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Responsibility

Cage-cum-pond: Integrated aquaculture systems recycle wastes

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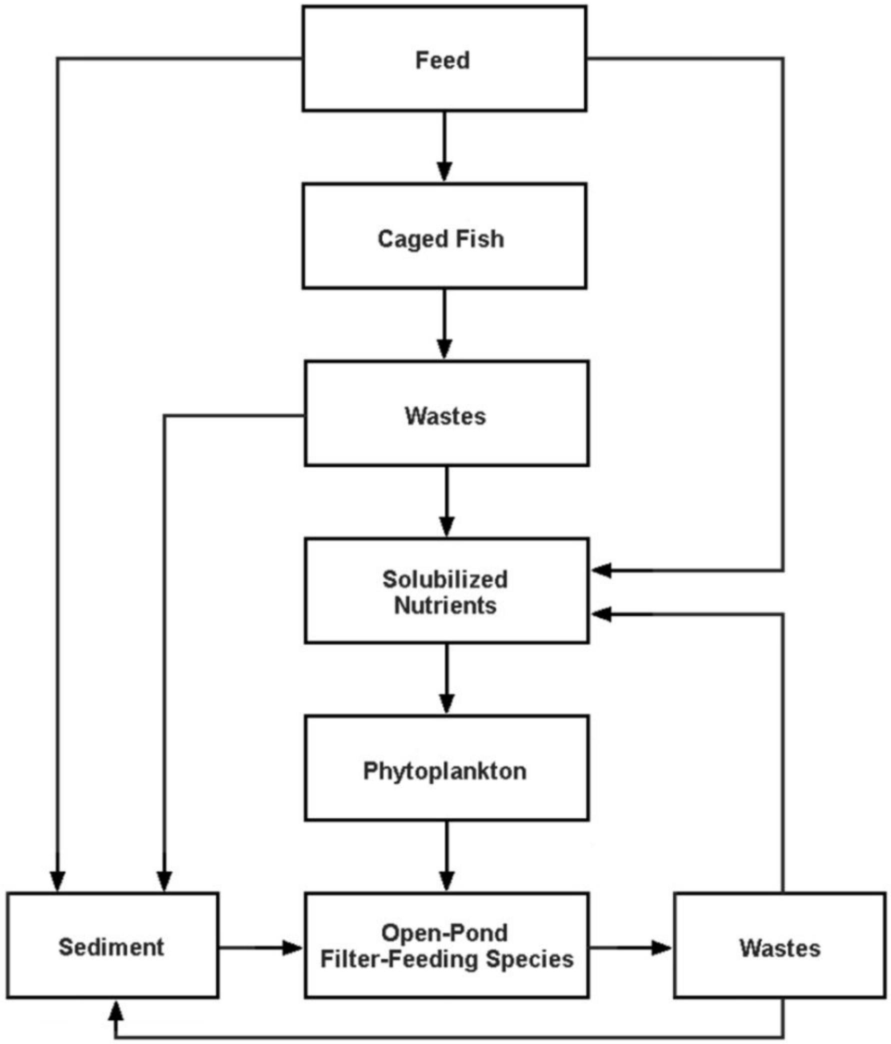
Integrated aquaculture systems recycle wastes

An integrated cage-cum-pond system is one where a fish species is stocked at high densities and fed high-protein diets in cages suspended in ponds, while a filter-feeding fish species is stocked outside the cages in the pond to utilize natural production derived from the cage wastes.

In intensive culture, fish are generally fed high-protein diets. The resulting nutrient-rich wastes are often directly or indirectly released to the surrounding environment, where they sometimes become a source of environmental pollution.

Animal manure and chemical fertilizers are typically used as nutrient inputs in fish ponds. The wastes from intensive fish culture are potential fertilizers, which can be reused to generate natural foods for culturing filter-feeding fish species at low cost, making aquaculture more profitable to farmers, and minimizing environmental impact.

Nile tilapia culture in an integrated cage-cum-pond system.



In a cage-cum-pond system, nutrients from wastes generated by fish in cages helps feed fish in the surroundng pond water.

Cage-cum-pond system

Nile tilapia (*Oreochromis niloticus*) are commonly grown in semi-intensive, fertilized ponds or systems integrated with livestock. However, to grow Nile tilapia to the large sizes that are most profitable, supplemental feeds are required.

