Chapter 49
Towards an Improved Tilapia Farming in Iraq: Recommendations for Future Application

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Abstract Tilapia is the familiar name used to call three genera of fish in the family Cichlidae: *Oreochromis*, *Sarotherodon*, and *Tilapia*. These species are natural to Africa and the Middle East and became the second most usual farm bred food fish in the world due to numerous positive features and have been cultured in large number of countries. Nonetheless, it has been faced some difficulties in tilapia culture yet in their tropical natural habitats.

Tilapias transported to Iraq in the late 1990s, when the Iraqi government at that time gave permission to introduce individuals for aquaculture purposes and not for stocking in the natural freshwater. Later, tilapia found its way to the rivers and lakes of Iraq and established a sustainable population.

In addition to the success of tilapia culture expansion as a consequence of technical advances linked with the increase of culture activities, several problems have arisen, among these: the development of new strains and hybrids, monosex male culture, formulated diets, a variety of semi-intensive and intensive culture systems (e.g., ponds, cages, tanks, and raceways), and the utilization of greenhouses, geothermal, or industrial waste heat, and advanced water treatment methods.

The present chapter reviews briefly the up-to-date and standard procedures and guidelines of aquaculture of tilapia that are followed globally. These procedures and guidelines together with the specific recommendations need to be followed by both the governmental and the private sectors aquaculturists in Iraq in order to raise the yield of the cultured tilapia in the future.

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49.1 Introduction

Among the native fish species of Africa and the Middle East is tilapia. It has been approved to be one of the utmost fecund and worldwide merchandized food fish globally. The history of the farming of tilapia probably goes back to more than 4000 years when the Pharaohs of Egypt have started this industry. In the modern history, the cultivation of tilapias has spread from Africa, where it has been first recorded scientifically oriented culture of tilapia in Kenya in 1924 and rapidly extent through Africa.

The tilapia farming business is deliberated the second most significant farmed fish globally next to carps, but is defined as the best vital aquaculture species of the twenty-first century (Shelton 2002). The fish is being introduced in around 85 countries around the globe (FAO 2002) and about 98% of tilapia produced in these countries is grown outside their original environment (Shelton 2002).

The species of the three genera that belong to the family Cichlidae, *Oreochromis*, *Sarotherodon*, and *Tilapia*, are known in common as “tilapia”. It has been found that the members of the genus Oreochromis are readily hybridized in captivity and can produce several strains.

In the developing countries, there are other than 20 tilapia species that have been cultured in chiefly growing countries, which have shortage of animal protein (Guerrero 2002). The two species (*Oreochromis niloticus* and *O. mossambicus*) and their hybrid are considered the utmost prevalent among tilapias. *Oreochromis niloticus* is the important cultured species and the foundation for the noteworthy increase in global tilapia aquaculture production.

In the mid of 1990s, a permission was given for national Iraqis to import individuals of tilapia species from the neighboring countries such as Jordan. The aim was solely to use these individuals in the closed and secured aquaculture system, so there will be no escape to the natural water systems. The aquaculture business that runs by the private sector was not perfect in their control over the escape of the individuals tilapia to the near rivers. Therefore, in a short period of time, tilapia species has appeared for the first time in the natural freshwater system of Iraq. The first two species of tilapia, *Tilapia* (=*Coptodon*) *zillii* and *Oreochromis aureus* were recorded from the southern part of the general estuary in Basrah Province (Mutlak and Al-Faisal 2009). Later on, *Tilapia* (=*Coptodon*) *zillii* was recorded in Hor Al-Dlameg (AL-Zaidy 2013) and *O. niloticus* in the Shatt Al-Arab south of Iraq (Al-Faisal and Mutlak 2015).

In Iraq, the aquaculture practices and programs that used in the Aquaculture of the common carp are used for the tilapia species. In such practices, several aspects of the normal procedure of the fish aquaculture were not followed. Among these are the control over the environmental factors, rearing the larvae in the hatcheries and collecting the individuals for getting semen and eggs from the field. Therefore, in the present chapter, an attempt is made to gather and review the basic and the regulations that usually followed by tilapia aquacultures in the world in order to be followed by tilapia aquaculturists in Iraq. Such information will certainly enhance and increase the yield tilapia farmed. At the end of the chapter, recommendations are given to assist in the application of the correct and the up-to-date procedure of tilapia aquaculture.

49.2 Synopsis of the Aquaculture Activities in South of Iraq

With the abundant of freshwater quantities in south of Iraq and especially in the vicinity of Basrah Province makes it a good opportunistic future business to develop aquaculture and aquaponics industries to make use of the neglected water bodies and turning them into fish and prawn farms (Salman 2011). Simple aquaculture methods such as fish cages and net enclosures are low cost and would be operative in southern Iraq, mainly for species tolerant of low water quality, such as carp or tilapia (Salman 2011). Such projects can be successful in south of Iraq with more community knowledge and support, as well as gradually improving wetland water quality (Salman 2011).

