3. Regional status and perspectives of catfish culture

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Present status and perspectives of the culture of catfishes (Siluroidei) in North America

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Abstract

Production of channel catfish *(Ictalurus punctatus)*, the most widely cultured foodfish in the United States, is confined for the most part to the southern states. The states of Alabama, Arkansas, Louisiana, and Mississippi account for more than 95% of total commercial production and processing. Mississippi accounts for more production and processing than the rest of the United States combined. Channel catfish are native to the United States. However, the farm-raised catfish, processed into many different consumer products, is considered to be a newly developed fish for marketing purposes.

Production methods include intensive tank culture, raceway culture, and open pond systems. The open pond method accounts for almost all of the commercial production because it is more profitable. The other methods usually represent special situations as opposed to general cost effective systems. The culture of catfish in North America attained industry status in 1974 as production methods were adopted to provide fish for processing throughout the year. This development enhanced market development and tremendously contributed to the growth of the industry over the past 20 years.

The industry is still in its infancy and shows much potential for continued growth in the United States. This potential is based upon the following: products from farm-raised catfish are widely accepted by consumers; the resources required are available for expansion on an economically efficient basis; and institutional support in terms of research, education, and market development is available to the industry.

Keywords: Siluroidei, channel catfish, aquaculture, economics, production, marketing costs.

Etat actuel et perspectives de l'élevage des poissons-chats (Siluroidei) en Amérique du Nord.

Résumé

La production de poisson-chat *(Ictalurus punctatus)*, poisson le plus largement élevé aux Etats-Unis, est confiné aux états du Sud pour la plupart. Les états de l'Alabama, l'Arkansas, la Louisiane et le Mississipi comptent pour plus de 95 % de la production totale commerciale et de la transformation. Le Mississippi compte plus, pour la production et la transformation, que les autres états. *Ictalurus punctatus* est originaire des Etats-Unis. Cependant, le poisson-chat d'élevage est transformé en de nombreux produits pour la consommation et considéré comme un poisson nouvellement développé à des fins commerciales. Les méthodes de production incluent l'élevage intensif en bassin, « en raceway » et en étang. La méthode d'élevage en étang compte pour presque toute la production commerciale car plus rentable. Les autres méthodes présentent des situations particulières par rapport aux coûts de production.

L'élevage de poissons-chats en Amérique du Nord a atteint le statut industriel en 1974 lorsque des méthodes de production ont été adoptées pour fournir du poisson pour la transformation tout au long de l'année. Ce développement lança le marché et contribua énormément à la croissance de l'industrie pour plus de vingt ans. L'industrie est encore dans une période de développement et montre un potentiel de

croissance continue aux Etats-Unis. Ce potentiel est basé sur les points suivants : les produits issus de poissons-chats d'élevage sont largement acceptés par les consommateurs ; les ressources en expansion sont établies sur une base économique à bon rendement et enfin un support institutionnel en terme de recherche, de formation et de développement de marché.

Mots-clés : *Ictalurus punctatus*, Siluroidei, poisson-chat américain, aquaculture, économie, coût de production.

INTRODUCTION

Channel catfish, *Ictalurus punctatus*, is the most widely cultured foodfish in the United States. Channel catfish were originally native to states within the Mississippi Valley and those along the Gulf of Mexico. However, they have been widely introduced throughout the U.S. during the last century. State and federal hatcheries have been providing channel catfish fingerlings to stock public and private waters for sport fisheries for well over 50 years.

Commercial production of channel catfish was developed in the southern U.S. during the late 1950s and early 1960s based on the pioneering work of H. S. Swingle of Auburn University in Alabama (Wellborn and Tucker, 1985). Catfish species that were evaluated for commercial production by various research organizations and aquaculturists, included the channel catfish, blue catfish *(I. furcatus)*, white catfish *(I. catus)*, brown bullhead *(I. nebulosus)*, yellow bullhead *(I. natalis)*, black bullhead *(I. melas)* and flathead catfish *(Pylodictis olivaris)*. The channel catfish displayed more of the desirable characteristics judged by commercial fish culturists than the other catfish species. Some of these desirable characteristics include: ease of reproduction; market size attained prior to sexual maturity (they seldom reproduce in culture ponds); acceptance of manufactured feed; rapid growth; efficient feed conversion; and toleration of relatively high stocking density associated with commercial production.