Research by the authors indicated that supplemental feeding of Nile tilapia starting at 100-gram size is probably the most effective approach to produce large tilapia. Thus, the integrated cage-cum-pond system could be used to grow tilapia in cages suspended in ponds, and to nurse tilapia in the open ponds by utilizing natural foods derived from the cage wastes.

System development

To develop the integrated cage-cum-pond system for Nile tilapia, experiments were conducted in 330-cubic-meter earthen ponds, with surface areas of 313 to 393 square meters and water depths of 1 to 1.2 meters. Metal frame cages (2 x 2 x 1.2 meters) covered with 2-cm mesh nylon net were suspended 20 cm off the pond bottom to maintain 1-meter water depth in the cages.

In a three-month grow-out cycle, large tilapia were grown in cages to marketable size while smaller tilapia nursed in the ponds to restock the cages. Caged tilapia were fed floating pelleted feed with 30 percent crude protein twice daily at 3 percent, 2.5 percent and 2 percent body weight per day during the first, second and third month, respectively. No fertilizer was applied. The growth of open-pond tilapia depended solely on the uneaten pelleted feed and foods derived from cage wastes.

Initial results

In the first experiment, the optimal stocking density determined for caged tilapia was 50 fish per cubic meter, with a total of 200 caged fish per pond. Results of the second experiment indicated that the appropriate number of cages per pond was two, with a total of 400 caged fish per pond. To make the system rotate every three months, the third experiment determined the optimal density of 1.4 fish per cubic meter for tilapia stocked in the open pond.

Final experiment

The results of the final experiment in the series are summarized in Table 1. Large-size tilapia (124 g) were stocked at 50 fish per cubic meter in two 4-cubic-meter cages, while 16-gram tilapia were stocked at 1.4 fish per cubic meter in open water.

Yi, Growth performance of caged and open-pond Nile tilapia, Table 1

Performance Measures	Caged Tilapia	Open-Pond Tilapia
Pond area (m^2)	313-393	313-393
Water depth (m)	1.0-1.2	1.0-1.2
Water volume (m^3)	4	330
Stocking		
Density (fish/m^3)	50	1.4
Total number (fish/pond)	400	462
Total weight (kg/pond)	49.4	7.2
Mean weight (g/fish)	124	16
Large:small tilapia ratio	1:1.2	1:1.2
Harvest		
Survival (%)	98.8	92.0
Mean weight (g/fish)	465	124
Extrapolated net yield (t/ha/year)	18.2	6.2
Extrapolated gross yield (t/ha/year)	24.9	7.1
Total extrapolated net yield (t/ha/year)	24.4	24.4
Total extrapolated gross yield (t/ha/year)	32.0	32.0
Feed conversion ratio	1.22	–

Waste loading rates (kg/ha/d)	1.75 N 0.37 P	1.75 N 0.37 P
Nutrient recovery rates (%)	20.52% N 27.98% P	20.52% N 27.98% P

Table 1. Growth performance of caged and open-pond Nile tilapia in an integrated cage-cum-pond system.

Mean weight and yield

The final mean weights of caged and open-pond tilapia were 465 grams and 124 grams, with daily weight gains of 4.06 and 1.35 grams per fish in the 86-day experimental period, respectively. Total extrapolated net yield was 24.4 metric tons (MT) per hectare per year.

Nutrient recovery

The nutrients incorporated in caged tilapia accounted for 36.41 percent nitrogen (N) and 45.47 percent phosphorus (P) of the total nutrient inputs. The nutrients in the wastes fertilized the ponds at a rate of 1.75 kg nitrogen and 0.37 kg phosphorus per hectare per day, giving an N:P ratio of 4.73. Open-pond tilapia recovered 20.52 percent N and 27.98 percent P in the wastes produced by the caged tilapia.

Conclusion

Integrated aquaculture systems like the cage-cum-pond system – with large tilapia intensively cultured in cages in earthen ponds and small tilapia semi-intensively cultured in the surrounding pond water – is technically feasible. The system is particularly appropriate for small-scale farmers. Since open-pond tilapia recover cage wastes effectively, this approach is of benefit not only to total aquaculture production, but also to the environments where pond waters are discharged.

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