.00
	Sep	$506.00	$464.00
	Oct	$448.00	$405.00
	Nov	$450.00	$411.00
	Dec	$457.00	$421.00
2015	Jan	$446.00	$408.00

Year	Month	32% protein feed $/ton	28% protein feed $/ton
	Feb	$420.00	$388.00
	Mar	$416.00	$384.00
	Apr	$399.00	$368.00
	May	$384.00	$354.00
	Jun		
	Jul		

These are the data for Figure 16: Estimated non-key ingredient costs as a percentage of total cost, 2000-2014:

Year	Month	Margin %
2000		
	Mar	41%
	Jun	43%
	Sep	42%
	Dec	33%
2001	Mar	44%
	Jun	45%
	Sep	43%
	Dec	45%
2002	Mar	45%
	Jun	45%
	Sep	42%
	Dec	45%
2003	Mar	46%
	Jun	45%
	Sep	41%
	Dec	38%
2004	Mar	53%

Year	Month	Margin %
	Jun	37%
	Sep	54%
	Dec	53%
2005	Mar	48%
	Jun	46%
	Sep	53%
	Dec	45%
2006	Mar	49%
	Jun	51%
	Sep	54%
	Dec	49%
2007	Mar	47%
	Jun	46%
	Sep	41%
	Dec	33%
2008	Mar	38%
	Jun	35%
	Sep	40%
	Dec	46%
2009	Mar	43%
	Jun	35%
	Sep	41%
	Dec	41%
2010	Mar	46%
	Jun	44%
	Sep	39%
	Dec	34%
2011	Mar	39%
	Jun	39%
	Sep	37%
	Dec	40%
2012	Mar	38%
	Jun	35%
	Sep	27%
	Dec	32%
2013	Mar	32%
	Jun	32%
	Sep	33%
	Dec	29%

Year	Month	Margin %
2014	Mar	34%
	Jun	38%
	Sep	38%
	Dec	37%
2015	Mar	
	Jun	
	Sep	
	Dec	

These are the data for Figure 17: Estimated feed ration cost and actual feed prices, 2000 – 2014:

Year	Month	30% ration estimate, $/ton	30% actual feed price, $/ton
2000	Mar	$180.14	$191.50
	Jun	$177.61	$195.50
	Sep	$175.88	$190.50
	Dec	$206.12	$194.00
2001	Mar	$168.23	$191.00
	Jun	$175.85	$201.00
	Sep	$184.74	$204.00
	Dec	$175.91	$200.50
2002	Mar	$174.42	$200.50
	Jun	$174.31	$199.50
	Sep	$201.00	$218.00
	Dec	$187.55	$217.00
2003	Mar	$190.44	$222.50
	Jun	$196.87	$226.50
	Sep	$221.91	$236.00
	Dec	$251.69	$258.00
2004	Mar	$208.99	$281.50
	Jun	$287.91	$289.50
	Sep	$181.13	$249.50
	Dec	$167.49	$225.00
2005	Mar	$182.79	$223.50
	Jun	$198.16	$231.00
	Sep	$173.29	$234.00
	Dec	$203.42	$235.00

Year	Month	30% ration estimate, $/ton	30% actual feed price, $/ton
2006	Mar	$190.36	$237.50
	Jun	$185.93	$241.50
	Sep	$180.00	$244.50
	Dec	$224.53	$278.50
2007	Mar	$239.50	$287.00
	Jun	$234.19	$271.00
	Sep	$267.44	$285.00
	Dec	$347.98	$327.50
2008	Mar	$364.71	$370.50
	Jun	$396.36	$385.00
	Sep	$378.49	$400.00
	Dec	$301.52	$349.00
2009	Mar	$294.29	$324.50
	Jun	$392.02	$380.50
	Sep	$344.51	$367.00
	Dec	$339.61	$361.00
2010	Mar	$279.27	$324.00
	Jun	$289.47	$327.50
	Sep	$341.01	$351.00
	Dec	$395.51	$379.00
2011	Mar	$397.52	$409.00
	Jun	$410.95	$427.50
	Sep	$432.50	$431.50
	Dec	$372.18	$390.00
2012	Mar	$404.42	$413.00
	Jun	$454.85	$444.50
	Sep	$589.08	$509.50
	Dec	$522.04	$482.00
2013	Mar	$510.62	$471.50
	Jun	$516.46	$481.00
	Sep	$499.63	$468.50
	Dec	$519.31	$461.00
2014	Mar	$507.40	$486.00
	Jun	$478.54	$486.00
	Sep	$476.97	$485.00
	Dec	$435.72	$439.00
2015	Mar		$400.00
	Jun		
	Sep		

Year	Month	30% ration estimate, $/ton	30% actual feed price, $/ton
	Dec		

These are the data for Figure 18: Error of the estimated feed ration vs. actual prices:

