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Cage Fish Culture as Sustainable Fish Farms on Salma Dam

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Aquaculture, specifically raising aquatic animals for food, is an ancient practice. Meat from aquatic animals is very often an excellent source for protein, essential fats, and vitamins. Aquaculture can also provide sustainable income to farmers in areas where feasible. Traditionally, aquaculture in Afghanistan has played only a small role in the production of animal proteins for human diets. This is despite the overwhelming acceptance by Afghans of fish, shellfish, and other seafood. The inauguration of the Salma Dam in Herat Province introduced new potential for increased aquaculture in the areas surrounding facility. The dam resulted in new large bodies of water and significantly increased irrigation for potentially 75,000 hectares. This article provides basic information on Cage Culture fish farming facilities. The aim of the research is a special focus on the Salma Dam and fish farming system that could take advantage of the facility and its increased water output and accessibility. The research did in a library method on January to April 2017. The result shows that Cage system is feasible and recommended as sustainable fish farms in the Salma dam.

Keywords: Cage culture; fish farming; Herat; Salma dam.

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1. INTRODUCTION TO AQUACULTURE

Aquaculture acknowledged as an ancestral practice. Global fish consumption has greatly increased in recent decades and is expected to increase substantially in the future. The wild capture fisheries have been supplying high quality fish and seafood to the market for a long time. However, unsustainable fishing practices and other factors such as habitat destruction, pollution, climate change or invasive species have led to fish stock depletion and collapse. Given these circumstances, aquaculture seems to be the most suitable alternative complementary to traditional fishing to gradually satisfy global consumer demand [1].

Fish farming has been practiced, in some parts of the world, for hundreds of years. Fishery is vital practice in Afghanistan, which started fifty years ago. Fish farming in Afghanistan assigned to fresh water fishery at Qargha Dam about 15 km from Kabul and warm water fish farming in Darunta Dam about 150 km east of Kabul [2].Today, half of th e seafood eaten in the U.S. ware farmed. To help meet the growing global demand for seafood, aquaculture is growing fast.

Due to the constant increase in the human population and health benefits of eating fish, demand for fish is on the increase [3]. In response to depleting wild fish stock and an increasing consumer demand for fish, they are being offered farmed fish as a viable alternative [4].

Aquaculture is the fastest-growing animal food-producing sector with a global production which has increased from less than 1 million tons per year in early 1950s to 66.6 million tons in 2012 [4] and [5]. Accordingly, aquaculture supplied approximately 50% of the global food fish production in 2010, compared with just 9% in 1980. However, in 2012 Europe contributed only with 2 880 641 tons in quantity or 4.32% of the world's total aquaculture production [1].

Fish consumption per capita has risen to above 20 kg globally now. It provides 6.7 % of protein also is a rich source of omega-3 fatty acid, vitamins, calcium, zinc and iron. In this sector engaged 57million people worldwide as a third of them in aquaculture [5]. The protein provide of fish farm is half of total protein intake in some small island as Bangladesh, Cambodia, Equatorial Guinea, French Guiana, Gambia, Ghana, Indonesia and Sierra Leone. However, the fish protein contribution to total animal protein supplies have risen up to 16.0 percent in the 1996 as it was only 13.7 percent in 1961. It is clear that the intake of animal protein is significantly lower in developing countries than in industrialized countries [6].

The environmental impact of fish farming varies widely, depending on the species being farmed, the methods used and where the farm is located. When good practices are used, it is possible to farm seafood in a way that has very little impact to the environment. Such operations limit habitat damage, disease, escapes of farmed fish and the use of wild fish as feed.

