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The Economic and Technical Efficiency of Yellow Cat Fish (Pelteobagrus Fulvidraco) Production in China

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ABSTRACT

China's yellow catfish (Pelteobagrus fulvidraco) productions has undergone a rapid growth since the year 2000 and Its Productions increased high ranging from 50, 000 tones to 114, 000 tons in 2007, and to over 300, 000 tons in 2014 by far the largest producer in the world. Yellow catfish (Pelteobagrus fulvidraco) are freshwater species native to Chinese waters. The aim of the study is to provide a better understanding on the present trends in the economic and technical efficiency of Yellow catfish (Pelteobagrus fulvidraco) production in China and learn from the Chinese wider experiences as a guide to the developing countries as they strive to develop their aquaculture sectors. The method of the study employed secondary data information collected from the reputable sources such as Food and Agriculture Organization of the United Nations, Nanjing Agriculture University-electronic library, China fisheries year books and annual reports including other relevant websites browsed containing some valuable information about Chinese aquaculture status and the data gathered was analyzed. Freshwater aquaculture in China has made a concerted effort to uplift culture practices on selected, high-valued, indigenous fish species. Currently yellow catfish has well established seed production technology, feed production, and efficient culture technology systems. It's economically preferred by many consumers both in the local markets as well as international markets particularly by the south-eastern Asian countries like Japan and Korea. Despite the economic importance of yellow catfish species in the aquaculture sector, there is still limited information on its economic and technical efficiency production. Thus, this review paper highlights the economic and technical efficiency of yellow catfish production performances and focus on identifying critical matters that can support and improve yellow catfish productions in China as well as in the developing countries.

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Introduction

Freshwater finfish aquaculture development has expanded in China during the last 20 years, and currently, China have taken the lead globally in production and consumption of farmed freshwater species. Approximately 70% of freshwater aquaculture production in China is carried out in ponds [1-3]. and its development has been influenced by production inputs, including and, or availability of water, fish diseases, and farmers' knowledge and practices [4]. Accounting for China's total aquaculture production are both Exotic and indigenous fish species. However, the aquaculture production of some alien species exceeded those in their native countries, such as the Nile tilapia (Oreochromis niloticus), largemouth black bass (Micropterus salmoides), channel catfish (Ictalurus punctatus) and freshwater crayfish [5,6].

Since the dawn of the new millennium, with increasing emphasis on environmental integrity and sustainable development globally, freshwater aquaculture in China has made a concerted effort to uplift culture practices on selected, often high-valued, indigenous species [8]. The most promoted indigenous species include the mandarin fish (Siniperca chuatsi), yellow catfish (Pelteobagrus fulvidraco) and paddy eel (Monopterus albus), and other aquatic species such as the mitten crab and soft-shelled turtle. Hence, yellow catfish (Pelteobagrus fulvidraco) coupled with its excellent meat quality and high market value has become one of the most important freshwater aquaculture species in China [9-11]. Despite importance of yellow catfish in aquaculture, there is still little or no information on its economic and technical efficiency.Therefore, this review is written to highlight the the economic and technical efficiency of yellow catfish.

Yellow catfish (Pelteobagrus fulvidraco) production in China

Yellow catfish (Pelteobagrus fulvidraco) is a freshwater species native to Chinese waters.It is widely distributed in a wide range of river basins in china particularly in Yangtze River, yellow river Liaohe, Huaihe, Xiangjiang, Minjiang and Pearl Rivers [12]. Yellow catfish belongs to the genus Pelteobagrus [13]. It is an omnivorous demersal feeder, with optimum growth temperature ranging between 25 °C -28°C and water oxygen levels not less than 2mg/l [14].

Yellow catfish was first introduced in aquaculture in the 20th century [15]. Since its introduction it did not make significant

contribution to the total aquaculture production in China. Its farming was still in its early stages, fry was usually collected from the wild hence making it difficult to develop large scale production [16]. Due to high demand and good market price for yellow catfish, artificial breeding was developed in 1999 in China [17]. However, there was still a challenge in rearing the larval stage because there was lack of knowledge on the on Yellow catfish feeding habits [16]. This shortage of fingerlings continued to inhibit large scale production. In 2001 larval stage rearing became possible which in turn led to the establishment of large-scale fingerling producing stations [18]. The breakthrough in Yellow catfish fingerling production coupled with high demand and good market prices led to a growing demand among farmers to culture it which in turn led to increase in production. In 2003 total annual Yellow catfish production was around 50 000 tons [15].