Year	Month	30% ration estimate, $/ton	30% actual feed price, $/ton	(Estimate - actual) / estimated= Error
2000	Mar	$180.14	$191.50	6.30%
	Jun	$177.61	$195.50	10.07%
	Sep	$175.88	$190.50	8.31%
	Dec	$206.12	$194.00	-5.88%
2001	Mar	$168.23	$191.00	13.53%
	Jun	$175.85	$201.00	14.30%
	Sep	$184.74	$204.00	10.42%
	Dec	$175.91	$200.50	13.98%
2002	Mar	$174.42	$200.50	14.95%
	Jun	$174.31	$199.50	14.45%
	Sep	$201.00	$218.00	8.46%
	Dec	$187.55	$217.00	15.70%
2003	Mar	$190.44	$222.50	16.84%
	Jun	$196.87	$226.50	15.05%
	Sep	$221.91	$236.00	6.35%
	Dec	$251.69	$258.00	2.51%
2004	Mar	$208.99	$281.50	34.70%
	Jun	$287.91	$289.50	0.55%
	Sep	$181.13	$249.50	37.75%
	Dec	$167.49	$225.00	34.34%
2005	Mar	$182.79	$223.50	22.27%
	Jun	$198.16	$231.00	16.57%
	Sep	$173.29	$234.00	35.03%
	Dec	$203.42	$235.00	15.52%
2006	Mar	$190.36	$237.50	24.77%
	Jun	$185.93	$241.50	29.89%
	Sep	$180.00	$244.50	35.83%
	Dec	$224.53	$278.50	24.04%
2007	Mar	$239.50	$287.00	19.83%
	Jun	$234.19	$271.00	15.72%
	Sep	$267.44	$285.00	6.57%

Year	Month	30% ration estimate, $/ton	30% actual feed price, $/ton	(Estimate - actual) / estimated= Error
	Dec	$347.98	$327.50	-5.89%
2008	Mar	$364.71	$370.50	1.59%
	Jun	$396.36	$385.00	-2.87%
	Sep	$378.49	$400.00	5.68%
	Dec	$301.52	$349.00	15.75%
2009	Mar	$294.29	$324.50	10.27%
	Jun	$392.02	$380.50	-2.94%
	Sep	$344.51	$367.00	6.53%
	Dec	$339.61	$361.00	6.30%
2010	Mar	$279.27	$324.00	16.02%
	Jun	$289.47	$327.50	13.14%
	Sep	$341.01	$351.00	2.93%
	Dec	$395.51	$379.00	-4.17%
2011	Mar	$397.52	$409.00	2.89%
	Jun	$410.95	$427.50	4.03%
	Sep	$432.50	$431.50	-0.23%
	Dec	$372.18	$390.00	4.79%
2012	Mar	$404.42	$413.00	2.12%
	Jun	$454.85	$444.50	-2.28%
	Sep	$589.08	$509.50	-13.51%
	Dec	$522.04	$482.00	-7.67%
2013	Mar	$510.62	$471.50	-7.66%
	Jun	$516.46	$481.00	-6.87%
	Sep	$499.63	$468.50	-6.23%
	Dec	$519.31	$461.00	-11.23%
2014	Mar	$507.40	$486.00	-4.22%
	Jun	$478.54	$486.00	1.56%
	Sep	$476.97	$485.00	1.68%
	Dec	$435.72	$439.00	0.75%
2015	Mar		$400.00	
	Jun			
	Sep			
	Dec			

These are the data for Figure 19: Catfish price and feed costs, per pound of fish sold:

	Catfish price $/lb	Feed costs per lb of fish, FCR 2.4
1/1/2000	$0.74	$-
2/1/2000	$0.79	$-
3/1/2000	$0.79	$-
4/1/2000	$0.79	$-
5/1/2000	$0.79	$-
6/1/2000	$0.79	$-
7/1/2000	$0.76	$-
8/1/2000	$0.74	$-
9/1/2000	$0.73	$-
10/1/2000	$0.71	$-
11/1/2000	$0.70	$-
12/1/2000	$0.68	$-
1/1/2001	$0.69	$-
2/1/2001	$0.70	$-
3/1/2001	$0.70	$-
4/1/2001	$0.69	$-
5/1/2001	$0.69	$-
6/1/2001	$0.67	$-
7/1/2001	$0.66	$-
8/1/2001	$0.62	$-
9/1/2001	$0.61	$-
10/1/2001	$0.60	$-
11/1/2001	$0.57	$-
12/1/2001	$0.55	$-
1/1/2002	$0.55	$-
2/1/2002	$0.56	$-
3/1/2002	$0.57	$-
4/1/2002	$0.56	$-
5/1/2002	$0.57	$-
6/1/2002	$0.59	$-
7/1/2002	$0.59	$-
8/1/2002	$0.58	$-
9/1/2002	$0.58	$-
10/1/2002	$0.57	$-
11/1/2002	$0.56	$-
12/1/2002	$0.54	$-
1/1/2003	$0.53	$-
2/1/2003	$0.54	$-
3/1/2003	$0.59	$-