1.1 Afghanistan Fish/Seafood Consumption/Trends

Fish catch from the rivers and streams, and eating fish meat in Afghanistan have traditional history, more than 100 fish species believed to be native, but Afghans people have less enrolment to fisheries during the time. There is not exist information about the number of fishermen, fish species captured and the yield. The FAO reported that fish catch is rise from 800t in 1986 to 1300t in 1995. Fish rearing and fishery has young story in Afghanistan. Fresh water fishery started in 1967 with collaboration of France government. First trout fish hatchery was established across the river Paghman, at Qargha Dam about 15 km from Kabul. In Qargha reservoir produced about 30,000 trout fingerlings in the 1970s, which were stocked into the dam and freed to Panjsher, Bamian, Salang and Sarde rivers [2].

After years in 1987, with assistance by United Nations Development Program UNDP/FAO rehabilitate Qargha fish farm. During 1988/89 spring water were restored, incubators repaired, fitted with new eggs trays and the hatchery was ready for production. In this time, the fish form in addition to fingerling must produce marketable fish too, so raceways became into useable condition. In 1988, eyed stage incubated eggs imported from Denmark, reared in this form and six tons fingerling were produced in 1989. Warm water fish farm in Afghanistan with the assistance of China started in 1966 in Darunta Dam, 150 km east of Kabul. In this farm with the technical support of China until 1972, four Carp species (grass, silver, common, and bighead)

reared. During these years in Darunta Dam 144.2 tons fish were produced [2].

FAO report indicates that 300 small farms are operational in Afghanistan. Cold-water fish eggs are provided from the old hatchery in the Qargha. Warm water hatcheries in Jalalabad city assisted by United States Agency for International Development (USAID), produced carp eggs for fish farms. In 2011 close to 850,000 hatching were produced and a number were stocked into nursery ponds. In 2011, 70.000 fingerlings were sold to farmer in Nangarhar and Laghman provinces [1].

1.2 Salma Dam

Salma dam has been built on Harirod River, the Salma Dam reservoir will be 20 kilometer long and 3 kilometer wide, the storage capacity of the reservoir will be 640 million cubic meters of water. This reservoir provide an ecological zone for sustainable fish farming and other aquatic with their high capacity of natural water conserving. It is a good opportunity for Herat society to employ several type of fish farm in this area.

Employment fish farm needs different facilities. The facilities will be included Specialist/expert, money and labor. Fish farming is difference in method as they are Extensive, semi intensive, intensive and high intensive, It depended to the location, where someone want to do this activity. In Salma dam, it is possible to free fingerlings to the natural reservoir, otherwise it is possible to introduce the Pen culture or Cage culture methods in the area. The last two methods need high management level; one must design a high production system, which needs Human resources, Economic resources and Ecological management resources.

In the past few months Ministry of Agriculture, Irrigation and Livestock of Afghanistan (MAIL) released at least 50,000 trout fingerlings in this dam Fig. 1, the (MAIL) reported that 1.5 million Afghans have invested for the establishment of the fish farm in Salma Dam.

1.3 Fish Farming

Fish farming is a form of aquaculture and many different systems used for farming fish worldwide as extensive, semi extensive, intensive, and high intensive. The act of intensive fish farm is raising fish commercially in tanks or enclosures and recirculation system Fig. 2 for human consumption. The Extensive fish farms are a wide and natural area like rivers and streams. In Extensive, fish farming method the management role is poor, no feeding, and no monitor the water physical and chemical properties and no deal with pests and diseases, therefor production value is low. Commercial production introduced several fish culture systems, which include ponds, raceways, recirculating systems, cages or in-water closed containment and irrigation canals [7].

