Eco. Env. & Cons. 26 (2) : 2020; pp. (824-831)
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ISSN 0971–765X

Culture of common carp (*Cyprinus carpio* L.) in Basrah Governorate, southern Iraq; Current status and suggestions for development

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(Received 15 December, 2019; accepted 16 January, 2020)

ABSTRACT

The present study aims to assess the status of the carp culture industry in Basrah governorate, south of Iraq. The survey revealed that the cage culture is the appropriate and preferred method in the study area. Feed, severe water quality and quantity problems are the main limiting factors for the aquaculture sustainability in Basrah. There are many unauthorized fish farms in Basrah. Thus, it is difficult for the Basrah Directorate of Agriculture to estimate and/or define the total productivity of fish farms. The present study concluded that the aquaculture projects in the province are economically unsustainable due to poor project management, shortages of raw materials for feed production, the high price of imported feed and the difficulty in competing with cheap imported fish. In general, the farmers are struggling under poor environmental conditions such as high temperatures and elevated water salinities, deficient or dearth of investments, lack of training and vocational education in aquaculture etc. Henceforth, this paper is set to review these issues and suggest a host of practical solutions to overcome these issues.

Key words : *Carp, Aquaculture management, Aquaculture development, Shatt Al-Arab, Basrah, Iraq.*

Introduction

Basrah is the third largest Iraqi city in terms of area (19,070km^2) and the second in terms of population density (2.908,491 in 2017)(Central Statistical Organization, 2017). The province has a unique geostrategic position, it is the only Iraqi city that is located on the northern coasts of the Arabian Gulf and has a coastline of 58 km (United Nations Environment Programme (UNEP) 2003; CIA World Factbook, 2018).

The province embraces the Shatt Al-Arab River which is formed by the confluence of the Euphrates and Tigris rivers north of Basrah city. The river flows southeast ward for 195 km to finally empty into the northeastern of the Arabian Gulf. The width of the river ranges between 400 m to more than 2km, while the depth ranges between 8-15m (Moyel, 2014).

The location of Basrah made the marine and freshwater fish an essential and indispensable diet for the people and testament to attain their food security through historical ages since times immemorial. In addition, the location of province has made fishing a source of income for the majority of the rural community, particularly the Mesopotamian Marsh Arabs, whose major work was fishing and tending water Buffalos (UNEP, 2001).

Fishing is an ancient practice for the rural and marshland population in the province,while fish farming is relatively young and was not practised on a commercial scale until 1980s in the 20thcentury

when the first fish farm was established in Abulkhaseeb (an agricultural district known for date palms on the western banks of Shatt Al-Arab) with a total area of 0.75 km^{2}and eventually given a license by Basrah Directorate of Agriculture (BDA). Gradually, the number of licensed fish farms increased to 327 farms during the first decade of the 2nd millennium. The flourishing of aquaculture during that period was attributed to the increased demand generated from a booming population, government policies that encouraged fish farming enterprises by providing loans to the farmers and supporting aquafeed imports. In addition, the collaboration and knowledge transfer between the farmers and BDA experts was a deeming effective strategy for establishing successful projects. The availability and suitability of the Shatt Al-Arab water for fish culture was the most important factor in the whole process (BDA, personal communication and unpublished data). Moreover, the same referencing source point indicated that fish farming was one of the profitable projects in the southern provinces due to high prices of the locally produced carp fish ($ 8,4 per kg) *versus*($ 1,8per kg)for the imported frozen fish.

The common carp (*Cyprinus carpio*),which is locally known as (Samti) is the major species that is currently cultured in mid and southern Iraq.

Carp is a hardy fish that survives close to anoxic conditions (<1 mg/L), tolerates wide thermal limits (1-35 °C) and a broad pH range (5-9) with mild halotolerance abilities too (0.5-5 practical salinity units-psu) (Woynarovich *et al*., 2011). Carp lives at high densities within small ponds, cages or tanks and the dietary regime of carp as an omnivorous fish is diversified comprising water plants, benthic warms, insects, crustaceans, and artificial diets (Pillay and Kutty, 2005). However, the aquaculture projects faltered in the recent years due to the large-scale destruction after the fall of the previous regime in 2003 resulting in termination of most licenses and reduction in the number of fish farms. Thus, the farmers started seeking other sources for earning a livelihood to meet daily sustenance threshold limits for their families.

