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GIANT CLAMS AQUACULTURE IN CHINA: ADVANTAGES AND CHALLENGES

Environment

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ABSTRACT

This paper analyzes the state and conditions of aquaculture in South China Sea both from technological and economic perspectives. We start from the historical review of China's aquaculture development. Base on the comparison on the cost between aquaculture sector and traditional agricultural sector, we conclude that China has a big potential in aquaculture and the government should impulse this industry by necessary policy instrument.

KEYWORDS

aquaculture; agriculture; marginal cost

1 Introduction

Aquaculture has been existed in China for more than 2500 years and it started by the farming of carps. In the modern aquaculture, China's fishery industry as well as aquaculture was suffering difficulties before the 1980s and short supply of aquatic products existed in not only rural but urban areas in China. However, after the reform and Opening-up in 1978, the aquaculture had been expanded since the 1980s. With the development of modern aquaculture, it has separated into two sub-sectors, one is freshwater aquaculture and the other one is marine aquaculture. In this paper, it will be focusing on marine aquaculture only. More than 1.33 million hectares of suitable area for marine aquaculture are available in China and there is extremely large potential to be developed in the future. Therefore, the marine aquaculture could provide numerous

nutrition and energy for the huge population in China and further relieve the land use pressure. But historically, the nutrition for the population in China is mainly provided by the agriculture on the land.

2 History

China has the largest population (more than 1.3 billion) in the world and the aquaculture has been developed in China since 1000 BC and spread to Asia as well as the rest of the world (Nash 2011). In terms of modern aquaculture in China, because of the booming of its population, the land resources are inadequate and therefore the animal protein and crops cannot match the sharply increasing demand. After the Reform and Opening up in 1978, marketization happened in China and pricing system had been operated in China's fishery industry and then management system as well as fishermen's motivation had been activated. After that, aquaculture has been emphasized by the China's government since 1980s and the purpose is to provide not only nutrition but also economic benefits and additionally relieve the pressure of the farming land (Yang et al, 2004). Then after 1980s, China has had become the biggest country with the greatest production in terms of aquaculture in the world (Fang et al, 2001; Qing 1994). Aquaculture commonly has two sub-sectors, one is freshwater aquaculture and the other one is marine aquaculture. According to the China Marine Statistical Yearbook in 2009, the total proportion of marine aquaculture is 1578909 hectares and the total area of freshwater aquaculture is 4,971,023 hectares, the ratio in terms of marine/freshwater is 1:3.15, which means that there is a great difference between the marine aquaculture proportion and the freshwater aquaculture proportion. However, the production per hectare of marine aquaculture is 8,489 kg/hectare which is much higher than it of freshwater aquaculture (3916 kg/hectare). All these data demonstrate that the marine aquaculture has a tremendous potential to be further developed in China. Therefore, the marine aquaculture will be mainly focused in this paper.

3 Advantages of Giant Clams cultivation

Tridacninae, the common name of Giant Clams, is one kind of the largest bivalve mollusks in saltwater and there are 6 subspecies which are *Tridacna gigas, Tridacnaderasa, Tridacna squamosa, Tridacna maxima, Tridacna crocea* and *Hippopus hippopus*. And the biggest one is *Tridacna gigas* which has ever found is 130 centimeters length, 500 kilograms weight and living for more than 60 years (John 1998). Giant Clams were dominant species which lived around coral reef ever, and were widely distributed in the Pacific and the Indian Ocean. But since 1960s, the Giant Clams had been significantly destroyed by human beings and disappeared in many ocean areas. However, it had been becoming a hot marine resource again since 1980s because of its extremely high economic, environmental as well as ecological values. Therefore, aquaculture of Giant Clams was deeply researched by the Pacific and Asian countries.

Giant Clams are worth being researched mainly because first it has ecological valuation. Yonge (1975) reveals that the mainly positive characteristic of Giant Clam is the symbiotic relationship between the Giant Clam and the zooxanthellae, which means that the nutrition could be provided by the zooxanthellae. In other words, Giant Clam can directly use the inorganic salt in shallow water which means that it is easy to cultivate and has high ecological values. Secondly, the cultivation of Giant Clam also has high quality of economic values. Specifically, the mollusk meat has wide sale market especially in Japan and Taiwan. Furthermore, the dried scallop which is made by its adductor is extremely famous in Taiwan. Finally, in terms of Carbon Sink Fishery, the cultivation of Giant Clams has its special meanings.

In terms of Carbon Sink Fishery, Giant Clam cultivation has a significant impact on it. A process of absorbing CO_2 in the ocean by cultivating the aquatic lives and transferring carbon out of ocean and then into marine production is called Carbon Sink Fishery. Davies (1984) reports 90 percent to 95 percent of carbon which is concentrated by the zooxanthellae's photosynthesis is transferred from the ocean into the host. In this case, large amount of carbon is transferred into the shell of Giant Clams. According to many researches, different carbon sequestrations of different species could be given in Table 1.