Fig. 1. Fingerlings released in Salma dam
Source: http://www.khaama.com/afghanistan launches fish farming

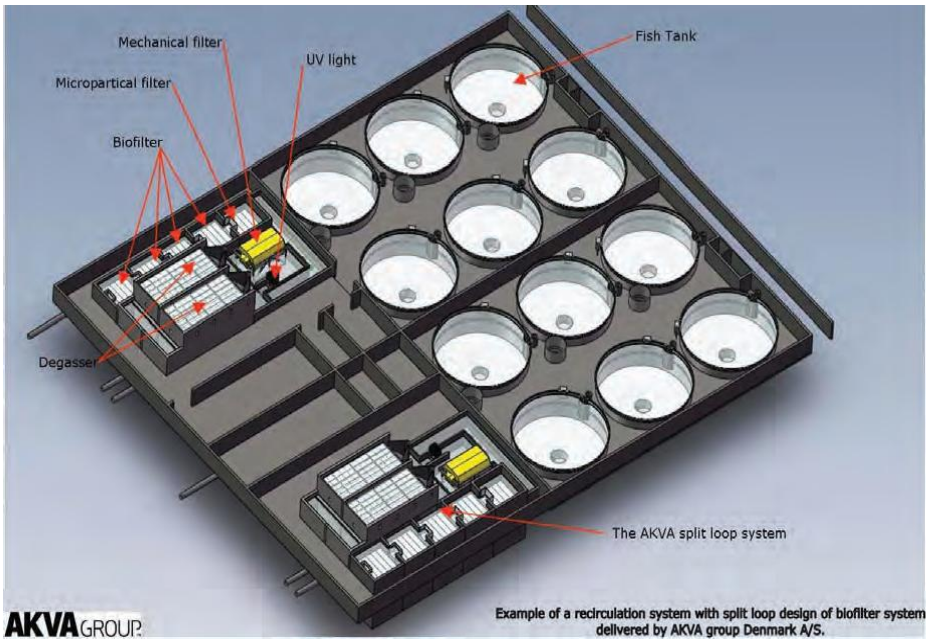

Fig. 2. Sketch of recirculation system
Source: AKVA group Denmark A/S. http://www.akvagroup.com

Fig. 3. Fish farming Cage system
Source: AKVA group and Department of Animal Husbandry, krishi Bhavan, 110001

1.4 Cage System

A cage or nit pen is a system that confines the fish in a mesh enclosure. This method applied in 35 countries in Europe, Asia, Africa and America during the last 15 years Fig. 3, and more than 70 species of fresh water fish reared in cages. Cages placed in lakes, ponds, reservoir, and oceans that contain the fish. This method is also widely referred to as off-shore cultivation. Fish kept in the cage like structures and are artificially fed, and harvested [7] and [8]. In addition, in this method the water physical and chemical condition, pest and diseases, are monitored and controlled [9].

There are approximately ten fish species, which commercially cultured in cages on both temperate and tropical waters as listed in Table 1.

1.5 Objective

The aim of the study is a special focus on the Salma Dam and fish farming systems that could take advantage of the facility and its increased

Table 1. Commercially important species in inland water cage and pen farming

Species		Countries	Climate	Type of feeding	Lotic/ Lentic	Cage/ Pen
Salmonids	Rainbow trout	Europe, North America, Japan, high altitude tropics (eg Colombia, Bolivia, Papua New Guinea)	Temperate	Intensive.High protein (40%)	Lentic	Floating cage
	Salmon (various species) *smolts*	Europe, North America, South America, Japan	Temperate	Intensive. High protein (45%)	Lentic	Floating cage
Carps	Chinese carps (Silver carp, grass carp, bighead carp)	Asia, Europe, North America	Temperate - tropical	Mainly semi-intensive, although also extensive (Asia) and intensive (Europe, North America)	Lotic and lentic	Cages and pens
	Indian major carps *(Labeo rohita)*	Asia	Sub tropical - tropical	Semi-intensive	Mainly lentic	Mainly cages
	Common Carp	Asia, Europe, North America, South America	Temperate - tropical	Mainly semi-intensive, although also intensive	Mainly lentic	Mainly cages
Tilapias	(*O. mossambicus, O. niloticus* etc.)	Asia, Africa, North America, South America	Sub-tropical - tropical	Mainly semi-intensive, although also intensive	Mainly lentic	Mainly cages
Cat fishes	Channel catfish	North America	Temperate sub-tropical	Intensive	Lentic	Floating cages
	Clarias spp.	Southeast Asia, Africa	Tropical	Semi-intensive	Lotic and lentic	Floating cages
Snake heads	*Channa* spp. *Ophicephalus* spp.	Southeast Asia	Tropical	Semi-intensive/intensive	Lotic and lentic	Floating cages
Pangasius spp.		Southeast Asia	Tropical	Semi-intensive	Lentic	Floating cages
Milk Fish		Southeast Asia	Tropical	Semi-intensive	Lentic	Pens