	Catfish price $/lb	Feed costs per lb of fish, FCR 2.4
4/1/2003	$0.63	$-
5/1/2003	$0.62	$-
6/1/2003	$0.59	$-
7/1/2003	$0.56	$-
8/1/2003	$0.55	$-
9/1/2003	$0.56	$-
10/1/2003	$0.57	$-
11/1/2003	$0.61	$-
12/1/2003	$0.63	$-
1/1/2004	$0.67	$-
2/1/2004	$0.70	$-
3/1/2004	$0.72	$-
4/1/2004	$0.73	$-
5/1/2004	$0.72	$-
6/1/2004	$0.69	$-
7/1/2004	$0.68	$-
8/1/2004	$0.68	$-
9/1/2004	$0.68	$-
10/1/2004	$0.70	$-
11/1/2004	$0.69	$-
12/1/2004	$0.69	$-
1/1/2005	$0.73	$-
2/1/2005	$0.73	$-
3/1/2005	$0.73	$-
4/1/2005	$0.73	$-
5/1/2005	$0.72	$-
6/1/2005	$0.72	$-
7/1/2005	$0.72	$-
8/1/2005	$0.72	$-
9/1/2005	$0.72	$-
10/1/2005	$0.72	$-
11/1/2005	$0.72	$-
12/1/2005	$0.73	$-
1/1/2006	$0.73	$-
2/1/2006	$0.73	$-
3/1/2006	$0.75	$-
4/1/2006	$0.79	$-
5/1/2006	$0.80	$-
6/1/2006	$0.81	$-

	Catfish price $/lb	Feed costs per lb of fish, FCR 2.4
7/1/2006	$0.81	$-
8/1/2006	$0.81	$-
9/1/2006	$0.83	$-
10/1/2006	$0.84	$-
11/1/2006	$0.84	$-
12/1/2006	$0.84	$-
1/1/2007	$0.84	$-
2/1/2007	$0.84	$-
3/1/2007	$0.84	$-
4/1/2007	$0.84	$-
5/1/2007	$0.84	$-
6/1/2007	$0.82	$-
7/1/2007	$0.76	$-
8/1/2007	$0.73	$-
9/1/2007	$0.70	$-
10/1/2007	$0.68	$-
11/1/2007	$0.67	$-
12/1/2007	$0.65	$-
1/1/2008	$0.66	$-
2/1/2008	$0.69	$-
3/1/2008	$0.74	$-
4/1/2008	$0.76	$-
5/1/2008	$0.78	$-
6/1/2008	$0.79	$-
7/1/2008	$0.82	$-
8/1/2008	$0.83	$-
9/1/2008	$0.83	$-
10/1/2008	$0.83	$-
11/1/2008	$0.82	$-
12/1/2008	$0.82	$-
1/1/2009	$0.81	$-
2/1/2009	$0.77	$-
3/1/2009	$0.77	$-
4/1/2009	$0.76	$-
5/1/2009	$0.76	$-
6/1/2009	$0.76	$-
7/1/2009	$0.77	$-
8/1/2009	$0.77	$-
9/1/2009	$0.77	$-

	Catfish price $/lb	Feed costs per lb of fish, FCR 2.4
10/1/2009	$0.77	$-
11/1/2009	$0.77	$-
12/1/2009	$0.76	$-
1/1/2010	$0.76	$-
2/1/2010	$0.77	$-
3/1/2010	$0.79	$-
4/1/2010	$0.80	$-
5/1/2010	$0.80	$-
6/1/2010	$0.79	$-
7/1/2010	$0.79	$-
8/1/2010	$0.79	$-
9/1/2010	$0.82	$-
10/1/2010	$0.83	$-
11/1/2010	$0.84	$-
12/1/2010	$0.86	$-
1/1/2011	$0.93	$-
2/1/2011	$1.00	$-
3/1/2011	$1.08	$-
4/1/2011	$1.14	$-
5/1/2011	$1.17	$-
6/1/2011	$1.23	$-
7/1/2011	$1.25	$-
8/1/2011	$1.28	$-
9/1/2011	$1.28	$-
10/1/2011	$1.27	$-
11/1/2011	$1.26	$-
12/1/2011	$1.25	$-
1/1/2012	$1.25	$-
2/1/2012	$1.23	$-
3/1/2012	$1.20	$-
4/1/2012	$1.17	$-
5/1/2012	$1.04	$-
6/1/2012	$0.93	$-
7/1/2012	$0.84	$-
8/1/2012	$0.80	$-
9/1/2012	$0.79	$-
10/1/2012	$0.80	$-
11/1/2012	$0.82	$-
12/1/2012	$0.83	$-

	Catfish price $/lb	Feed costs per lb of fish, FCR 2.4
1/1/2013	$0.82	$-
2/1/2013	$0.82	$-
3/1/2013	$0.87	$-
4/1/2013	$0.89	$-
5/1/2013	$0.93	$-
6/1/2013	$0.97	$-
7/1/2013	$0.99	$-
8/1/2013	$1.03	$-
9/1/2013	$1.06	$-
10/1/2013	$1.11	$-
11/1/2013	$1.11	$-
12/1/2013	$1.10	$-
1/1/2014	$1.10	$-
2/1/2014	$1.13	$-
3/1/2014	$1.15	$-
4/1/2014	$1.17	$-
5/1/2014	$1.19	$-
6/1/2014	$1.20	$-
7/1/2014	$1.20	$-
8/1/2014	$1.20	$-
9/1/2014	$1.19	$-
10/1/2014	$1.19	$-
11/1/2014	$1.16	$-
12/1/2014	$1.14	$-
1/1/2015	$1.14	$-
2/1/2015	$1.14	$-
3/1/2015	$1.13	$-
4/1/2015	$1.13	$-
5/1/2015		
6/1/2015		

