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Tilapia: The "Aquatic Chicken" - At Last

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For almost a century, tilapia has failed to live up to its promise as the "aquatic chicken". Tilapia is not the one who has not lived up to its promise, it was the experts who were over optimistic. As Bardach, Ryther and McLarney decried in 1972 in their seminal book Aquaculture, we have more questions than facts regarding tilapia culture. Beginning in the 1920s, colonial Britain and Japan tried to apply tilapia culture for the benefit of the poor and to end hunger. But without a stake in the end result, tilapia extensive pond systems were recommended and spread worldwide in the tropics. In 2014, after almost a century, the World Resources Institute working paper 5, Creating a Sustainable Food Future, in 2014 concluded that after hundreds of millions spent, aquaculture production as a percentage of world aquaculture (<1%) have not risen in Africa. Fish consumption in Africa (19% of the diet) is second to Asia.

Why? Able to reproduce at 3 months of age, tilapia fill ponds with fish that stay small stunted. Especially in Africa, where small fish are not prized, this was a failure to farmers. Who would want to eat baby chicks? In Asia, where a fish per person is desired, Java tilapia of small sizes and dark in color were also not welcome, and when stocked together with the already existing cultures or finding their way into these cultures tilapia out competed the existing species and reduced their production. Thus, rather than the desired "aquatic chicken", tilapia became the "aquatic turkey/trash fish." However, wild caught tilapia were known and revered from the pharaonic period on in Egypt. Beautiful hieroglyphics depict Nile tilapia (Figure 1), and nobles catching them from artificial pools.

A change in attitude is now growing. Tilapia is the second most produced fish after carps, and among the widest cultured. Where carp and tilapia are cultured, tilapia is the preferred fish, with no intermuscular bones and a mild, firm white flesh. Spawning is also much easier than with riverine carps. Tilapia may become the number one cultured species soon. In terms of value, shrimp will stay in first place. Tilapia, as with chicken, has become accepted worldwide for its low cost, versatility, as well as palatability. The breakthrough in tilapia culture began with efficient reproduction control in the 1970s, replacing hand-sexing. Now, several monosex methods are available, and cage systems that will prevent reproduction of mixed-sex populations.

Figure 1: An aesthetically pleasing portrait of tilapia, Egyptian frieze, circa 2000 B.C. (Nikola Fijan, courtesy of Mirjana Fijan).

The biggest challenge is to prevent the tilapia avalanche from swamping environments with waste. Each kilogram of tilapia requires approximately 1.5-2.0 kg of dried feed in the current intensive, fed commercial culture systems. Only 40% is incorporated in fish flesh, with the remainder released into the culture environment. At the high densities stocked, the water of the culture unit soon fouls and discharges and replacement with fresh water is essential. The economics of this juggernaut aquaculture finds release into the streams, lakes and reservoirs the best option. Some systems are diverting wastes to cropland, and treating to a degree before release. Others seek to find water bodies large enough that wastes will be absorbed and processed by existing ecological cycles. Without sufficient knowledge of tropical limnology and long term effects of nutrient additions, these open/flow-through systems may be disasters waiting to happen. If they do happen, other regions in need of foreign exchange and jobs, albeit low-paying, will be found. A tragedy of the intensive culture systems is the reduction in nutritive value of tilapia from grain-based feeds. Cries of a seafood (tilapia) that can be worse than hamburger or bacon have been raised because the grain pellets contain high levels of omega 6 fatty acids. These combined with the small amounts of good omega 3 fatty acids (largely from adding fish meal and fish oil to the pellets) produce unhealthy high ratios of omega 6: omega 3. The irony is that tilapia in the genus *Oreochromis* are adapted to feeding on and digestion of phytoplankton and other microorganisms that add omega 3, not omega 6, and make wild populations much healthier to consume. In addition, planktonic algae overabundance is becoming one of the major, growing environmental problems, with no controls and increasing levels of algal-stimulating nutrients (N and P) released from human activities.

Is the scenario entirely bleak? Not at all. Tilapia must be recognized, with the Chinese silver carp which has significant and perhaps greater environmental impacts, as the only effective consumer of planktonic algae, and one that could potentially balance our activities with the environment sustainably and cost effectively. If *Oreochromis* tilapia (the major cultured group) are confined in cages, with limited feeding, they will filter feed on their natural diet of algae, zooplankton, bacteria and organic matter, and fail to reproduce. On this diet, if sufficiently dense, they will attain up to 0.5 kg in six months in temperate regions where the author tested them in co-culture with channel catfish. Blue tilapia grew faster than Nile tilapia, but was not as effective in control of larger problematic phytoplankton. Blue tilapia undoubtedly fed on a wider range of natural production. Problematic algae are members of the photosynthetic bacteria or cyanobacteria (also known as blue green algae) that form surface scums, tastes and odors, and toxins to humans and other mammals. If one wanted to control blue green algae-

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infested waters, whether for drinking or recreation, placing large cages or net pens of tilapia could help. From the author's research, levels of 5000 fish/ha would shift the algae to smaller more desirable species in a month's time. If one wanted to control these algae and off-flavors in aquaculture systems and improve water quality (dissolved oxygen, ammonia and pH levels), reduce effluent strength, and improve production, one would stock again at 5000 tilapia/ha in cages or net pens with no or limited feeding. The projected tilapia production in a season in the catfish ponds of the U.S. in 2003 (before tilapia and catfish imports from Asia cut the industry in two) would be on the order of 0.12 mmt, along with the 0.27 mmt of catfish. Admittedly, this level would be dwarfed by the 0.61 mmt of equivalent whole tilapia currently imported. The still substantial quantity of marketable tilapia would be traceable and subject to U.S. standards, as well as able to be marketed live or fresh to local markets. The cost of fingerlings, cages and labor would have to be subtracted, but would add to the bottom line and sustainability. In all likelihood and in need of verification, tilapia grown on natural feeds would also be healthier for human consumption.

It must be noted that algal levels would not be reduced by tilapia, however altered in composition and converted into valuable fish flesh. Another, little understood, tilapia-induced ecological change would be from pathogenic gram-negative to beneficial gram-positive bacteria. This is beginning to be realized by shrimp farmers devastated by early mortality syndrome (EMS).

The appreciation of tilapia's role in algal control and utilization could provide a counterpart to cattle-cum-chicken litter pastures. Litter spread on fields has resulted in lush pastures and large cattle production. Greater harmony with the environment of man's activities and increased sustainability being the greatest benefit[1].

[1]The author with noted tilapia researcher Robert Stickney are editing a book covering these aspects and more in: Tilapia in Intensive Co-culture. Contributors are from 8 countries and discuss tilapia co-culture in 15 systems.