Channel catfish process well and if cultured correctly, have a firm, white flesh with a mild flavor that is very acceptable to consumers in a wide variety of products. Channel catfish are a warmwater species, thus a growing season of at least 6 months or longer with water temperatures above 23°C are needed for their economic culture. Thus the major growth of the industry is limited to the southern U.S. due to climatic condition.

Several unique and some site specific factors have contributed to the rapid and successful development of the catfish industry. For example, the following environmental and socioeconomic factors contributed to the rapid growth of the industry in Mississippi. The delta region of Mississippi had an abundance of suitable land (flat and of the proper soil type) with the availability of plentiful supplies of suitable water at relatively shallow depth. Thus it offered a productive and profitable use of a land resource that had few alternative uses. The industry became an important source of employment for a large number of people with low levels of education and marketable skills who had become unemployed due to increased mechanization in other areas of agriculture. It also has become a productive and profitable alternative use of land resources that had previously been used for cotton, rice and soybean production.

DEVELOPMENT OF THE INDUSTRY

Channel catfish may be cultured in cages, netpens, tanks, and raceways, all of which are characterized as high-density culture systems. However, culture in any of the above in North America would be classified as a special case, attributable to either a unique resource situation (thermal springs, natural lakes, etc.) or a special marketing situation (Tucker and Robinson, 1990).

Essentially all of the farm-raised catfish are produced in static ponds. Initially, pond size varied from 0.4 to 16 ha in size however, subsequent research indicated that the most economical size was about 9 ha (Waldrop and Dillard, 1985). Prior to 1970, fish were stocked in ponds during the spring, raised through a single growing season and harvested during the fall by draining the pond. The major problem with this type of production system was the seasonal supply of fish and the inability to provide fresh fish throughout the year. In the early to mid 1970s, the industry developed a different production system which involved multiple harvesting, or topping, throughout the year. This continuous production system involves selectively removing marketable sized fish, allowing the submarketable sized fish to remain in the pond, and then an equivalent number of small fingerlings are added to replace the large fish removed. This production system allows the producer to maintain a consistently higher standing crop of fish throughout the year. This more fully utilizes the carrying capacity of the pond and assures a continual supply of marketable fish. These ponds are operated indefinitely without draining. The major problem with this type of production system is the difficulty of maintaining an inventory of the number of fish in the pond.

The industry depends on a continual supply of fingerlings or juvenile fish for stocking. Even though certain catfish producers specialize in fingerling production, a large number of catfish farmers maintain broodstock and produce their own fingerlings as part of their commercial operation. Channel catfish normally spawn in late spring and early summer. The broodfish are maintained at low density in ponds provided with spawning containers. The spawning containers are normally checked daily. When an egg mass is found, it is removed and transferred to a hatching trough. Hatching occurs in 5 to 8 days depending on water temperature. Following hatching, the yolk-sac fry are held in a rearing trough and then the swim-up fry are fed a nutritionally complete high protein fry feed. Stocking density affects the growth rate of the fry; therefore, the standing crop in the nursery ponds must be reduced at intervals by moving the larger fish to fingerling ponds. Fingerlings are normally stocked in production ponds when they reach 15 to 20 cm in length.

Initially, catfish farmers stocked 2 000 to 4 000 fingerlings per hectare with annual yields of 1 000 to 2 000 $kg.ha^{-1}$. However, with improved management strategies, high quality feeds, supplemental aeration and the development of the continuous production system, stocking rates and production yields have increased dramatically. Current estimates indicate that most commercial operations contain 24 700 or more fish per hectare consisting of a mixture of small, medium and large fish. Most of the increase in production during the last few years can be attributed to increased stocking densities as opposed to increased pond construction.

Production size fish are fed an extruded or floating feed during the normal warm water growing season. Floating feeds are preferred by most fish farmers because it allows the culturist to observe the feeding behavior of the fish. Essentially all of the catfish feed fed in Mississippi is produced in Mississippi by four major feed mills, three of which are owned by fish farmers.

When the fish reach marketable size, they must be harvested and transported live to a processing plant. Several custom harvesting firms are available to seine catfish ponds for a fee. This service is used by most commercial catfish producers. Harvested fish are transported to processing plants by live-haul trucks owned by the processing plant. Several processing plants are located in close proximity to the major catfish farms. Several of the processing plants are also owned by the fish farmers.