water output and accessibility to developing functional and sustainable fish farms on Salma Dam in Herat-Afghanistan.

2. MATERIALS AND METHODS

This is a qualitative research; this study is an analytical review. Scientific books and scientific articles related to the topic has been used for information collection from January to April 2017 at Purdue University, Indiana State USA.

3. RESULTS AND DISCUSSION

Resource use flexibility: Cage culture can be established in a variety of water bodies, including lakes, ponds, mining pits, streams or rivers with proper water quality, provided the potential operator has access and legal authority. This makes cage culture one of the most flexible form of aquaculture.

Comparably low capital cost: Compared to the cost of construction for other large-scale aquaculture methodology cage culture can be relatively inexpensive.

Simplified husbandry (fish care) practices: Cage culture is a relatively 'hands-on themselves to direct observation of the fish. The observation of fish behavior, especially feeding behavior, is essential for good husbandry.

Simplified harvesting: Traditionally, cages have been harvested by temporarily crowding the fish into a restricted area, and dipping the fish out of the cage. Fish pumps and other mechanized methods have recently become popular. One of the advantages of cage culture is that it is possible to partially harvest fish from cages as needed.

Multi-use of water resources: The husbandry of fish in cages should not hinder other users of the water resource, including those pursuing fishing, boating, and swimming.

Fish farming systems vary greatly from not only one country to another, but from one region to another, and one province to another. A system that works best for one area may not be ideal for another area and multiple factors should considered.

Based on land topography, different fish farming systems can be extensive and intensive. Earthen pounds and raceways often used in intensive fish farming. Earthen ponds can built on flat land, while row raceways are usually better suited for mountainous area.

Before starting fish farming in the area, the producer must consider the soil structure and soil texture, as the structural integrity of a pond or raceway is largely dependent on soil structure and type. Ponds constructed in marshes, wetlands, or and weak soils are usually problematic.

The entire life cycle of the fish takes place in water. Thus, the availability of high quality water is integral for fish farming success. Water resource can include lakes, ponds, seas, reservoirs, irrigation canals, oceans, etc. The oxygenation levels of the water can also dictate the type of fish farming that is most appropriate. The type of available water will also dictate the type of fish most appropriate as some fish are cold-water resistance and others are warm water resistance. Likewise, it is important to select fish species accustomed to weather conditions in the area.

Sociology and understanding the habits and customs of society are very important for developing a successful fish farming business. While most societies consume fish and seafood, tastes and preferences can vary greatly across communities. Therefore, it is important to seek the customer's income and consumer trends and food habits.

Fish diet must also considered, as fish may be herbivores, carnivores, or omnivore. Nutrition is key to healthy fish and feeds are generally the largest costs in fish farming. Fish farming in an area close to feed sources can reduce costs; thus, it is important to seek food availability in an area prior to initiating the fish farm. It goes without saying that selecting the type of farmed fish, availability of water resource, regional climate, feed availability, and availability of feed supplements or alternatives in the area inextricably linked together.

Numerous other factors that must seek to initiate a fish-based business. Farm location, labor availability, availability of advisors or technical assistance, harvest practices, transportation, market price, and marketing time and date all impact the feasibility of a fish farm.