Yellow catfish exhibit sexual dimorphism in growth rates, males grow faster and bigger than females. This led to the development of technology to produce all-male Yellow catfish [19]. Furthermore, development of yellow catfish formulae feed, disease prevention, and determination of optimal stocking densities further triggered a rapid increase in production. Yellow catfish annual production increased from 50, 000 tons in 2003 to about 140 000 tons in 2008. The production has continued to increase rapidly since 2008 in line with the improvement in aquaculture technology. Currently yellow catfish culture occurs in Hubei province, Jiangxi, Zhejiang, Sichuan, Guangdong, Anhui, Jiangsu, and Hunan Provinces [5].

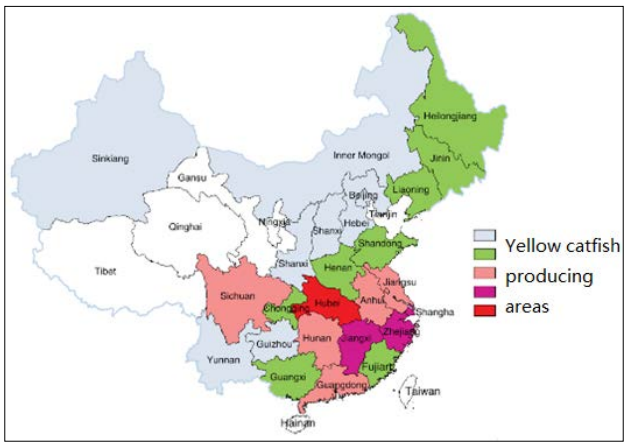

Figure 1: Map of China showing regions of yellow catfish production [15].

Materials and Methods

Ethical Approval

The method of the study employed secondary data information collected from the reputable sources such as Food and Agriculture Organization of the United Nations, Nanjing Agriculture University-electronic library, China fisheries year books and annual reports including other relevant websites perused containing certain valuable information about Chinese aquaculture status and the data gathered was analyzed. The study proto-calls were approved by the Freshwater Fisheries Research Centre of the Chinese Academy of Fisheries Sciences, Wuxi-China (Jiangsu province).

Observations and Discussion

Aquaculture Technology and Innovations in China

Aquaculture in China driven by high demand for aquatic products by local and international markets has gone through rapid expansion in scale and technology [20]. Technology and innovation have improved fish breeding, feed and feeding management, water quality monitoring system.

Over the past years genetic and biotechnology principles have been applied to improve several strains and to increase seed production in the aquaculture industry. This led to many success stories in seed production, development of disease resistant and fast-growing strains in the aquaculture industry. Today there are several improved strains available in the aquaculture industry in China. Some of these strains includeChongwei number 1Tilapia, shrimps (Penaeus chinensis), GIFT strain Nile tilapia, High breed tilapia of niloticus and blue tilapia or Mozambique tilapia, the Fenneropenaeus chinensis "Yellow Sea No. 1," triploid crucian carp (genetically engineered), and triploid common carp (genetically engineered), have been widely cultured [22,35,36,21,23,5].

Furthermore, the determination of nutrient requirements and feeding habits of most cultured fish species led to the development of the feed industry [24]. Currently the feed is well developed and produce feed for most cultured fish species. Advancement in technology has led to effective management of fish farms. For example, the development of demand and automatic feeders has improved the feeding management. Furthermore, the development of digital water quality testing kits has further improvement aquaculture water management. Today water quality is monitored using water testing kits or computerized water management systems. Other innovations such as the use of EM bacteria to control water are being used on several farms in China to improve water quality [25,7].