Table 1. Carbon sequestrations

	Production per (ton/hectare *yr)	Inventory per (ton/hectare)	carbon sequestrations (ton/yr)	Ref.
Tridacna gigas	180	400	18	1
Sinonovacula constricta	12	12	1	2
Scallop	11.4	11.4	1	3
Forest		63 (m^3)	1.4	4

1 Lucas, JS 1992, 'Density of Clams and Depth Reduce Growth in Grow-out Culture of Tridacna gigas'
2 Lin, ZH & You, ZJ 2005, 'High-tech model of shellfish cultivation in intertidal zone in ZheJiang province'
3 Li, CL 2011, 'The development strategies of scallop cultivation in ShanDong province'
4 Li, NY, Song, WM & Zhang, SD 2009, 'Forest Carbon Sink management and development'

Table 1 illustrates that Giant Clams have significantly comparative advantage rather than other three items. In addition, the shell could be considered as a permanent Carbon Sink. In other words, carbon which has already been sunk into shells would require millions of years to

cycle back to the atmosphere as well as the oceans (Xiao & Liu 2010).

In addition, the time it uses to grow up is extremely short. Stephen (1976) points out that the living requirement of Giant Clam is similar to other bivalve mollusks but its maturation age is only 3-5 years. Moreover, 6 subspecies in China's nearby sea areas have high growth rates and many literatures are concentrating on its rate of growth (centimeters) which is listed in Table 2.

Table 2. Growth of Giant Clams

Species	Ref.	Area	Years to grow up								
			1	2	3	4	5	6	10	15	20
Tridacna gigas	5	Palau	4.80	16.91	27.47	36.69	44.74	51.77	72.01	85.82	92.82
	6	Phil	4.80	12.73	20.00	26.67	32.78	38.38	56.49	71.84	81.77
	7	AUS		14.16	20.72	26.63	31.95	36.74	56.96		
	weight (kg)			0.54	1.79	3.95	7.02	1.90	43.38		
Tridacna derasa	5	Palau	4.7	11.67	17.56	22.55	26.77	30.35	39.92	45.63	48.10
	7	AUS		9.87	13.66	17.06	20.12	22.86	34.32		
	weight (kg)			0.11	0.36	0.79	1.43	2.25	9.61		
Tridacna squamosa	5	Palau	4.75	7.82	10.62	13.17	15.51	17.64			
	8	AUS	4.75	9.16	12.99	16.32	19.22	21.74			
Tridacna maxima	8	AUS	2.08	5.09	7.78	10.19	12.34	14.27			
Tridacna crocea	9	AUS	2	3.5	5						
	10	JAP	1.88			6.61					
Hippopus hippopus	5	Palau	5.04	8.37	11.38	14.10	16.57	18.80			
	8	AUS	5.04	11.75	17.17	21.55	25.09	27.90			

It could be demonstrated that a sizable return commonly has been existed since fifth or sixth year, which is a relatively less time cost while cultivating Giant Clams. All these evidences above could prove that the marginal cost of developing aquaculture is extremely low for China. According to data from the World Bank, the proportion of farming land out of usable land in China has been over 56.2% since 2009. Undoubtedly, the marginal cost will be higher while further developing agriculture with the scarce land sources in China, especially under the fact that it has such a huge population.

4 Challenges

Although the aquaculture such as Giant Clam cultivation has such numerous advantages, the current situation is that the aquaculture does not achieve enough attention in China.

According to National Technology System for Conventional Freshwater Fishery Industry website, the total marine aquaculture area is 15790 km^2. Additionally, around 280 km^2 water areas near Scarborough Reef in the South China Sea which has been used for cultivating Giant Clams are only accounts for nearly 2% out of total aquaculture area are suitable for aquaculture and areas such like this are not enough while comparing with agricultural areas on the land (Zhou et al, n.d.). They further argue that areas suitable for cultivation exist in massive areas of the South China Sea, which has similar conditions as Orpheus Island in Australia (successfully establishing the industry of Giant Clams cultivation). Furthermore, based on the Report of China's Territorial Resources in 2008, total agriculture areas are 1,217,352 km^2, which is extremely greater than it of aquaculture areas. In other words, all this information proves that there are obvious potentials in terms of aquaculture in China.

Another barrier for developing aquaculture in China is the disputes in the South China Sea. According to the review above, most of the aquaculture and fisheries are operating in the Southeast sea of China. But in the South China Sea, the most suitable area for establishing aquaculture cultivation stations, there are many conflicts between China and its neighbors such as Philippines and Vietnam, which is deeply limiting the development of aquaculture.

5 Conclusion

Conclusion can be drawn that not only the production quantity but the policy orientation is limiting the development of aquaculture in China. There is an unbalanced development between the agriculture and aquaculture in China. One confirmed reality is that the production as well as productivity in China will be continuously increasing in the future. Therefore, all actions which would be done by the government should focus on the production to be closer to the equilibrium point. In other words, the duties that government should be taken are to create incentives for the aquaculture industry expansion in order to achieve the target of minimizing social variable costs.

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