The fisheries in Iraq, both freshwater and marine, have shown a fluctuation in the fish production. FAO (2004) has estimated the total fish production in Iraq for the years 2001 and 2003 as 22,800 and 32,100 tons live weight, respectively. For the marine fisheries, the fish production in this industry has declined by 12,000–13,000 tons annually from the 1980s through the early 2000s due to the Gulf war and the political instability. Marine fishing now depends completely on the artisanal industry, where the primary species are shad (*Tenualosa ilisha*), pomfret (*Pampus argenteus*), and different species of mullet (family: Mugillidae) (FAO 2004). The fish species that form the main catch is the non-native carp species and to less extents, the different species of the indigenous species of the genus *Barbus* (FAO 2004).

Although there is an increase in the aquaculture production of the fish in the inland waters of Iraq to 16,000 tons in 2007 (Dyck 2017), the procedures and controls are not up to the international standard. As the carp culture is quite easy task and giving less problems through its growth, the majority of the aquaculturists in Iraq have chosen to go with carp farming. The common carp, Cyprinus carpio was introduced into Iraq in the 1950s, as an experiment to study whether carp could be raised in Iraqi waters without negative impact on endemic species (Dyck 2017). Soon after that, the different carp species have become adapted to the Iraqi freshwater and they are now common in the region. Salman (2011) has suggested that the native species Bunni (*Mesopotamichthys sharpeyi)* and Gattan *(Leuciobarbus xanthopterus)* are also possible candidates for aquaculture.

49.2.1 Some Factors Shown to Hinder the Aquaculture Industry in Iraq

In addition to the nonmodern aquaculture practices followed in Iraq, there are several other factors that can hinder the production of fish in this industry. Among these are:

49.2.1.1 Environmental Factors

The main environmental matters that influence the success of aquaculture in southern Iraq are high salinity and poor water quality, high water temperature, and large seasonal variation. Productivity will additionally be determined by stockade level—which is influenced by the availability of fingerlings and food quantity and quality (Dyck 2017).

The studies on the status of water in the fish farm in Iraq in general are few to nil. On the other hand, studies on the water quality of the rivers and marshes are available (Richardson and Hussain 2006; Ewaid and Al-Hamzawi 2017).

49.2.1.2 Availability of Fish Fingerlings and Fish Food

For the availability of fish fingerlings, carp fingerlings are being produced in bigger numbers and are more available to fish farmers, but fish food remains constricted. The raw material for the fish food used for aquaculture in Iraq is an expensive imported. Therefore, it is feasible and commercial to build a fishmeal pellet production in Basrah by growing marsh reeds (mostly *Phragmites*) to be turned into fish food. Local production would reduce costs, boost the economic impact of fish farming, and motivate marsh reed cultivation.

49.2.2 Fish Farms in Iraq

In 1980s, there were 2000 fish farms in Iraq. In Basrah Province, there were 15 fish farm registered in the period 1982 and 2003, with 6.6% produced fish (Salman 2011). Across all of Iraq in 2003, there were 1893 licensed fish farms covering an area of 7500 hectares. The average farm size is 4 hectares; ten farms are larger than 100 hectares; and Babel fish farm is the largest at 500 hectares (Kitto and Tabish 2004). Since 1985, expansion in the aquaculture industry was evident, but, simply reflooding farmland areas and adding fish are hardly successful, because it does not account for the environmental variables.

Among the successful fish farm in Iraq is Alsabah farm (Ali 2013). This farm is 95 hectares in total and 50 of those hectares are used for fish production. The farm contains six ponds that are 1.5 meters deep, 50 meters wide, and 400 meters long, and a feeding canal that is 1.5 meters deep, 10 meters wide, and 800 meters long. The ponds are dried every one to two years and treated with manure and quick lime. Alsabah uses water from the Shatt Al-Arab, so fish are directly affected by the poor water quality and high salinity of the river (Ali 2013). Each of the six ponds began with 10,000, 50–250 gram fingerlings of common carp, 1200 silver carp, and 400 grass carp. A seventh pond is kept for broodstock. Additional fingerlings are placed in feeding and draining canals. The ponds are stocked three times per year (Ali 2013). Fish are fed through floating silos that are stocked with pellets twice daily. Fish food is processed on-site, but the raw material is imported. Alsabah is interested in moving away from soya and meat-protein-based food to algae-based foods (Ali 2013), which would be more sustainable and made of raw materials that could be locally produced.