Aquatic Environmental Management in China

After the Open and Reform of the late1970s fisheries and aquaculture in China was dominated by a supply-driven paradigm mainly focusing on output volume.To meet the increasing demands from both domestic and international markets for aquatic products, more and more priorities were given to the development of aquaculture, which is now playing a more and more important role in the output contribution [26]. During this period China did pain attention to the strict water management. Therefore, the rapid expansion of aquaculture as well other sectors of the economy led to several water problems including water pollution, food safety, fish disease outbreaks, etc.

However, after the WTO Accession, China has vigorously promoted the standardization of aquaculture development, based on the principle of the Standard for Pollution-free Aquaculture and the Quality and Safety Standard for Aquatic Products [27,28]. Both of which aim at boosting the level of healthy aquaculture development as well as the quality and safety of aquatic products. Since 2002, over 60 new technical standards for pollution-free aquaculture, and more than 40 standards or specifications for drug residues in aquatic products and inspection methods, have either been developed or revised. In addition, local standards for veterinary drugs have also abolished or elevated to the level of national standards, conditional upon re-examination and approval [29].

Following the pollution incidences that occurred in 2008 [30]. The Chinese government has responded by shifting policy focus, setting up regulations and introducing technological innovations to strengthen sustainability and responsibility in aquaculture [26]. In the new water management policy, it stated that no agriculture activities are supposed to be carried near water bodies, not discharge should be taken sent directly into the water, and cage should have been prohibited in many lakes. With this policy, there is no cage culture in most lakes and reservoirs and aquaculture will be more intensive based on circulatory technologies.

Policies Enabling Aquaculture Practices in China

The development of policies and the role of the government in creating an enabling environment for aquaculture have been important factors in Chinese aquaculture achievements [15]. Regarding policy, there are three main phases that characterize the Chinese aquaculture development. The first, which covers the period before 1949 and during which aquaculture development was slow, is poorly documented in terms of policies. The second phase, which runs from 1949 to 1978, is characterized by tight government control and policy prescriptions. This period can best be described as a period of highly centrally- planned economy policies. In the third period, from 1978 onwards, economic and policy reforms were established to allow producers to make production decisions, including marketing. This period can be referred to as a period of free market economy policies [20].

Since 1978 Chinese aquaculture has been growing rapidly at annual of about [20]. During this period there have been several reforms in policies and regulations and aquaculture promotions that led to the creation of an enabling environment for aquaculture. At begging of the rapid aquaculture growing stage two important instructions were initiated by the Government in 1979. These were the "Regulation on Breeding and Protection of Aquatic Resources", promulgated by the State Council on 10 February 1979. The second is the "Directive Notice on Approval and Implementation of the Report on National Aquatic Product Industry Working Conference", promulgated by the State Council on 29 April 1979. The principle of the "Regulation on Breeding and Protection of Aquatic Resources" was to protect aquatic resources. Through this regulation, fishing was restricted by area, time and species. To some extent, the protection of aquatic resources led to the development of aquaculture in the whole country [31].

Establishment of aquaculture supporting structures for easy and effective aquaculture management. The supporting structures include the National Fishery Technology Extension Station, the Chinese Fishery Academy and the China Society of Fisheries. The National Fishery Technology Extension Station is semi-governmental institution dealing with implementation of the state's policies on fishery technology and extension services. The Chinese Fishery Academy is the national level academy involved in research on specific subjects such as the biology of aquatic animals, fishery resources and socio-economy of fisheries. The China Society of Fisheries is an organization of fishery technicians who deal with technical exchange and promotion Fisheries [20].

The government promoted the aquaculture industry by providing economic incentives to fish farmers and feed manufactures and policies favoring aquaculture development [32]. As the aquaculture industry expands quickly at home, large quantities of some feed ingredients, mainly fishmeal and soybean, are imported. To promote development of the aquaculture feed industry, relatively low tariffs are levied on the major imported raw materials. For example, in 1999, import tariffs for fishmeal intended for aquatic animal feed were only 3 percent in 1999 compared to 30 percent for fishmeal intended for human consumption. Similarly, import duties for soybean meal used for feed production were 40 percent, compared to 114 percent for soybean imported for other uses Other policies and reform proving an enabling environment include the legalization of private farms to take part in the production of fish seed. Before 1978, nearly all hatcheries were in the Government's hands. However, later the government encouraged private companies to get involved in the production of seed, this in led further expansion of aquaculture.Furthermore, promotion and introduction of exotic of fish species of high economic value into the country led increase in aquaculture production [20].