Currently, the information about fish farming activity in Basrah province is faintly limited. In this exigency, this study aims to assess the aquaculture sector in Basrah in terms of methods, production and limitations. In addition, we are offering analysis and suggestions for sustainable aquaculture in the province.

Methodology

Various data collection methods were applied to collect information during the current study from the sites as shown in Figure 1 and Table 1.

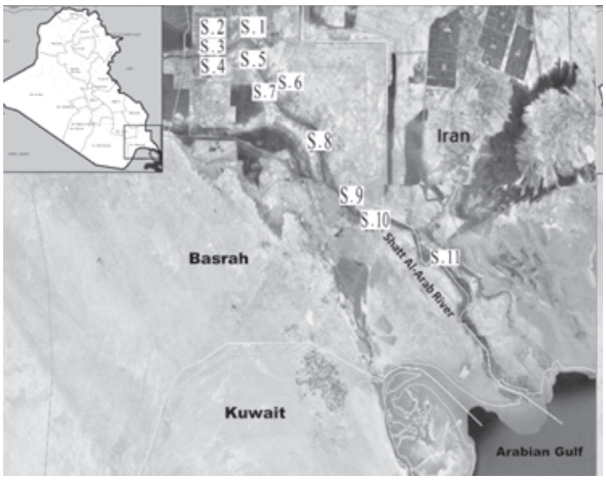

Fig. 1. Map showing the study area in Basrah province, South of Iraq

Table 1. GPS of the location of fish farms in Basrah, south of Iraq

Stations	Location	GPS
Site 1	Al-Qurna	N 31° 01′ 02″ E 47° 25′ 28″
Site 2	Al-Huwair	N 30° 58′ 25″ E 47° 19′ 00″
Site 3	Al-Madina	N 30° 59′ 33″ E 47° 15′ 13″
Site 4	Al-Emam Al-Kaeem	N 30° 54′ 55″ E 30° 55′ 53′′
Site 5	Al-Emam Al-Sadik	N 30° 55′ 53′′ E 47° 20′ 41″
Site. 6	Ad-Dayr	N 30° 47′ 52″ E 47° 34′ 26″
Site 7	Al-Nashwa	N 30° 49′ 20″ E 47° 35′ 29″
Site 8	Al-Hartha	N 30° 41′ 35″ E 47° 44′ 20″
Site 9	Shatt Al-Arab	N 30° 31′ 37″ E 47° 52′ 02″
Site 10	Abul-khaseeb	N 30° 27′ 00″ E 47° 58′ 59″
Site 11	Al-Seeba	N 30° 20′ 79″ E 48° 15′ 15″

The data collection was through questionnaire, observations, direct communication, and group discussion with the farmers from the visited sites.

Table 2. The questionnaire form that used to collect the information from fish farmers

Form number
Owner name
Farm location (GPS)
Aquaculture method (ponds, cages or mixed)
Source of feed
Type of feed
Feed price ($ US/ton) - if buying
Feed and feeding management
Source of water
Source of seeds
Marketing
Fish culture constrainsts from your experience
Others

This study presents a compilation of data obtained through direct interviews with a group of farmers from different parts of Basrah province.The basal aim is to understand and evaluate how the farmers operate and manage their farms, reasons behind closing many of these farms, the problems and difficulties that the business is facing and their immediate and future needs based on their experience and what are their suggestions to improve production and competition in the market as well as improving fish quality. To obtain sufficient information, we decided to ask specific set of a question module (vide Table 2) to prospected and potential farmers as possible to computationally assess the size of the aquaculture industry and assess constraints, rationalizing the problem and categorical evolution of possible curative measures.

Results

Fish culture methods

Based on the feedback received from the questionnaire and the information gathered from BDA, there are two main methods for fish culture in the province, cage culture and earthen ponds. The official number of licensed cages farms in Basrah are about 327 (92 are operatives and the rest are closed).

The documents of BDA indicate the limited number of licensed pond farms (only 44). Most of them were closed in 2016 except two big farms, one in Abul-khaseeb (0.225km^2) and the second in Al-Seeba (0.945km^2) (Fig. 1, Table 1).

Source of seeds

There are three government owned and managed hatcheries in Basrah for carp seed production. The hatchery of the general company of livestock that was established in 2006 in Al-Qurna, north of Basrah with a production capacity of one million larvae. The second one is Basrah shrimp hatchery in al-Hartha region established in 2007. This hatchery is exploited for carp seed production with a production capacity of two million larvae. The third hatchery; which was established in 2004 for research purposes; is the property of Marine Science Center, University of Basrah. The last one provides carp seeds and fingerlings to a significant number of farms.

