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## Quantitative Estimates of Ecological Sustainability in Upland Integrated Agriculture-Aquaculture Systems in the Philippines

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### Abstract

To meet the increasing demand for food, there is a need to intensify agricultural production in rural areas of developing countries without negative social and environmental impacts. Sustainable intensification can be achieved when innovative technology is adopted by farmers who are supported by appropriate government policies and institutions. To allow system comparison and decision-making, quantitative estimates of the sustainability of technological innovations are needed. Sustainability can be defined in economic, social and ecological terms. Aquaculture may be such a technological innovation. In this study, we estimated the ecological sustainability of aquaculture in upland farms in Quirino province in the Philippines by calculating nitrogen flows between the different farm enterprises.

Based on a two-year survey of resource flows and production, we used Ecopath to estimate static mass balance nitrogen models of farms before and after integration of aquaculture. It was shown that several indicators of ecological sustainability based on nitrogen flows in the farm were higher after integration of aquaculture into the farm system. In the discussion, we present several options for improving this methodology and for linking it to economic sustainability indicators.