Tilapia Culture in Arid Lands

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Arid lands and tilapia culture together seem a bit incongruous. Tilapia are freshwater fish and arid lands, by definition, do not have much freshwater. How are you supposed to grow tilapia with limited water supplies and secondly, why bother? To address the second question first, many of the poorest countries are arid. Any method which can economically produce protein in these countries can help alleviate malnutrition. As for the "how", that question is being addressed by a cooperative project between the Kuwait Institute for Scientific Research (KISR) and ICLARM at KISR's Mariculture and Fisheries Department in Salmiya, Kuwait.

Arid lands are often subjected to extremes of temperature and evaporation. Any aquaculture system in these areas should minimize the loss of precious freshwater through evaporation and protect the fish from the temperature fluctuations. Also, the soil is often unsuitable for fishponds because of very high sand content. Given these constraints, the only systems which are practical are:

1. tilapia mariculture;
2. integrated aquaculture-agriculture or waste water aquaculture systems; and
3. "closed" aquaculture systems.

Tilapia mariculture eliminates the need for freshwater when rearing the fish from fingerling to market-size. Starting around 1960, a number of papers have been published which showed that some tilapia (for example, *Oreochromis niloticus (aureus?), O. aureus, O. mossambicus, O. spilurus)* can be acclimated to and will grow in seawater. However little, if any, commercial tilapia mariculture has resulted. One reason may be that the literature on relative growth rates in fresh- versus seawater is conflicting and secondly, most of the research was done in areas which have freshwater. It is unlikely that a tilapia mariculture operation could ever profitably compete against a tilapia operation using freshwater. This potential competition from "freshwater tilapia" is negligible on the Arabian peninsula. The White Fish Authority (currently known as the Sea Fish Industry Authority) conducted growth trials with *O. aureus* and *O. spilurus* in Saudi Arabia and at least one

Top: Collecting fry in tilapia hatchery greenhouse. *Above:* Tilapia from project being sold. *Below:* Harvesting tilapia from 250-m^3 tank at KISR.

engineering group has proposed constructing a tilapia mariculture farm there.

The KISR-ICLARM project, which began in 1982, has started mariculture yield trials with *O. aureus* and *O. spilurus.* Initial results show that the growth rates of these tilapias are comparable to the growth rates of many cultured marine fishes but are somewhat slower than tilapia growth in freshwater. Use of all-male populations should increase the overall growth rates. The *O. spilurus* were found to spawn at a salinity of 42 ppt, but *O. aureus,* although they will grow in seawater, are subject to chronic infections

which cause severe external ulcers.

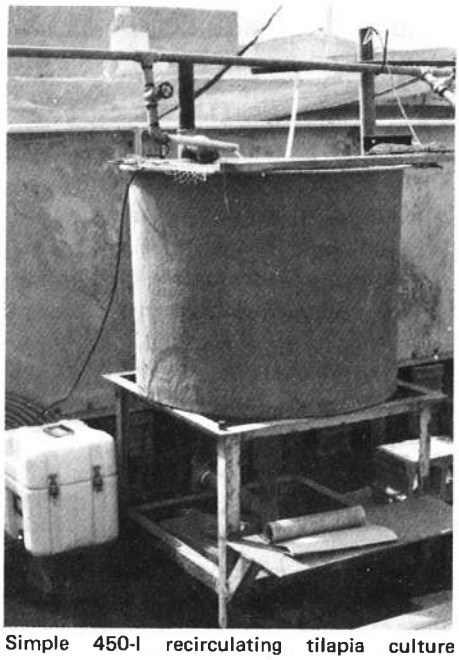
Integrating tilapia culture with agriculture or industry in arid lands can simply consist of stocking tilapia in irrigation reservoirs and placing caged fish in supply canals. This is widely practiced in some Middle Eastern countries and has been recently started in Saudi Arabia and Kuwait. Tilapia can also be cultured in the discharge from evaporative-cooling systems which are widely used on chicken farms in the Middle East. The wastewater discharge from industrial areas may be suitable for tilapia culture if it has received adequate treatment. KISR's Biotechnology Department has already conducted preliminary trials using effluent from a major petrochemical and industrial complex.