Commercial catfish farmers maintain a high level of technical management of their production ponds. They must continually monitor, predict, diagnose and treat water quality and disease problems as they develop in order to avoid substantial fish kills. An adequate supply of good quality water and widespread use of aeration equipment has allowed the catfish farmers to manage most of the water quality problems associated with the recent increases in stocking densities. These increases in stocking densities have also made disease management more important due to the greater potential losses involved. Diseases in catfish are caused by parasites, bacteria, viruses and fungi. Various chemical treatments are available to control most parasites and fungi. Only two antibiotics are available to control bacterial infections and bacterial strains resistant to both antibiotics have appeared. Only one virus has been identified that affects channel catfish. It is channel catfish virus or CCV and no therapeutic treatment is available for this disease. The most severe disease problems occur during the spring and fall when the water temperature changes or during periods of stress on the fish.

A continual problem that has plagued the industry since its beginning is off-flavor. Estimates indicate that from 30 to 90% of marketable size fish are off-flavor, depending on the time of the year. The term off-flavor refers to an earthy or musty flavor in the flesh of the fish. Compounds such as geosmin and 2-methylisoborneol have been identified as causing off-flavor in catfish. These compounds are known to be synthesized by actinomycetes and blue-green algae which are often present in most fish culture ponds. Considerable research effort has been devoted to elucidate the various environmental factors responsible for this problem; however, no specific solution to the problem has been identified (Tucker and Robinson, 1990). Fish farmers currently have to have a sample of their fish tested for off-flavor before and at the time of harvesting before the processing plant will accept the fish. If the fish test positive for off-flavor, the farmer must retain the fish until they test negative for off-flavor. This delay in harvest results in an added cost for the fish farmer. This delay may be for a few weeks to a few months depending on the situation.

An important feature of the industry which has undoubtedly contributed to its success is the integrated, cooperative effort among the producers, feed manufacturers, processors, marketers and various University research and extension specialists. Due to the high capital investment required for fish farming, most successful fish farmers are well-financed businessmen who also farm several different row crops. Many farmers also own stock in catfish processing plants and feed mills. Many individuals involved in the industry have graduate training in science or business. As a group, producers, processors, and feed manufacturers are innovative and receptive to new technology. University research and extension specialists maintain a close working relationship with the entire industry to assist them in their necessary research and development activities. A report on this close working relationship with respect to nutrition research has appeared elsewhere (Wilson and Lovell, 1993).

Another important feature of the industry has been its cooperative effort in promoting its product. A

check-off system was established several years ago whereby a certain amount of money was set aside for each ton of catfish feed sold by each feed mill. These funds have been used to promote the sales of farm-raised catfish.

CURRENT STATUS OF THE INDUSTRY

The industry grew rapidly in Mississippi and in other states following the change to the continuous production system initiated in 1974. The rate of increase in catfish delivered for processing each year from 1974 through 1993 in shown in *figure* 1 and illustrates this phenomenal growth. The benefit of the continuous production system can be seen in *figure* 2 which shows that this new culture system made a relatively constant supply of fish available to the processing plants throughout the year. These data do not include catfish sold to buyers other than processing plants. This occasionally large market is known to the industry as the live-haul market because fish are loaded on live-haul trucks at the farm and are not sold directly to processors. The fish often are sold to owners of recreational fishing lakes and to live-fish markets.

The growth in hectares used to produce farm-raised catfish in the United States is depicted in *table* 1. Data for the United States are not available year to year prior to 1988. The 61 397 hectares includes those devoted to foodfish, broodfish, and fingerling production. Recent low prices for fish have slowed growth in hectares. However, increased production per hectare allows for continued increases in annual sales. The current high prices, if sustained, are expected to stimulate additional pond construction in the future.

Commercial catfish farms are currently in production in 16 states as illustrated in *figure* 3. However, production is concentrated in the states of Alabama, Arkansas, Louisiana, and Mississippi, with Mississippi accounting for 19% of the farms, 60% of the water surface area, and a much larger percentage of production, perhaps as high as 75%. A comparison of the number of catfish farms and water surface area in the United States in 1980 and 1993 indicates the nature of the changes that have occurred as the industry continues to grow (*table* 2). The average size of a catfish farm in Mississippi has increased more than two-fold, and is more than three times the size of the industrial average. Research has shown that economies of size of fish farms increased as size increased to 260 hectares of water surface (Waldrop and Dillard, 1985).