These are the data for Figure 20: Catfish producer margin, fish price minus feed costs:

	Catfish price minus Feed cost
1/1/2000	$0.74
2/1/2000	$0.79

	Catfish price minus Feed cost
3/1/2000	$0.79
4/1/2000	$0.79
5/1/2000	$0.79
6/1/2000	$0.79
7/1/2000	$0.76
8/1/2000	$0.74
9/1/2000	$0.73
10/1/2000	$0.71
11/1/2000	$0.70
12/1/2000	$0.68
1/1/2001	$0.69
2/1/2001	$0.70
3/1/2001	$0.70
4/1/2001	$0.69
5/1/2001	$0.69
6/1/2001	$0.67
7/1/2001	$0.66
8/1/2001	$0.62
9/1/2001	$0.61
10/1/2001	$0.60
11/1/2001	$0.57
12/1/2001	$0.55
1/1/2002	$0.55
2/1/2002	$0.56
3/1/2002	$0.57
4/1/2002	$0.56
5/1/2002	$0.57
6/1/2002	$0.59
7/1/2002	$0.59
8/1/2002	$0.58
9/1/2002	$0.58
10/1/2002	$0.57
11/1/2002	$0.56
12/1/2002	$0.54
1/1/2003	$0.53
2/1/2003	$0.54
3/1/2003	$0.59
4/1/2003	$0.63
5/1/2003	$0.62

	Catfish price minus Feed cost
6/1/2003	$0.59
7/1/2003	$0.56
8/1/2003	$0.55
9/1/2003	$0.56
10/1/2003	$0.57
11/1/2003	$0.61
12/1/2003	$0.63
1/1/2004	$0.67
2/1/2004	$0.70
3/1/2004	$0.72
4/1/2004	$0.73
5/1/2004	$0.72
6/1/2004	$0.69
7/1/2004	$0.68
8/1/2004	$0.68
9/1/2004	$0.68
10/1/2004	$0.70
11/1/2004	$0.69
12/1/2004	$0.69
1/1/2005	$0.73
2/1/2005	$0.73
3/1/2005	$0.73
4/1/2005	$0.73
5/1/2005	$0.72
6/1/2005	$0.72
7/1/2005	$0.72
8/1/2005	$0.72
9/1/2005	$0.72
10/1/2005	$0.72
11/1/2005	$0.72
12/1/2005	$0.73
1/1/2006	$0.73
2/1/2006	$0.73
3/1/2006	$0.75
4/1/2006	$0.79
5/1/2006	$0.80
6/1/2006	$0.81
7/1/2006	$0.81
8/1/2006	$0.81

	Catfish price minus Feed cost
9/1/2006	$0.83
10/1/2006	$0.84
11/1/2006	$0.84
12/1/2006	$0.84
1/1/2007	$0.84
2/1/2007	$0.84
3/1/2007	$0.84
4/1/2007	$0.84
5/1/2007	$0.84
6/1/2007	$0.82
7/1/2007	$0.76
8/1/2007	$0.73
9/1/2007	$0.70
10/1/2007	$0.68
11/1/2007	$0.67
12/1/2007	$0.65
1/1/2008	$0.66
2/1/2008	$0.69
3/1/2008	$0.74
4/1/2008	$0.76
5/1/2008	$0.78
6/1/2008	$0.79
7/1/2008	$0.82
8/1/2008	$0.83
9/1/2008	$0.83
10/1/2008	$0.83
11/1/2008	$0.82
12/1/2008	$0.82
1/1/2009	$0.81
2/1/2009	$0.77
3/1/2009	$0.77
4/1/2009	$0.76
5/1/2009	$0.76
6/1/2009	$0.76
7/1/2009	$0.77
8/1/2009	$0.77
9/1/2009	$0.77
10/1/2009	$0.77
11/1/2009	$0.77

	Catfish price minus Feed cost
12/1/2009	$0.76
1/1/2010	$0.76
2/1/2010	$0.77
3/1/2010	$0.79
4/1/2010	$0.80
5/1/2010	$0.80
6/1/2010	$0.79
7/1/2010	$0.79
8/1/2010	$0.79
9/1/2010	$0.82
10/1/2010	$0.83
11/1/2010	$0.84
12/1/2010	$0.86
1/1/2011	$0.93
2/1/2011	$1.00
3/1/2011	$1.08
4/1/2011	$1.14
5/1/2011	$1.17
6/1/2011	$1.23
7/1/2011	$1.25
8/1/2011	$1.28
9/1/2011	$1.28
10/1/2011	$1.27
11/1/2011	$1.26
12/1/2011	$1.25
1/1/2012	$1.25
2/1/2012	$1.23
3/1/2012	$1.20
4/1/2012	$1.17
5/1/2012	$1.04
6/1/2012	$0.93
7/1/2012	$0.84
8/1/2012	$0.80
9/1/2012	$0.79
10/1/2012	$0.80
11/1/2012	$0.82
12/1/2012	$0.83
1/1/2013	$0.82
2/1/2013	$0.82