The other successful, but to less extent of Al-Sabah fish farm is the University of Basrah fish farm. It is investigating at the moment constructing a wastewater treatment system that could support fish farming. In this system, reed marshes would filter effluent from the University. In 2016, Jassim Al-Maliky, then a PhD student at University of Basrah, successfully created test bed marshes that cleaned urban wastewater (Al-Maliky 2016; Pournelle et al. 2017).

The plan of the University of Basrah is to build a water treatment plant and fish farm. This plant can be explained as the University wastewater would flow through a series of treatment ponds and then into an aquaponics system that would grow reeds and fish (mostly carp). The herbivorous fish could then be harvested and used to produce fishmeal for carnivorous fish farms, providing a domestic option for fish food production, rather than importing from abroad, and supporting the larger aquaculture industry. Fish food for the herbivorous fish in the University of Basrah fish farm could come from a local aquatic biomass pellet mill, which would further keep production and support the local economy.

49.3 Tilapia as a Global Important Food Fish

There are several reasons that make tilapia fish as an important food fish globally. Among these, this chapter will enumerate the main and most effective reasons adopted from Fitzsimmons et al. (2011) with slight variation to fit the aquaculture status in Iraq. These are:

49.3.1 Genetics

One of the vital reasons for tilapia'‘s continued increase of production in future years is grounded on the genetic variety obtainable from which to construct. The farmed tilapias are derivative from many species in the genus *Oreochromis*. Literally, numerous species are simply hybridized and yield large numbers of productive young has enable fish breeders to cross some species and cultivate strains that comprise several characters from each of the parent species. This added support to the argument that the tilapia have been carefully bred and domesticated to an even greater degree than the eatable carps.

49.3.2 Nutrition

The tilapia is omnivores—herbivores, a criterion that endures to make tilapia general with the green movement. They feed chiefly on a very low trophic level. Naturally, the tilapias feed upon algae, fresh and decaying plant substances, and periphyton. In tamed locations, the numerous tilapias remain on the made diet that contains grains and agricultural by-products that aid to keep tilapia diets below the average for generally other farmed fishes. While many of the carps have similar feeding and nutritional patterns, tilapia on the other hand, are smaller and have smaller teeth and mouths, they incline to be even more able at rasping off the finest biofilms and periphyton assemblies.

49.3.3 BioFlocs

The capability of tilapia to flourish in biofloc systems is an additional benefit that tilapia have over many of the other common aquaculture species. Avnimelech and Kochba (2009) describes how tilapia are exclusively modified to flourish under biofloc circumstances that would impact the majority of other fish. This moderately low cost system for making healthy fish and dropping prepared feed charges could be an additional advantage that should keep tilapia prices inexpensive with other wild and farmed species.

49.3.4 Agricultural Plant Wastes

Tilapia have established to be one of the most important fishes used in additional component studies. The most usual goal is to substitute fish meal and fish oils. Whereas these incline to be very slight constituents in tilapia diets, the farmers and researcher still need to more reduce fish products in the diet and use locally obtainable elements (Zerai et al. 2008).

49.3.5 Production Systems and Locations

49.3.5.1 Diversity of Production Modes

Tilapia are elite in the selection systems used to rear them in confinement. Commercial procedures contain: ponds, cages, raceways, tanks, net pens, lake ranching, seawater, brackish water, freshwater, aquaponics, plastic drums, and computer-controlled exhaustive recirculation systems. This diversity of production surpasses that of any other farmed fish. Tilapia's treatment with recirculating systems has allowed their production in urban areas, high latitude locations, and even on the international space station (Fitzsimmons 2005).

49.3.5.2 Geographic Distribution

The tilapia production has been introduced to over 100 nations according to the FAO reports (Fitzsimmons et al. 2011). This huge yield and attention in the fish enormously surpasses any other farmed fish. The consumer appeal is likewise prevalent. There are not any accounts of cultural or religious restrictions on eating tilapia.

49.3.5.3 Low Cost Production Costs

Tilapia with their vegetarian grounded feeding habit and capability to collect substantial nutrition from grazing on algae and biofilms, have some of the lowermost feed costs of any farmed fishes**.** With the high densities achieved on many farms, the infrastructure costs are consequently extent across a larger volume of fish. Lastly, hatchery technique is comparatively modest, letting for fewer hatchery workers.

49.3.6 Polyculture

An additional area in which tilapia yield is rapidly growing is polyculture. In several instances, this is for the better market price that tilapia infrequently gets and in others they acquire the different habitats that the tilapia live in related to the carps. Mingling of tilapia and shrimp has been found to be valuable for shrimp health and for financial yield (Yuan et al. 2010). Through many shrimp farming businesses, tilapia are progressively being grown in cages inside shrimp ponds, or are cultivated in supply channels or head ponds. The rising interest in combined multitrophic aquaculture systems for tropical yield is certain to further support to general tilapia yield as most systems consider tilapia to be a main component to the systems.