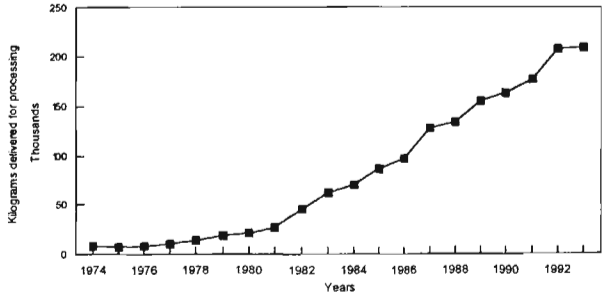

Figure 1. – United States domestic commercial catfish, kilograms delivered for processing, 1974-1993.

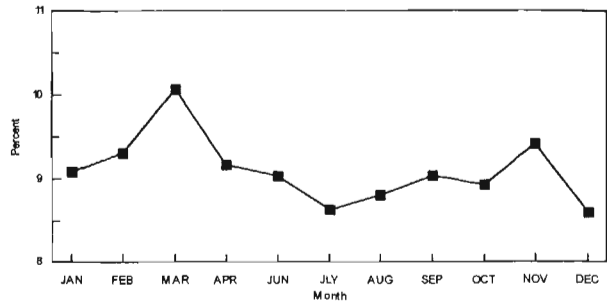

Figure 2. – Percentage of live weight delivered for processing by *month*, 1989-1993, average.

Table 1. - Water surface hectares in catfish production in Mississippi and the United States, 1980-1993[1].

Year	Hectares in production in Mississippi	Hectares in production in United States
1980	11 056	N/A[2]
1981	16 337	N/A
1982	22 637	N/A
1983	25 208	N/A
1984	26 459	N/A
1985	26 233	N/A
1986	29 777	N/A
1987	34 423	N/A
1988	36 373	56 407
1989	37 063	61 413
1990	38 041	65 551
1991	38 462	65 271
1992	36 842	61 482
1993	36 842	61 397

[1] USDA (1994).
[2] Data not available prior to 1988 for the United States.

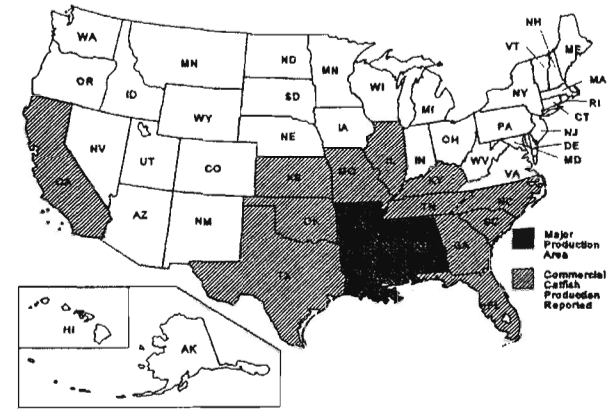

Figure 3. – Catfish production in the United States.

Table 2. – Number of catfish operations and water surface area, selected states and U.S., 1980[1] and 1993[2].

	Number of operations	Water surface hectares	Water surface hectares/operation	Number of operations	Water surface hectares	Water surface hectares/operation
		1980			1993	
Alabama	260	3 136	12.06	260	6 923	26.63
Arkansas	139	3 124	22.47	170	7 692	45.25
Louisiana	31	304	9.81	120	4 777	39.81
Mississippi	204	13 201	64.71	262	36 842	140.62
Other States[2]	327	2 283	6.98	592	5 162	8.72
United States	961	22 048	22.94	1 404	61 396	43.73

[1] USDA (1991).
[2] USDA (1994).
[3] Includes: California, Florida, Georgia, Illinois, Kansas, Kentucky, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee and Texas.

Production costs and current prices

Costs per kilogram of fish harvested vary by size of production unit. The latest comprehensive cost study of fish produced in Mississippi indicated that all costs, including returns to resources that could be expected to be earned in their next most profitable use, average about $\$1.43.kg^{-1}$ (Waldrop and Dillard, 1985). The most recently reported prices averaged about $\$1.74.kg^{-1}$. These data indicate that incentive exists for the catfish industry to continue to expand.