Source of raw water for carp culture projects

The water of Shatt Al-Arab River is the only prime source for fish farming in both methods (cages and earthen pond). Ponds are filled by tide or by electric or diesel water pumps which elevate the production costing.

Feed and feeding strategy

Fish feed is available in the local market from different sources and trademarks, the prices ranging between ($400-900/ton) which is dreadfully very high and principal driving factor for raising the production cost figure mark.

There are two private (small-scale manufacturing) feed factories that produce fish diets in traditional method. Briefly, the dry ingredients are ground and mixed together and water proportionately added to get the optimum texture. Then the dough is made to different size pellets and air dried. Usually, the fish are fed twice a day (morning and afternoon) to apparently satiation limits.

Skills and experiences in aquaculture sector

In the province, the farmers are relying on their own experience to choose farm sites, design and cage / pond sizing and counts tailoring the available locations and befitting their limited financial resources for the project. Feed type is changed depending on its availability in the local market and the buying power of the farmer.

Production and marketing

There are many unauthorized fish farms in the province of Basrah. Thus, it is difficult for the BDA

to estimate the total productivity of fish farms.

The preferred farmed fish size for marketing is 1 kg. The price at the farm's gate is about $2.00 US dollars/ kg which does not cover the production cost.

Discussion

The cage culture is the preferred system in the study area due to the low construction cost compared to building earthen ponds. Fish cages are easily built from materials available in the local markets with little economic costs. In addition, the farmers use the Shatt al-Arab water and it's tributaries with no necessity for digging or providing other water sources. In floating cage system, water movement (tide and current) provides the water exchange and the metabolic waste removal from the culture water by natural processes to maintain the suitable water quality (Mosing and Fallu, 2004; Masser, 2012). In addition, there is a simplicity in controlling feeding, monitoring fish health, growth, and harvesting processes (Chua and Ting, 1982). Despite the advantages of the cage system, most of the cage farms in the province failed and their licenses were cancelled due to the changes in water quantity and quality of the streams and rivers. River water quality is one of the major issues impeding the development of sustainable fish culture industry in the province.

Basrah province faces severe water quality and quantity problems for being at the receiving end of the Tigris-Euphrates watersheds (UNEP, 2001). Dam building, intensive use of water, climate change and mismanagement of the water resources among the head water states and internally among the Iraqi provinces along the two rivers (Tigris and Euphraties) caused an increase in both salinity and pollution of Shatt al-Arab (UNEP, 2001). Further, the increasing salinity level has been attributed to an advancing salt wedge from Arabian Gulf (Abdullah *et al*., 2015; Moyel and Hussain, 2015).

It is well known that the Karun River is the main source of freshwater for Shatt Al-Arab and has a significant effect on the quality of its water. Therefore, diversion of the Karun River through the Hamanshir canal in addition to the intensive use of the Karun water (irrigation and dams' constriction) resulted in a reduction of flows to Shatt Al-Arab and subsequently triggered elevation of the salinity, thereby affecting water quality (UN-ESCWA and BGR, 2013; Fawzi and Mahdi, 2014). The scarce water that Shatt Al-Arab receives being laden with pollutants, industrial wastes, agriculture fertilizers, and domestic sewage poses another safety threat indeed. In addition, water flux from southern Al-Hammar marsh is highly saline causing elevation in water salinity and thereby affecting the aquaculture and agriculture activities in the area (UN-ESCWA and BGR, 2013).

Feed represents 40 to 60% of total costs in aquaculture production (Meyers, 1999) and the quantity of feed needed to operate any aquaculture system is about 2-3 times the production volume (Simard *et al*., 2008). In the Iraqi market, The private companies monopolizing fish feed while the locally manufactured feed (small scale) rely on cheap raw materials consist of carbohydrate (barley, wheat bran, and maize powder). It is well-known that common carp as an omnivorous fish has a good ability to utilize carbohydrate as a source of energy (Stone, 2003). However, carp's ability to utilize carbohydrate is weaker compared to mammals. For this reason, carbohydrate should not exceed 30-40% of carp diet (Takeuchi *et al*., 2002).