49.4 General Problems and Solutions in Tilapia Culture: Problems and Solutions

In addition to their positive criteria as an excellent aquaculture fish species, tilapia can show some restrictions toward farming process such as the case in the subtropical region, where it cannot tolerate cold water. Physiological changes occur to tilapia when temperature drops less than 14 °C that could result in the death of the fish.

The other trouble is that tilapias attain sexual maturation in early age and short total length, and then reproduce with the intervals of 4–6 or 8 weeks as reliant on species and habitat circumstances, therefore number of fish start to upsurge, which disturb the care and feeding settings in the ponds. That is not expected in the culture since disarranging the culture scheme instigates high feed conversion rate, low growth rate of the fish, and gathering of immature tilapias having low economic status (Guerrero 2002; Chervinski 1982).

49.5 Extensive Culture

49.5.1 Pond Culture

One of the earliest aquaculture facility to cultivate tilapia was a simple pond in the earth with no inputs and depends on the native plankton and debris present in water and soil (Ramnarine 2000). In most growing countries, large ponds have a low social, cultural, and economic category and restricted admittance to technology, markets, and credit (Alceste-Oliviero 2000). The impact of such ponds is hard to attain, widespread tilapia culture has helped the rural poor to enhance their daily nutrition and increase their lifestyle in some areas of the Americas.

49.5.2 Semi-Intensive Culture (Ponds)

With the market loads increase, growing of industry and enduring technology development, old style widespread culture systems are being substituted by semi-intensive and exhaustive yield schemes.

Semi-intensive pond culture of tilapia is characteristically shared with agricultural or animal husbandry events, because pond fertilization with organic fertilizers can kindle natural pond efficiency in addition to being directly ingested by the tilapia. In this technique of culturing, nutrient contributions fluctuated from inorganic phosphorus to numerous stages of organic fertilizer, mixtures of organic and inorganic fertilizer, and blends of fertilizers and feeds.

49.5.3 Intensive Culture

49.5.3.1 Cages

Cultivation of tilapia in cages is mounting in some countries of the Americas. This technique is useful for growers who use public or common waters, containing reservoirs, lakes, bays, irrigation systems, or village ponds. Cages diverge widely in structure, from simple bamboo attainments to complex steel and plastic designs. Capital asset is low related with ponds, and by concentrating fish the farmer has improved control over feeding and yield. Some disadvantages of cage culture contain stealing risk, lack of ability to evade deprived water quality settings, and reliance on nutritionally complete feeds.

49.5.3.2 Integrated Tilapia and Shrimp Production

Consecutive polyculture includes cultivating shrimp and tilapia in detached ponds. In the case of the conditioned farms, water from tilapia ponds is directed to shrimp ponds, while in others the reverse case is true. Tilapia-shrimp polyculture may bring yields in several ways**.** The behavior of Tilapia in ingesting dead or diseased shrimps can be a disadvantage for the polyculture techniques as the disease will be transferred to the fish from the shrimps. Water from a tilapia culture pond, which tends to contain mainly of Gram-positive bacteria, might restrain the spread of *Vibrio* and other bacterial pathogens in shrimp ponds, which are Gram-negative. Tilapia unsettle bottom sediments when looking for food and in constructing nests, which may improve oxidation of the substrate and interrupt life cycles of shrimp pathogens or release nutrients that could upsurge algal growth (Fitzsimmons 2000).

49.6 Development of Technologies and Tilapia Farming

In tilapia culture, there are particular restrictions regarding the hybridization, masculinization of the whole tilapia groups through hormonal sex reversal. The method, which includes adding of steroids in feeds for a short period during the fry stage, showed to be simply performed, moderately steady in producing nearly all male populations and could be frequent in numerous country situations by farmers. The use of this method though has not been settled upon in some countries owing to environmental and social limitations; for example, the metabolism and the influences on the habitat of the dilapidation yields of synthetic androgen are not yet fully understood in fish (Baroiller 1996). The recently established method for gaining monosex population is by producing “supermales” through genetic management.

49.7 Recommendations

The followings are some main recommendations to enhance the yield of the farmed tilapia. Such recommendations need to be taken on board by both the government and the private sectors who own the tilapia farms in Iraq in order to improve their products.

1. Investigate into the type of plankton/algae that yield chemicals leading to the off-flavors in tilapia.
2. Cautiously management of store feed.
3. Further studies on foods for breeding or nursing stocks are required.
4. The usage of methyltestosterone hormone for sex reversal should be supervised and controlled.
5. Values for accountable culture of tilapia established by the World Wildlife Fund or Best Aquaculture Practices program could be followed.

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