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SUSTAINABLE AQUACULTURE FOR A SECURE FUTURE

Title: A comparative analysis of the fixed-input, computer modeling, and algal bioassay approaches for identifying pond fertilization requirements for semi-intensive aquaculture

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Abstract: This paper compares three different strategies/treatments for determining fertilization rates for producing natural foods in semi-intensive aquaculture ponds. The first strategy used a predetermined, fixed-input rate of nitrogen (N) and phosphorus (P) based on results from previous yield trials. The second strategy was based on algal nutrient concentrations, and used biweekly water quality measurements in combination with a microcomputer-based expert system, PONDCLASS©, to determine fertilization rates. The third approach, the algal bioassay fertilization strategy (ABFS), was based on algal growth responses to nutrient [i.e., N, P, and carbon (C)] enrichment, and used weekly, pond-specific algal bioassays to determine both nutrient requirements and associated rates of nutrient inputs. The three fertilization strategies were applied to Nile tilapia (*Oreochromis niloticus*) growout ponds over a 120-day period, with five ponds per treatment. All ponds were fertilized weekly with urea, triple superphosphate, agricultural lime, and/or chicken manure in amounts determined by each strategy.

Results indicated that net fish yields (NFYs) were not significantly different ($P = 0.094$) between treatments, with the fixed-input treatment giving the highest but most variable yields. Average NFYs ± S.E. (standard error) for the 120-day growout period were 2124 ± 276, 1476 ± 151, and 1651 ± 133 kg ha^{-1} for the fixed-input strategy, PONDCLASS©, and ABFS treatments, respectively. The relatively lower NFYs for PONDCLASS© and ABFS indicate that neither approach maximized fish production.

Nitrogen utilization efficiencies of fertilizer inputs were similar for all three strategies. Although the fixed-input approach used approximately 20% more N than the other two approaches, mean algal productivities and NFYs were also proportionally higher with this treatment. This

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is consistent with the observation that algal productivities in PONDCLASS© and ABFS ponds were nearly always limited by N availability.

However, both P utilization and fertilization cost efficiencies were significantly better with PONDCLASS© and ABFS than with the fixed-input treatment. The fixed-input approach not only used a higher P input rate than necessary, it did not account for ecological differences between ponds within the same treatment (e.g., nutrient and light limitation of algal productivity, inorganic turbidity, etc.), which can affect a pond's response to fertilization. In particular, the fixed-input treatment did not add carbon to compensate for nonuniform losses in alkalinity, which resulted in relatively high soluble P concentrations in treatment ponds where C availability apparently limited algal productivity. Including C fertilization in the fixed-input treatment would have likely reduced NFY variability and improved P utilization efficiency in those ponds.

Because both PONDCLASS© and the ABFS adjusted pond-specific fertilization requirements throughout the study, they provided increased fertilization efficiencies and profitability over the fixed-input strategy. However, the ABFS is more practical than PONDCLASS© for rural application because it is far simpler and does not require water chemistry, computers, laboratory equipment, technical expertise, or electricity to implement. Based on this study, the recommended fertilization strategy designed to achieve cost-efficient, consistently high yields is a modified ABFS approach that uses a fixed-input fertilization rate for N, and algal bioassays to determine time-specific and pond-specific fertilization requirements for P and C.

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