Productions systems of Yellow Catfish (Pelteobagrus fulvidraco)

In china, several fish culture methods are used. Fish is cultured in cultured in ponds, pens, rice fields, lakes, reservoirs, raceways and cages. However, pond and cage culture are the most common methods used for yellow catfish production with a few farmers rearing it in rice fields and raceways [7].

Pond Culturing

Ponds are the most common culture models for yellow catfish; accounting for about 80% of the total production. Ponds are used for culturing both fingerlings and adult fish [7].

Pond Seeds Production of yellow catfish (Pelteobagrus fulvidraco)

Generally yellow catfish are stocked in the nursery pond and grown to fingerlings stage. Nursery ponds should have a flat bottom substrate and depth of not more than 50 cm. Before stocking the pond, pond preparations should start approximately a month before the actual stocking day hen [16,34]. The pond should be drained and left to expose the substrate to the sun and for removal of weeds and others macrophysics. After 15 days the pond is should be filled with water to the depth of not more than 50 cm, usually 20cm – 30cm and quicklime or other authorized chemicals can be used to should to disinfect the pond [18]. A week before the pond should be fertilized to promote the growth of natural feed organisms for the fry. After fry are stocked oxygenation, feeding, and other management practices should be applied. Normally in China the fry of yellow catfish requires a year to reach the fingerling stage [16,34].

On-Grown Ponds of yellow catfish (Pelteobagrus fulvidraco)

The on-growing ponds of Yellow catfish usually have depths ranging between 2-3 meters, with dissolved oxygen (DO) levels should be not less than 2mg/l, pH between 6 and 9 [18]. The pond should weed and pathogen free. In yellow catfish mono culture, the stocking density is usually 10-15 fish/m2 is the most common practiced. However, in most cases it is poly-cultured with silver carp, big head carp, and grass carp. In this case the silver Carp need to stocked at 2-3 fish/6.67m2 (30g per fish), big head carp 1-2 fish/6.67m2 (30g per fish), and Grass carp 0.1-0.2 fish/6.67m2 (50g per fish) [37,38]. In other places it is often poly-cultured with other aquatic animals like the turtles. Depending on the management and market size preference the yellow catfish fish will can be ready for market size [15].

Figure 2: Yellow Catfish Pond Production Model in China [37].

Cage Culturing of yellow catfish (Pelteobagrus fulvidraco)

Cage is another important culture model of for Yellow catfish culture in China, often for culture from fingerling stage to table size (market size). Cage culture is often practiced in reservoirs, and lakes, and very rarely in in rivers. The stocking densities in

cages are higher than in ponds, usually 2000-3000 fish/m2 in the first phase, 1000-1500 fish/m2 in the second phase, and 500-600 fish/m2 in the final phase. In fish cage cultured Yellow catfish is completely feed on formulated, the fish fed 2-3 times a day at 2 percent their body weight [15].

Figure 3: yellow catfish cage production model in China [15].

Seed Supply

The breakthrough in artificial propagation of yellow catfish between 1999 and 2001 led to the development of a stable supply of fingerlings. Further breakthrough in yellow catfish seed production was achieved when all-male yellow catfish seed production was successfully developed [17,16,19,33]. Currently there is adequate supply of good quality all male yellow catfish fingerlings in regions that are involved in the culture of fish species [34].

Feed Production

Feed is one of the most important factors in aquaculture. The efforts to improve yes catfish production led to the determination of its nutrient requirements which in turn led to the success in the production of formulated yellow catfish feed [39]. Currently many feed companies produce feed for juvenile and adult fish. The feed mills companies that produced include Haida, Tangwei, Dabeinong, and many other companies [15].

Table 1: Catfish nutritional requirements [39].

