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SUSTAINABLE AQUACULTURE FOR A SECURE FUTURE

Title: Modeling growth of Nile tilapia (*Oreochromis niloticus*) in a cage-cum-pond integrated culture system

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Abstract: A bioenergetics model was developed to simulate growth of both caged and open-pond Nile tilapia in a cage-cum-pond integrated culture system. The model incorporated six key variables affecting Nile tilapia growth in the cage-cum-pond integrated culture system: body size, water temperature, photoperiod, dissolved oxygen, unionized ammonia and food availability. Caged tilapia were given artificial feed, while growth of open-pond tilapia was dependent on uneaten artificial feed from the caged tilapia and natural foods derived from cage wastes. In the model, availability of natural foods was estimated by a relative feeding level parameter, which was a function of potential net primary productivity based on fish standing crop and the limiting nutrients in the ponds. The model was validated using growth data for both caged and open-pond tilapia in 28 ponds. The model described 96 and 85% of the variance in growth of caged and open-pond tilapia, respectively. Statistical analyses indicated significant agreements between predicted and observed values for both cage and open-pond systems. The model showed that the growth of open-pond tilapia was limited by phosphorus limiting primary production when the total number of tilapia stocked in cages was not greater than 200 fish $pond^{-1}$, beyond which the limiting nutrient was phosphorus at the beginning of experiments and then shifted to nitrogen. The percentages of the culture period during which nitrogen limitation occurred increased from 0 to 84.4% with the increase of artificial feed inputs. The model revealed nitrogen from biological nitrogen fixation accounted for 44.2–74.8% of total nitrogen available for primary production. Under the model assumptions, pelleted feed accounted only for 13.8–14.6% growth of open-pond tilapia when dissolved oxygen was above the critical limit (1.2 mg l^{-1}) for caged tilapia during entire experimental period, however, the percentages ranged from

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19.0 to 51.0% when dissolved oxygen was below this critical limit. Sensitivity analysis showed that parameters for caged tilapia affected growth of open-pond tilapia but not the reverse, and lowering water quality by decreasing dissolved oxygen or raising unionized ammonia for 10% further reduced growth of caged tilapia, but increased growth of open-pond tilapia.

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