Market development

One of the most important factors responsible for the commercial success of the channel catfish industry in North America has been the development of markets for catfish products. The importance of marketing efforts is summarized in Tucker and Robinson (1990). They indicate that the rapid growth of the industry during the 1980s in the United States was a result of an active and extraordinarily effective marketing effort by the industry. Initially, the market was in the southeastern region of the United States where catfish was known and prized as a food item. However, in other areas of the United States, catfish were regarded as scavengers with little appeal as a food item. Advertising campaigns, modestly funded through feed sales, check-offs, and supported by other agencies, have resulted in farm-raised catfish becoming the third most popular fish consumed in the United States.

The early support and promotion of farm-raised catfish by the Mississippi Department of Agriculture was invaluable in developing initial markets. The Catfish Institute, an association of catfish feed manufacturers, has developed a modest but highly effective generic advertising campaign to expand markets. In addition, individual companies advertise their particular brands. Farm-raised catfish have a very mild flavor, are high in protein, low in fat and cholesterol, and are very adaptable to cooking methods and varied recipes. They have a long fresh shelf life, freeze and store well for several months, and currently are very acceptable to a broad base of consumers. They are grown in water free of pollutants, and fed feed manufactured from tested ingredients to insure a clean, wholesome product.

While the highest per capita consumption is still in the general region where the fish are produced, distribution is throughout the United States (*fig.* 4). Export markets (Japan and Germany) are being tested and developed at this time although the domestic market continues to expand rapidly.

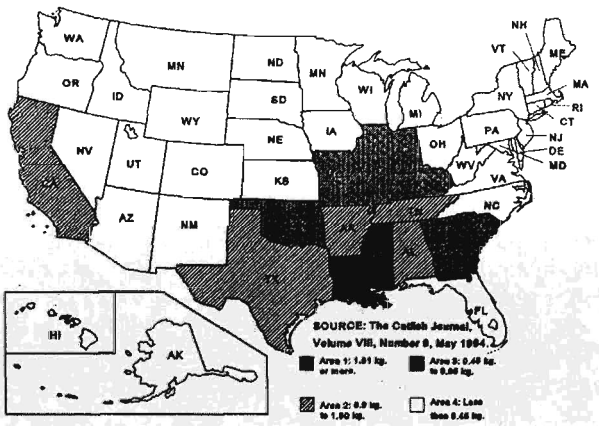

Figure 4. – Per capita catfish consumption in the United States.

The type of products offered for sale are too numerous to list. The majority of the products fall into the further processed category (*table* 3). A majority of the products are frozen as opposed to fresh. The acceptance of frozen products may be a direct result of consumer education through advertising. Consumers now understand that frozen products provide the freshest product possible when the product is frozen at the processing plant.

Table 3. – Tons of major product forms of processed farm-raised catfish by commercial processors, all years reported, United States[1]

Year	Whole dressed	Fillet	Other	Total
1986	24 067	19 098	8 605	51 770
1987	29 034	24 720	12 838	66 592
1988	25 227	29 178	13 576	67 981
1989	28 204	36 646	15 283	80 133
1990	26 855	39 525	16 868	83 248
1991	28 154	43 521	19 147	90 822
1992	33 179	50 891	21 083	105 153
1993	28 611	55 298	22 216	106 125

[1] USDA (1994).

PROSPECTS FOR FURTHER GROWTH OF THE FARM-RAISED CATFISH INDUSTRY

Future growth of the catfish industry in North America will depend on the level of consumer demand for products, and the industry's ability to increase supplies consistent with consumer demand. The demand for fish and seafood is likely to continue to grow over the long run. World populations are growing; incomes, in general, are increasing; tastes and preferences for fish are increasing, perhaps due to health concerns; and fish are relatively cheap compared to many other sources of high quality protein.

The potential to increase the supply of catfish at current cost levels appears to be substantial. Efficient production depends on the availability of appropriate land, pure water for pond culture at reasonable cost, management skills, proper support institutions to provide continued manager-producer education, research support, and financial institutions to furnish the required capital at a reasonable cost. All of these resources and support institutions are available in North America. There is no reason to suspect that any one of the above requirements will hinder continued growth in production of farm-raised catfish.

The United States alone imports more than $5 billion of fish and seafood. Aquaculture is capable of supplying much of this demand through growth. The current per capita consumption of ready-to-eat catfish in the United States is 0.41 kg. In some areas, consumption exceeds 1.81 kg. There is no indication that the market is saturated in any area in the United States. Based on available data, the conclusion of continued rapid growth is warranted. The industry is hardly 20 years old and has made tremendous progress. The right conditions exist for continued development well into the foreseeable future.

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