Parameter	Proportion
Crude protein	≥40.0
Crude fat	≥3.5
Crude fiber	≤6.0
Crude ash	≤12.0
Calcium	0.7–2.3
Total phosphorus	≥0.75
Lysine	≥1.8
Moisture	≤10.0

Production Trends

Since the breakthrough in artificial propagation of yellow catfish, its production has been increasing rapidly from 2003 up to date. The total annual production was approximately 50 000 tons and reached 114 000 tons in 2007, a fast was growth representing 16% per year. Advancements in breeding technology, feed production, and culture technology further increased production [38]. In 2013, yellow catfish production was reached 296 000 tons (figure 1). At present Yellow catfish industry looks promising due to use its demand from consumers in the country and international market, hence it has a great potential for further expansion.

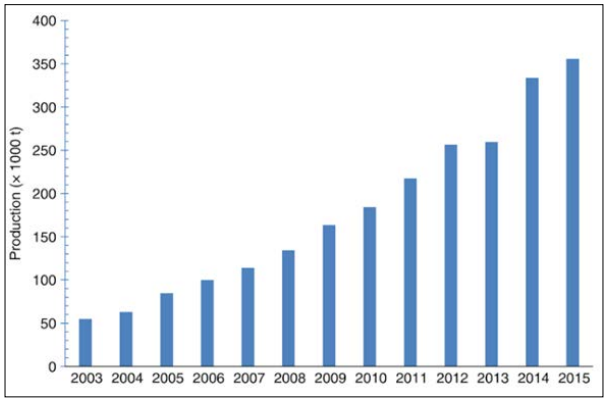

Figure 4: Yellow catfish production between 2003– 2015 [15].

Disease Control

Yellow catfish is subject to a number of diseases caused by viruses, bacteria, fungi, viruses, parasites etc. High incidences have been that of developing a hole in the in the head cause by Edward siella especially when the temperature is high. Another outbreak recorded is hemorrhage edema disease caused by Aeromonas hydrophila [9]. at present no drug is drug is allowed to be used to treat disease in yellow catfish because the available drugs tend to accumulate in the tissues and hence threaten human health [15]. The only cure is good and health water management.

Handling and Processing

Harvested fish are loaded into live-hauling trucks and taken to different markets in china and to international markets [15]. Depending on fish size and market demand, some of the fish may be steaked; filleted; or sold headed, gutted, and skinned.

Yellow Catfish Marketing

The long-term sustainability of the aquaculture industry is ultimately determined by its economic performance in terms of market. Hence, market share determines the progress and development of the industry. Yellow catfish has a high demand on the local market, especially in Beijing, Shanghai, Nanjing, Wuhan, and many other cities around China [15]. Yellow catfish is also popular in other south-east Asian countries like Japan and Korea, hence it has a potential in the international market [15]. So far it has been live yellow catfish have exported to Japan, this has further created more interest among farmers to culture it.

Economic analysis of Yellow catfish (Pelteobagrus fulvidraco) production.

Yellow catfish holds a great potential for expansion due to its demand from customer, it is considered as one of the most important indigenous fish species. Currently it has higher economic benefits compared to the majority of freshwater fish cultured in in China. The current retail price for farmed yellow catfish ranges between 18 -21 RMB/Kg and 60 RMB/those that are caught from the wild [15].

Conclusion and Recommendations

Conclusion

Yellow catfish production in China has undergone a rapid growth since 2000. Production increased from approximately 50, 000 tones to 114 000 tones in 2007, and to over 300, 000 tons in 2014. Currently yellow catfish has well established seed production technology systems, feed productions, and efficient culturing technology. Yellow catfish (Pelteobagrus fulvidraco) is preferred by the consumers in both local markets and international markets specifically the south-eastern Asian countries like Japan and Korea.

The only challenge is absence of legally allowed drug to cure disease in case of outbreak. However, yellow catfish (Pelteobagrus fulvidraco) current production seems to be economically and technically efficient in china and more studies is required in future into its productions and the application of drugs alongside diseases control.

Recommendations

- Currently there is no cure for the whole infection in the head and hemorrhage edema diseases of yellow catfish. Hence there is need to carry research so as to find vaccines or drugs that can be used to cure the disease without leaving residues in the fish tissues.
- Yellow catfish is a newly introduced fish species in aquaculture; therefore, there is need for more research on genetic improvement to improve its growth and disease resistance.
- More market surveys especially on the international market should be conducted to assess the possible entry into those markets so as promote the expansion of yellow catfish industry.

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