	Catfish price minus Feed cost
3/1/2013	$0.87
4/1/2013	$0.89
5/1/2013	$0.93
6/1/2013	$0.97
7/1/2013	$0.99
8/1/2013	$1.03
9/1/2013	$1.06
10/1/2013	$1.11
11/1/2013	$1.11
12/1/2013	$1.10
1/1/2014	$1.10
2/1/2014	$1.13
3/1/2014	$1.15
4/1/2014	$1.17
5/1/2014	$1.19
6/1/2014	$1.20
7/1/2014	$1.20
8/1/2014	$1.20
9/1/2014	$1.19
10/1/2014	$1.19
11/1/2014	$1.16
12/1/2014	$1.14
1/1/2015	$1.14
2/1/2015	$1.14
3/1/2015	$1.13
4/1/2015	$1.13
5/1/2015	
6/1/2015	

These are the data for Figure 21: Lagged catfish price forecast models:

Year	Month	Forecasted 6 month lag	Forecasted one-year lag
2000	Jan		
	Feb		
	Mar		
	Apr		
	May		

Year	Month	Forecasted 6 month lag	Forecasted one-year lag
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
	Dec		
2001	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul	$ 0.75	
	Aug	$ 0.75	
	Sep	$ 0.74	
	Oct	$ 0.73	
	Nov	$ 0.72	
	Dec	$ 0.71	
2002	Jan	$ 0.70	$ 0.75
	Feb	$ 0.70	$ 0.75
	Mar	$ 0.69	$ 0.74
	Apr	$ 0.68	$ 0.73
	May	$ 0.67	$ 0.72
	Jun	$ 0.66	$ 0.71
	Jul	$ 0.65	$ 0.70
	Aug	$ 0.63	$ 0.70
	Sep	$ 0.62	$ 0.69
	Oct	$ 0.61	$ 0.68
	Nov	$ 0.60	$ 0.67
	Dec	$ 0.59	$ 0.66
2003	Jan	$ 0.58	$ 0.65
	Feb	$ 0.58	$ 0.63
	Mar	$ 0.57	$ 0.62
	Apr	$ 0.57	$ 0.61
	May	$ 0.57	$ 0.60
	Jun	$ 0.57	$ 0.59
	Jul	$ 0.57	$ 0.58
	Aug	$ 0.57	$ 0.58
	Sep	$ 0.57	$ 0.57

Year	Month	Forecasted 6 month lag	Forecasted one-year lag
	Oct	$ 0.57	$ 0.57
	Nov	$ 0.57	$ 0.57
	Dec	$ 0.58	$ 0.57
2004	Jan	$ 0.58	$ 0.57
	Feb	$ 0.57	$ 0.57
	Mar	$ 0.57	$ 0.57
	Apr	$ 0.57	$ 0.57
	May	$ 0.57	$ 0.57
	Jun	$ 0.57	$ 0.58
	Jul	$ 0.58	$ 0.58
	Aug	$ 0.59	$ 0.57
	Sep	$ 0.61	$ 0.57
	Oct	$ 0.62	$ 0.57
	Nov	$ 0.63	$ 0.57
	Dec	$ 0.63	$ 0.57
2005	Jan	$ 0.64	$ 0.58
	Feb	$ 0.65	$ 0.59
	Mar	$ 0.66	$ 0.61
	Apr	$ 0.67	$ 0.62
	May	$ 0.68	$ 0.63
	Jun	$ 0.69	$ 0.63
	Jul	$ 0.70	$ 0.64
	Aug	$ 0.70	$ 0.65
	Sep	$ 0.70	$ 0.66
	Oct	$ 0.70	$ 0.67
	Nov	$ 0.70	$ 0.68
	Dec	$ 0.70	$ 0.69
2006	Jan	$ 0.71	$ 0.70
	Feb	$ 0.71	$ 0.70
	Mar	$ 0.71	$ 0.70
	Apr	$ 0.72	$ 0.70
	May	$ 0.72	$ 0.70
	Jun	$ 0.72	$ 0.70
	Jul	$ 0.73	$ 0.71
	Aug	$ 0.73	$ 0.71
	Sep	$ 0.73	$ 0.71
	Oct	$ 0.73	$ 0.72
	Nov	$ 0.73	$ 0.72
	Dec	$ 0.74	$ 0.72
2007	Jan	$ 0.74	$ 0.73