Fish meal is locally prepared according to conventional methods. Fishing byproducts in the small tributaries, mainly tilapia species, are dried out under the direct sun heat where the fish are exposed to rancidity reduces nutritional value. The dried tilapia ground to mix with cheaper energy source in random ratio achieves a balance between production cost and reasonable profits. In some farms, whole dry fishes are thrown into the ponds or cages as protein source without any processing or addition of other materials. Some farmers collect the small shrimp (*Macrobrachium nipponense*) from the interior canals as feed for their fish in addition to adding whole grains. In ponds specifically, fertilizers are considered as another option to increase productivity of system. In general, the raw materials do not meet international specifications for feed production and there is no specific recipe for locally manufactured fish feed.

Almost all farmers in the province are following improper feeding strategies. Therefore, huge amount of feed is being wasted which adversely affects water quality and fish health as well as rendering economic loss to farmer. While according to a USDA publication, documenting daily feed consumption, analyzing feed conversion efficiency and determining weight gain are essential practices to identify the best feeding strategy and helping farm-

ers to change feed types and amount, feeding pattern suiting fish behavioural understanding (Getchis *et al*., 2014).

In most fish farms, the feed input amount is not calculated in relation to the weight and number of farmed fish as well as water temperature conditions. Poor quality feed in addition to mismanagement produced poor quality fish with fatty texture which is unacceptable to the diner's plate and palate. On the other hand, high prices of imported aquafeed increased production cost preventing the local farmers from developing their projects.

In most countries, aquaculture or the "food producing industry" has made a positive contribution to economy, poverty reduction and food security (FAO, 2016). Therefore, it is imperative to provide technical and financial support to improve fish farming and all the allied services that support the production process, particularly feed formulation that meet nutritional requirements as well as the whole process of fish farming management from production up to the marketing point of action.

The sustainable development of the aquaculture sector in Basrah needs scientific and technological support as the basis for identifying appropriate site for aquaculture, suitable systems design and successful operational maintenance procedures. There were many attempts by the government to develop the sector through providing loans for farmers to set up their own businesses. It is clearly failing since these efforts are not supported by provision of necessary training and development for farmers conferring possibly allied industry partnering networking and infrastructural assistances.

There are many unauthorized fish farms in the province, mainly because farmers do not have documentation to prove their ownership of the land or to confirm the unsuitability of the soil for agriculture. These two aspects are otherwise, the conditional prerequisites for the establishment of a fish farm according to the Iraqi law. Thus, it is difficult for the BDA to estimate total productivity of fish farms. Some fish are sold directly to local restaurants and hotels where fish are show-cased alive in aquaria with continuous water recirculation for live marketing and trading. The majority of the products are sold in the markets and high streets through primitive means, thereby exposing fish to damage and reducing the selling price. To this day, there are no canning and refrigerating factories for fish in the province.

Briefly, the selling price is very low compared to the cost of production due to failure to compete with a peer import product from neighboring countries at low prices. Therefore, the aquaculture projects are not profitable under these circumstances.

In general, the climate of the lowlands of Iraq, including the Shatt al Arab region, is a typical desert climate (hot and arid). During summer, air temperature rises to a maximum of 45-50 °C (Jaradat, 2002). Water crisis that is connected to climate change, international relations, and political unrest in addition to the salinity elevation of the Shatt Al-Arab water resulted in significant losses to farmers that led to closure of the fish farms, drying culture ponds, and removing the cages from water bodies. Increasingly prevalent cultured-fish diseases due to high temperatures and bad water quality are the considered reasons that forced fish farmers to abandon their projects and seeking alternative jobs to reduce the risk of loss.

Conclusion and recommendations

Food and Agricultural Organization recognized aquaculture as a vital player in countries development as a source of employment, food security and economic growth (FAO, 2016). For success, sustainability and profitability of an aquaculture project; certain fundamentals need to be taken into considerations including appropriate site selection, suitable aquaculture system as well as applying appropriate feed and feeding strategy with continuous search for alternative sources of reasonable ingredients of fish diet (Martinez-Porchas and Martinez-Cordova, 2012).

There are major setbacks for the aquaculture industry in the province which reflected negatively on environment, farmers, community health, wellbeing and economy as a whole. Standing values strongly project that there is a good potential including financial and human capital that can turn this into a major success for the province as long as strategic planning and support is provided.

