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## ECONOMIC AND ENVIRONMENTAL IMPACTS OF GENETIC IMPROVEMENT IN FISH FARMING DEPEND ON LIMITING FACTORS

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The target of fish breeding is to increase economic profit by producing faster growing fish with lower feed intake. Genetic improvement, therefore, is also expected to reduce environmental impacts of fish farming. However, little is known about the economic and environmental consequences of improving growth rate and feed efficiency in fish farming.

At farm level, genetic improvement of a trait affects feeding strategy and/or management practices according to the limiting production factor. Evaluating the impact of a genetic improvement requires therefore, (1) to model the whole farm operations via a bioeconomic model and (2) to calculate the environmental impacts along the production chain using Life Cycle Assessment. We calculated environmental and economic values (ENV and EV) of thermal growth coefficient (TGC) and feed conversion ratio (FCR) in two different farming systems: recirculating aquaculture system (RAS) of catfish and sea cages (SC) of sea bass. In RAS, the limiting factors are nitrogen treatment capacity of the bio-filter and fish density. In SC, the limiting factors are fish production quota and oxygen availability. ENV and EV were calculated using the difference in profit and in environmental impacts per kg of fish produced between the current population mean for both traits ( $\mu_i$ ) and the next generation of selective breeding ( $\mu_i + \Delta_i$ ).

The results show that ENV and EV are both dependent on limiting factors. Improving TGC is economically and environmentally beneficial in RAS and SC, only when the limiting factors are respectively rearing density (RAS) and oxygen availability (SC). There is no benefit in improving growth rate when nitrogen treatment capacity or production quota are the limiting factors. On the other hand, improving FCR always increases profit and decreases environmental impacts in RAS and SC irrespective of the limiting factor.

These results emphasize the importance of calculating environmental and economic values in the right farming context in order to develop efficient future breeding programs in aquaculture. FCR is the most important trait increasing profitability and decreasing environmental impacts in fish farming. This result emphasizes, the need for further studies aiming at better characterising the genetic bases of feed efficiency.

*Keywords: selection, bioeconomic model, life cycle assessment, feed efficiency, thermal growth coefficient*

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