Year	Month	Forecasted 6 month lag	Forecasted one-year lag
	Feb	$ 0.75	$ 0.73
	Mar	$ 0.76	$ 0.73
	Apr	$ 0.77	$ 0.73
	May	$ 0.78	$ 0.73
	Jun	$ 0.79	$ 0.74
	Jul	$ 0.80	$ 0.74
	Aug	$ 0.81	$ 0.75
	Sep	$ 0.81	$ 0.76
	Oct	$ 0.82	$ 0.77
	Nov	$ 0.83	$ 0.78
	Dec	$ 0.83	$ 0.79
2008	Jan	$ 0.83	$ 0.80
	Feb	$ 0.83	$ 0.81
	Mar	$ 0.82	$ 0.81
	Apr	$ 0.81	$ 0.82
	May	$ 0.80	$ 0.83
	Jun	$ 0.78	$ 0.83
	Jul	$ 0.77	$ 0.83
	Aug	$ 0.75	$ 0.83
	Sep	$ 0.74	$ 0.82
	Oct	$ 0.73	$ 0.81
	Nov	$ 0.72	$ 0.80
	Dec	$ 0.72	$ 0.78
2009	Jan	$ 0.72	$ 0.77
	Feb	$ 0.72	$ 0.75
	Mar	$ 0.73	$ 0.74
	Apr	$ 0.74	$ 0.73
	May	$ 0.75	$ 0.72
	Jun	$ 0.77	$ 0.72
	Jul	$ 0.78	$ 0.72
	Aug	$ 0.79	$ 0.72
	Sep	$ 0.80	$ 0.73
	Oct	$ 0.80	$ 0.74
	Nov	$ 0.80	$ 0.75
	Dec	$ 0.80	$ 0.77
2010	Jan	$ 0.80	$ 0.78
	Feb	$ 0.79	$ 0.79
	Mar	$ 0.79	$ 0.80
	Apr	$ 0.79	$ 0.80
	May	$ 0.78	$ 0.80

Year	Month	Forecasted 6 month lag	Forecasted one-year lag
	Jun	$ 0.78	$ 0.80
	Jul	$ 0.77	$ 0.80
	Aug	$ 0.77	$ 0.79
	Sep	$ 0.77	$ 0.79
	Oct	$ 0.77	$ 0.79
	Nov	$ 0.77	$ 0.78
	Dec	$ 0.77	$ 0.78
2011	Jan	$ 0.78	$ 0.77
	Feb	$ 0.78	$ 0.77
	Mar	$ 0.78	$ 0.77
	Apr	$ 0.78	$ 0.77
	May	$ 0.79	$ 0.77
	Jun	$ 0.79	$ 0.77
	Jul	$ 0.80	$ 0.78
	Aug	$ 0.82	$ 0.78
	Sep	$ 0.84	$ 0.78
	Oct	$ 0.86	$ 0.78
	Nov	$ 0.89	$ 0.79
	Dec	$ 0.92	$ 0.79
2012	Jan	$ 0.96	$ 0.80
	Feb	$ 1.00	$ 0.82
	Mar	$ 1.04	$ 0.84
	Apr	$ 1.07	$ 0.86
	May	$ 1.11	$ 0.89
	Jun	$ 1.14	$ 0.92
	Jul	$ 1.18	$ 0.96
	Aug	$ 1.20	$ 1.00
	Sep	$ 1.22	$ 1.04
	Oct	$ 1.23	$ 1.07
	Nov	$ 1.24	$ 1.11
	Dec	$ 1.22	$ 1.14
2013	Jan	$ 1.20	$ 1.18
	Feb	$ 1.17	$ 1.20
	Mar	$ 1.13	$ 1.22
	Apr	$ 1.09	$ 1.23
	May	$ 1.05	$ 1.24
	Jun	$ 1.01	$ 1.22
	Jul	$ 0.98	$ 1.20
	Aug	$ 0.94	$ 1.17
	Sep	$ 0.91	$ 1.13

Year	Month	Forecasted 6 month lag	Forecasted one-year lag
	Oct	$ 0.88	$ 1.09
	Nov	$ 0.85	$ 1.05
	Dec	$ 0.85	$ 1.01
2014	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
	Dec		
2015	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		

These are the data for Figure 22: Errors of the lagged catfish price models

Year	Month	Forecasted 6 month lag Error	Forecasted one-year lag Error
2000	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		
	Aug		

Year	Month	Forecasted 6 month lag Error	Forecasted one-year lag Error
	Sep		
	Oct		
	Nov		
	Dec		
2001	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul	13%	
	Aug	16%	
	Sep	17%	
	Oct	18%	
	Nov	22%	
	Dec	22%	
2002	Jan	22%	27%
	Feb	20%	26%
	Mar	18%	23%
	Apr	17%	23%
	May	14%	21%
	Jun	10%	18%
	Jul	9%	16%
	Aug	8%	16%
	Sep	7%	16%
	Oct	7%	16%
	Nov	7%	16%
	Dec	8%	17%
2003	Jan	9%	18%
	Feb	6%	14%
	Mar	-2%	6%
	Apr	-10%	-3%
	May	-9%	-3%
	Jun	-3%	1%
	Jul	1%	3%
	Aug	2%	4%
	Sep	1%	2%
	Oct	0%	1%
	Nov	-7%	-7%
	Dec	-9%	-11%

