

Tilapia Genetic R&D in the Philippines: Challenges and Prospects for Future Development

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Tilapias (*Oreochromis* spp.) are important aquaculture commodities that have been constantly studied in aquaculture genetic research and development (R&D). Specifically, genetic technologies including sex and chromosome-set manipulations, DNA markers, and transgenesis have created practical applications in tilapia culture. Recent advances in computing and sequencing technologies have facilitated the genetic and genomic studies in tilapia, making this commodity one of the most studied aquaculture species with robust available genomic-scale data. After dedicating efforts to the implementation of breeding programs that aim to improve the performance of farmed tilapia stocks, the Philippine tilapia aquaculture industry had rapidly developed and made substantial impacts on the country's total fish production. Success in such endeavors has changed the status of the country's tilapia aquaculture industry into a more productive one, shifting the Philippine perspective of becoming a globally-competitive tilapia producer. Nevertheless, despite the success in producing novel strains of tilapia with improved qualities, the tilapia aquaculture industry of the Philippines still continues to face challenges particularly in the area of genetic R&D.

During the past decades, genetic technologies including sex and chromosome-set manipulations, genome mapping, DNA markers, transgenesis, and marker-assisted selection (MAS) have already found their way for new and practical applications in aquaculture. However, results of the application of these modern technologies, especially gene transfer and manipulation, and DNA marker technique, have not yet made much impact on the aquaculture industry. It is believed that verification of the former although holding much promise has been constrained by inadequate resources while the latter has allegedly led to not very positive effects, thus, its adoption has been restricted to certain extent (Hulata, 2001). Nonetheless, many genetic tools are now continuously being applied to the aquaculture of a wide range of commodities, e.g. salmon, trout, catfish, common carp, tilapia, and ornamental fishes.

Tilapia (*Oreochromis* spp.) is not only economically valuable but has also been considered scientifically important for research studies on aquaculture genetics from the classical selective breeding and hybridization to drafting its recently released whole genome sequence (<http://www.broadinstitute.org>). Through the traditional

breeding programs of the Philippines, benefits from genetic applications in tilapia R&D including the development of various genetically improved tilapia species have been reaped. The country's project on Genetic Improvement of Farmed Tilapia (GIFT), the first selective breeding initiative launched in the Philippines, served as a starting point for tropical fish genetic improvement programs around the world (Gupta and Acosta, 2004) and was recognized as the first project to formulate a selective breeding program for *O. niloticus* (Eknath *et al.*, 1993). The introduction of GIFT and other improved tilapia stocks to the aquaculture industry since 1998 resulted in the rapid boost of tilapia production not only in the Philippines (Toledo *et al.*, 2009) but also in other Southeast Asian countries (Table 1). However, despite successes in genetic enhancement of tilapia, the country's efforts to apply modern tools and techniques such as DNA marker technology in tilapia genetic research continue to be insufficient.

Table 1. Tilapia production (in metric tons: MT) of Southeast Asia

Southeast Asian countries	2006	2007	2008	2009	2010
Brunei Darussalam	50	...	...	...	6
Cambodia	600	600	...	...	...
Indonesia	95,699	97,085	328,831	...	458,152
Lao PDR	...	...	...	...	...
Malaysia	28,887	32,024	34,823	35,583	38,886
Myanmar	10,000	3,300	30,938	34,860	85,848
Philippines	190,043	228,748	...	260,911	258,638
Singapore	5	3	...	...	40
Thailand	205,568	213,800	217,200	209,141	179,355
Vietnam	...	...	50,000	...	...
TOTAL	530,852	575,560	661,792	540,495	1,020,925

Note: Some countries were unable to provide updated data during the reporting periods (SEAFDEC, 2009-2012)

Genetic Applications in Tilapia Aquaculture

Various commodities have been used in carrying out genetic improvement of stocks for the aquaculture industry. Specifically for tilapia, selective breeding, hybridization, and chromosome set manipulation, also known as traditional