250-m^3 tanks used for tilapia culture.

Another approach is to use the nutrient-rich effluent from intensive tilapia culture operations for irrigation or hydroponics. A simple raceway system uses water very inefficiently and the nutrient content is low. The KISR-ICLARM project is experimenting with a system which uses the water much more efficiently and a "richer" effluent results. The system consists of tanks from which water is removed, reaerated and returned. "New" water is added continuously to dilute metabolic by-products to safe levels. Preliminary results showed fish densities greater than 70 kg/m^3 of tank or 35 kg/l/min of new water and monthly yields in excess of 10 kg/m^3 of tanks or 2.5 kg/l/min. These yields are an order of magnitude higher than those normally attained in trout raceways.

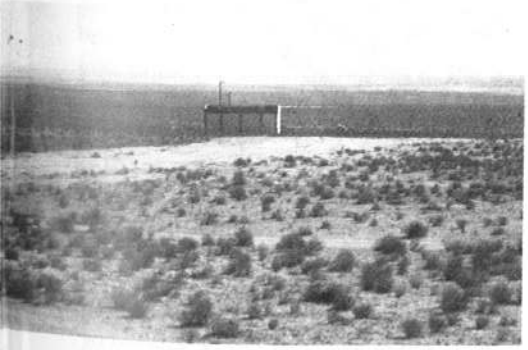
"Closed" systems utilize water most efficiently but they tend to be both complicated and expensive. However, in some situations, they may be very appropriate. An indoor tilapia hatchery using biological filters is already operating in Saudi Arabia. The KISR-ICLARM project is starting work using rotating purification equipment ("bio-discs" or "bio-drums").

The potential for the expansion of tilapia culture in arid lands will depend on the delicate interplay between system complexity and cost, operating costs and market potential. In the highly special situation of Kuwait where consumers are willing to pay high prices for fresh fish, live tilapia were successfully sold by the project at more than US$6/kg. Tilapia culture appears to be profitable even given the extremely high production costs in Kuwait. Further research should reduce the production costs and, hopefully, the retail price. •

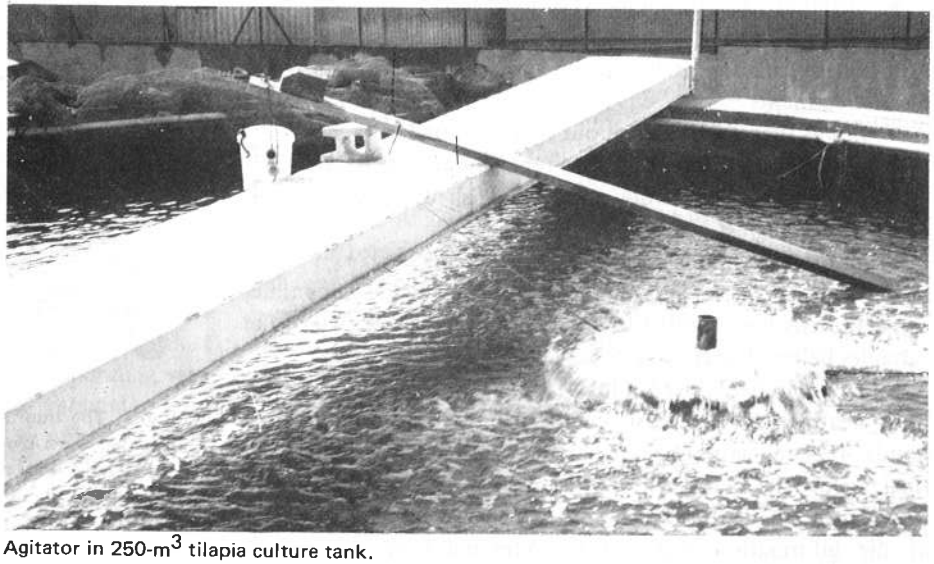


Simple 450-l recirculating tilapia culture system with O_2 monitor.

Kuwait—arid lands, by definition, do not have much freshwater.



Kuwait—proposed site for integrated chicken-fish farm!



Agitator in 250-m^3 tilapia culture tank.