Year	Month	Forecasted 6 month lag Error	Forecasted one-year lag Error
2004	Jan	-16%	-18%
	Feb	-23%	-24%
	Mar	-27%	-28%
	Apr	-28%	-28%
	May	-26%	-26%
	Jun	-20%	-20%
	Jul	-17%	-18%
	Aug	-15%	-19%
	Sep	-13%	-20%
	Oct	-13%	-22%
	Nov	-10%	-21%
	Dec	-9%	-20%
2005	Jan	-13%	-25%
	Feb	-12%	-23%
	Mar	-10%	-21%
	Apr	-8%	-17%
	May	-5%	-15%
	Jun	-4%	-14%
	Jul	-4%	-12%
	Aug	-3%	-11%
	Sep	-3%	-9%
	Oct	-3%	-7%
	Nov	-3%	-6%
	Dec	-3%	-5%
2006	Jan	-3%	-4%
	Feb	-3%	-4%
	Mar	-4%	-6%
	Apr	-10%	-12%
	May	-11%	-13%
	Jun	-12%	-15%
	Jul	-12%	-15%
	Aug	-12%	-14%
	Sep	-15%	-17%
	Oct	-15%	-17%
	Nov	-14%	-16%
	Dec	-14%	-16%
2007	Jan	-12%	-15%
	Feb	-11%	-16%
	Mar	-10%	-16%
	Apr	-9%	-16%

Year	Month	Forecasted 6 month lag Error	Forecasted one-year lag Error
	May	-8%	-15%
	Jun	-4%	-11%
	Jul	4%	-2%
	Aug	9%	3%
	Sep	14%	8%
	Oct	17%	11%
	Nov	19%	14%
	Dec	22%	17%
2008	Jan	21%	17%
	Feb	17%	15%
	Mar	9%	9%
	Apr	6%	8%
	May	3%	6%
	Jun	-2%	4%
	Jul	-7%	2%
	Aug	-10%	0%
	Sep	-12%	-1%
	Oct	-13%	-2%
	Nov	-14%	-3%
	Dec	-14%	-5%
2009	Jan	-13%	-6%
	Feb	-7%	-2%
	Mar	-6%	-5%
	Apr	-3%	-4%
	May	-1%	-5%
	Jun	0%	-6%
	Jul	1%	-8%
	Aug	3%	-7%
	Sep	3%	-6%
	Oct	4%	-4%
	Nov	5%	-2%
	Dec	5%	0%
2010	Jan	4%	2%
	Feb	4%	3%
	Mar	1%	2%
	Apr	-2%	0%
	May	-2%	1%
	Jun	-1%	2%
	Jul	-2%	1%
	Aug	-3%	1%

Year	Month	Forecasted 6 month lag Error	Forecasted one-year lag Error
	Sep	-6%	-3%
	Oct	-8%	-6%
	Nov	-9%	-8%
	Dec	-11%	-11%
2011	Jan	-20%	-21%
	Feb	-29%	-31%
	Mar	-38%	-40%
	Apr	-46%	-49%
	May	-48%	-52%
	Jun	-55%	-59%
	Jul	-56%	-61%
	Aug	-56%	-64%
	Sep	-52%	-64%
	Oct	-47%	-62%
	Nov	-42%	-60%
	Dec	-36%	-58%
2012	Jan	-30%	-56%
	Feb	-23%	-51%
	Mar	-16%	-44%
	Apr	-9%	-36%
	May	6%	-17%
	Jun	18%	-2%
	Jul	28%	12%
	Aug	34%	20%
	Sep	35%	23%
	Oct	35%	25%
	Nov	33%	26%
	Dec	32%	27%
2013	Jan	32%	30%
	Feb	29%	32%
	Mar	23%	29%
	Apr	18%	28%
	May	11%	25%
	Jun	4%	21%
	Jul	-1%	18%
	Aug	-9%	12%
	Sep	-17%	6%
	Oct	-26%	-2%
	Nov	-30%	-6%
	Dec	-30%	-9%

Year	Month	Forecasted 6 month lag Error	Forecasted one-year lag Error
2014	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
	Dec		
2015	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		

These are the data for Figure 23: Catfish gross margins, 2000-2014:

	Catfish price minus Feed cost
1/1/2000	$0.74
2/1/2000	$0.79
3/1/2000	$0.79
4/1/2000	$0.79
5/1/2000	$0.79
6/1/2000	$0.79
7/1/2000	$0.76
8/1/2000	$0.74
9/1/2000	$0.73