There is an immediate need for integrated modern aquaculture methods, including the introduction of mixed culture (aquaponic and hydroponic). This introduction cannot be achieved without collaboration between research institutions, government and farmers. The aim is to enhance productivity, profitability, reduce environmental impacts and

saving the ever-diminishing surface waters. Given the environmental conditions and the reduction in water resources in Iraq, it is recommended to adopt earthen ponds aquaculture and applying biofloc technology which is effective in controlling water quality and producing protein rich feed for cultured organisms (Crab *et al*., 2012). Of notable mention, constructed wetlands technology is effective in the treatment of wastewater and re-use in sustainable aquaculture projects (Brix, 1999). Moreover, there is a need to study the possibility of exploiting the available underground waters for fish culture to minimize the pressure on the surface water.

Most of the environmental and agricultural legislations in Iraq were developed or updated after the falling of the previous regime and the adoption of the parliamentary system after 2003. Regulation No. 17 of 2009 (Ahmmad, 2012) prescribes the prevention, exploitation and protection of aquaculture. However, this regulation is weak and is not accompanied by clear guidelines, implementation process, and legal cover to hold those who break the law is not available.

The collaboration between private, public sector and research institutions is required to develop commercially successful and environmentally sustainable aquaculture business. In order to better manage the industry, a local agricultural community conglomerate/ syndicate should be established. This recognized body can be the focal point for communication between farmers and research institutions, international organizations and allied industries to provide support, facilitate training, introduce new and proven technologies, provide statistical information and highlight relevant issues and concerns.

Feed production industry as a major allied sector needs to be promoted to investors. The production of fish feed must be regulated and production subjected to international standards with effective quality control systems, so that the products compete with imported feed in the local market platform. Capacity building for local small scale backyard farming of Spirulina among the women community to harness the abundance of solar energy and heat is imperative so that domestic availability of algal feedstock could instil economic leverage on the local feed industry. Medium scale entrepreneurs could eye upon the fresh water Haematococcus pluvialis farming for astaxanthin production and local existence of carotenoid supplements.Soya flour, contains about 35% protein. Qualitatively, Spirulina provides complete proteins as it contains the full range of essential amino acids which is 47% of total protein weight. Spirulina is contended to have several health benefits as it contains essential proteins, carbohydrates, essential fatty acids, vitamins, minerals, carotenes, chlorophyll a and phycocyanin to fight against malnutrition (Soni *et al*., 2017).

One of the main limiting factors affecting fish production in Iraq is the shortage of feed resources, especially protein or fish meal. Thus, grass carp as a herbivorous fish is recommended for farming in the province. Applying heat treatment to starch-rich pulses and grains (pea seed meal) etc improves carbohydrate availability and digestible energy levels through starch gelatinization and oil-release. This advance in extrusion / cooking technology in feed manufacture could contribute to a higher magnitude in nutritional enhancement (Fontaínhas-Fernandes *et al*., 1999; Ratnayake *et al*., 2002; Svihus *et al*., 2005; Drew *et al*., 2007).

The increased salinity of the Shatt al-Arab and the expected continuity of water shortage accompanied by increasing temperatures may provide a potential opportunity to introduce new fast grower, controlled atmosphere (to avoid escapees) business aquaculture species of fishes like the Asian seabass that tolerate 0.5 to 50 psu salinity and adapted to these partially halo environmental conditions or introducing newer Carp species with desirable genetic characteristics suitable to local environment through cooperative efforts amongst farmers and associations and the relevant local, regional and international research institutions.The production cost of *Labeo rohita* , Indian carp strain 'Jayanti rohu' developed by ICAR-CIFA is fairly lower as it does not require high protein feed and accepting low cost plant-based feeds (25%) protein level. Being feed-neutral and amenable for all culture practices, it fetches a competitive market price due to carotenoid visual attraction. Jayanti rohu is not a genetically modified organism (GMO) and so not harmful to the natural wetland biodiversity (Rasal, 2017).

The ultimate objectives of the recommendations are to improve the social and economic well being of farmers, particularly in the marshes which are an ideal environment for aquaculture development, protecting and supporting local fish production and restricting import from neighboring countries which adversely affect local farmers at the grassroots. Fi-

nally, establishment of a database of aquaculture projects in the province led either by the farmer's association or the Department of Agriculture.

Acknowledgments

We would like to thank Mr. Shaker Al-Saimary, the owner of Al-Ahwar Company for fish production, who was our guide in the study area. We would also like to show our gratitude to the fish farmers and BDA for providing the necessary data to complete the study.

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