Finally, the Salma Dam may offer some unique opportunities for growing fish farming in the Herat Province area. The dam is located 165 km east of Herat town on the Harirod River in Chishti-e-Sharif district. Salma Dam is approximately 20

Table 2. Comparison between Cage fish culture and others fish farms systems

Fish farms systems	Pro	Cons
Cage system	• requires less investment • installation is easy and harvesting is very simple • provides opportunity for controlled culture of choice • inspection and feeding is easier • treatment of disease is simple • it can be removable • preserve fish from predators • placed in lakes, ponds and oceans • artificially fed and harvested • reducing diseases and environmental concerns	• fish escaping and being loose among the wild fish population • fish suffering mortality due to • suffocation • loss of food • fed many times a day • unable to get the natural food
Irrigation ditch or pond systems Composite fish culture	• self-sustaining (grows plants and algae) • artificially fed • waste used to fertilize fields • coexist of (5-6) fish species • different varieties of fishes utilize efficiently the natural food • yield of fish is very high • the mortality rate is negligible	• construction cost (ditch or a pond) • water resource supply • competition for food • lack of availability of good quality food • many fishes are breeds only during monsoon
Integrated recycling systems	• large scale method • hydroponic beds • fish feed waste goes to provide nutrients to the plant	• large scale method • economic cost is high • needs large plastic tanks, greenhouse, water resource supply
Cage system	• requires less investment • installation is easy and harvesting is very simple • provides opportunity for controlled culture of choice • inspection and feeding is easier • treatment of disease is simple • it can be removable • preserve fish from predators • placed in lakes, ponds and oceans • artificially fed and harvested • reducing diseases and environmental concerns	• fish escaping and being loose among the wild fish population • fish suffering mortality due to • suffocation • loss of food • fed many times a day • unable to get the natural food

km length and 3 km with the capacity to produce 42 MW electricity power while storing 640 million cubic meters of water. This reservoir provides an ecological zone for sustainable fish farming and aquaculture. There are several fish farming systems and methods, both extensive and intensive that could take advantage of the dam and its location.

The reservoir itself offers a complete ecosystem could support extensive fish farming. In this system, large numbers of Salmon and/or Trout should release to initial stock the waters. These fingerlings could utilize the natural flora and fauna already found in the reservoir ecosystem. This would be a simple and low cost initiative as freeing fingerlings does not have construction costs, labor cost, feeding, or management costs. The fish mature and develop naturally utilizing available resources. Such a system would produce brood stock in the reservoir within two years producing further stock for both farming and recreation.

Cage culture and pen culture is practiced in 35 countries in the world. Freshwater fishes have

the ability to rear in cages and pens, and more than 70 fish species have been experimentally grown in cages since 1978. Management and maintenance of cages is easy and economically affordable.

4. CONCLUSION

Fish farming has a high development potential. It could contribute to improving food security, nutrition and income generation in rural areas and the main consumption centers in Afghanistan. It has good demand and market for fishes, especially for fresh water fishes, therefore farmers might serve as an income source and create many jobs both in rural and urban areas. Fish cage culture is the art of growing fish from seed to marketable size in cages. The use of cages to rear fish in dams is an increasingly popular method of fish culture involving relatively low initial costs and simple technology and management methods. Fish cage culture can be considered as an advanced type of aquaculture, its productivity is 10 to 20 times higher than that of pond culture for comparable inputs and area.

Salma Dam reservoir could also provide opportunities for intensive fish farming. In this aspect, cage or pen culture as sustainable fish farm recommended. While the concept of fish farming taking advantage of the Salma Dam is new, some benefits may include:

- Creation of new agriculture occupations in aquaculture, especially for those who have lost their farmland due to the construction of the reservoir;
- New jobs for people in aquaculture systems;
- New jobs creating for women in fish marketing;
- Utilization of feeds and by-products;
- Aquaculture extension opportunities;
- Improved access to animal protein in surrounding communities;
- Prevention of economic migration from the area with the creation of new jobs;
- Increased income;
- New tourism and hunting opportunities.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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