	Catfish price minus Feed cost
10/1/2000	$0.71
11/1/2000	$0.70
12/1/2000	$0.68
1/1/2001	$0.69
2/1/2001	$0.70
3/1/2001	$0.70
4/1/2001	$0.69
5/1/2001	$0.69
6/1/2001	$0.67
7/1/2001	$0.66
8/1/2001	$0.62
9/1/2001	$0.61
10/1/2001	$0.60
11/1/2001	$0.57
12/1/2001	$0.55
1/1/2002	$0.55
2/1/2002	$0.56
3/1/2002	$0.57
4/1/2002	$0.56
5/1/2002	$0.57
6/1/2002	$0.59
7/1/2002	$0.59
8/1/2002	$0.58
9/1/2002	$0.58
10/1/2002	$0.57
11/1/2002	$0.56
12/1/2002	$0.54
1/1/2003	$0.53
2/1/2003	$0.54
3/1/2003	$0.59
4/1/2003	$0.63
5/1/2003	$0.62
6/1/2003	$0.59
7/1/2003	$0.56
8/1/2003	$0.55
9/1/2003	$0.56
10/1/2003	$0.57
11/1/2003	$0.61
12/1/2003	$0.63

	Catfish price minus Feed cost
1/1/2004	$0.67
2/1/2004	$0.70
3/1/2004	$0.72
4/1/2004	$0.73
5/1/2004	$0.72
6/1/2004	$0.69
7/1/2004	$0.68
8/1/2004	$0.68
9/1/2004	$0.68
10/1/2004	$0.70
11/1/2004	$0.69
12/1/2004	$0.69
1/1/2005	$0.73
2/1/2005	$0.73
3/1/2005	$0.73
4/1/2005	$0.73
5/1/2005	$0.72
6/1/2005	$0.72
7/1/2005	$0.72
8/1/2005	$0.72
9/1/2005	$0.72
10/1/2005	$0.72
11/1/2005	$0.72
12/1/2005	$0.73
1/1/2006	$0.73
2/1/2006	$0.73
3/1/2006	$0.75
4/1/2006	$0.79
5/1/2006	$0.80
6/1/2006	$0.81
7/1/2006	$0.81
8/1/2006	$0.81
9/1/2006	$0.83
10/1/2006	$0.84
11/1/2006	$0.84
12/1/2006	$0.84
1/1/2007	$0.84
2/1/2007	$0.84
3/1/2007	$0.84

	Catfish price minus Feed cost
4/1/2007	$0.84
5/1/2007	$0.84
6/1/2007	$0.82
7/1/2007	$0.76
8/1/2007	$0.73
9/1/2007	$0.70
10/1/2007	$0.68
11/1/2007	$0.67
12/1/2007	$0.65
1/1/2008	$0.66
2/1/2008	$0.69
3/1/2008	$0.74
4/1/2008	$0.76
5/1/2008	$0.78
6/1/2008	$0.79
7/1/2008	$0.82
8/1/2008	$0.83
9/1/2008	$0.83
10/1/2008	$0.83
11/1/2008	$0.82
12/1/2008	$0.82
1/1/2009	$0.81
2/1/2009	$0.77
3/1/2009	$0.77
4/1/2009	$0.76
5/1/2009	$0.76
6/1/2009	$0.76
7/1/2009	$0.77
8/1/2009	$0.77
9/1/2009	$0.77
10/1/2009	$0.77
11/1/2009	$0.77
12/1/2009	$0.76
1/1/2010	$0.76
2/1/2010	$0.77
3/1/2010	$0.79
4/1/2010	$0.80
5/1/2010	$0.80
6/1/2010	$0.79

	Catfish price minus Feed cost
7/1/2010	$0.79
8/1/2010	$0.79
9/1/2010	$0.82
10/1/2010	$0.83
11/1/2010	$0.84
12/1/2010	$0.86
1/1/2011	$0.93
2/1/2011	$1.00
3/1/2011	$1.08
4/1/2011	$1.14
5/1/2011	$1.17
6/1/2011	$1.23
7/1/2011	$1.25
8/1/2011	$1.28
9/1/2011	$1.28
10/1/2011	$1.27
11/1/2011	$1.26
12/1/2011	$1.25
1/1/2012	$1.25
2/1/2012	$1.23
3/1/2012	$1.20
4/1/2012	$1.17
5/1/2012	$1.04
6/1/2012	$0.93
7/1/2012	$0.84
8/1/2012	$0.80
9/1/2012	$0.79
10/1/2012	$0.80
11/1/2012	$0.82
12/1/2012	$0.83
1/1/2013	$0.82
2/1/2013	$0.82
3/1/2013	$0.87
4/1/2013	$0.89
5/1/2013	$0.93
6/1/2013	$0.97
7/1/2013	$0.99
8/1/2013	$1.03
9/1/2013	$1.06

	Catfish price minus Feed cost
10/1/2013	$1.11
11/1/2013	$1.11
12/1/2013	$1.10
1/1/2014	$1.10
2/1/2014	$1.13
3/1/2014	$1.15
4/1/2014	$1.17
5/1/2014	$1.19
6/1/2014	$1.20
7/1/2014	$1.20
8/1/2014	$1.20
9/1/2014	$1.19
10/1/2014	$1.19
11/1/2014	$1.16
12/1/2014	$1.14
1/1/2015	$1.14
2/1/2015	$1.14
3/1/2015	$1.13
4/1/2015	$1.13
5/1/2015	
6/1/2015	