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ECOLOGICAL INTENSIFICATION OF MULTI TROPHIC AQUACULTURE PONDS: EXPERIMENTAL APPROACH

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Introduction

Attempts increase considerably toward aquaculture, which needs to be simultaneously more productive and more environmentally friendly. On the basis of a participatory process, an ecological intensive pond system has been designed. Different hypotheses were taken into account (Aubin et al., 2014): the combination of intensive and extensive areas provides more services than solely intensive or extensive areas; the coupling of intensive ponds and planted pond permits to decrease environmental impacts while maintaining or increasing the fish productivity; The use of feed in polyculture benefits to all reared species. To test these assumptions, the system studied was a specific Integrated Multi Trophic Aquaculture (IMTA) composed by a polyculture of common carp (*Cyprinus carpio*) associated with secondary species: roach (*Rutilus rutilus*,) and Perch (*Perca fluviatilis*), fed by formulated feed and coupled with a planted pond for water depuration and biodiversity support.

Materials and methods

The experiment lasted from March 1st to December 8th 2016. The experimental design was composed of three treatments (Fig. 1) with 2 replicates by treatment, in 500 m² ponds. The first treatment consists in 2 “extensive” fishponds in which nutrients were only provided by the watershed river water, at filling up and evaporation compensation. The second treatment consists in “semi-intensive” fishponds, where fish were fed with commercial pellets. The third treatment consists in 2 “coupled” systems composed of two connected ponds: one similar to “semi-intensive” fishponds and the second, only planted of different species of indigenous macrophytes.

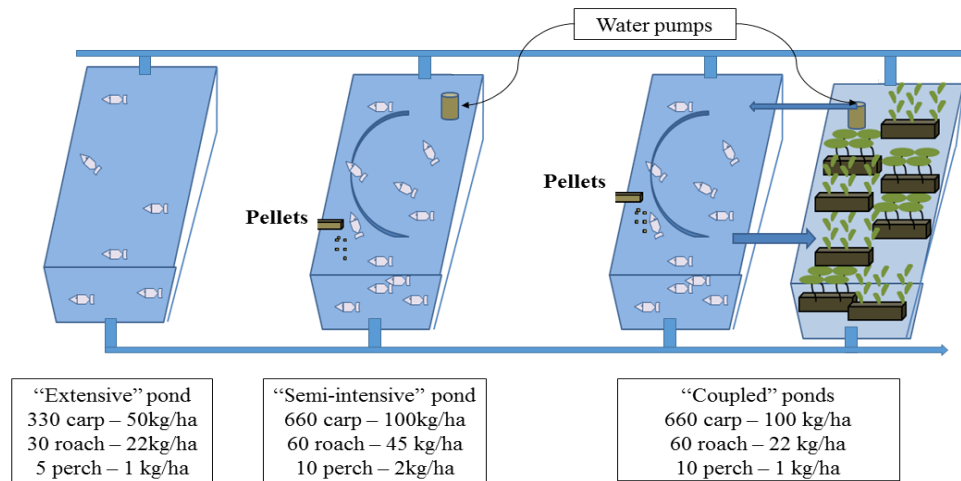


Figure 1: schematic representation of the experimental design

At stocking and harvesting, fish in each pond were sized and weighed. Survival rate, condition factor (K), Specific Growth Rate (SGR) and Feed Conversion Rate (FCR) were calculated. Water was weekly monitored for pH, temperature, dissolved oxygen saturation, conductivity, and turbidity. Water was monthly analyzed for phosphorus (P) and nitrogen

(N) compound concentrations. In each pond, total phytoplankton concentration was monthly assessed with a fluorometer phytoplankton analyzer. In order to determine the emissions of each treatment to waterbodies, mass balance for N and P compounds was established. Rates of nutrients (N and P from water and feed) recovery in fish biomass were also calculated.

Results

Production intensity was higher in “semi-intensive” treatment with an average value of 2 256kg/ha whereas average value for “coupled” fishponds was 1 926kg/ha. Including the planted pond area, average production yield in “coupled” treatment was 963kg/ha compared to 507kg/ha for “extensive” treatment. At harvest, fish biomass gain corresponded to an average multiplication factor of 6.3 in “extensive” fishponds, 15.5 in “intensive fishponds and 13.6 in “coupled” fishponds. FCR values for “semi-intensive” fishponds were globally 16% better than “coupled” fishponds. Total chlorophyll concentration ranged between 2 and 101µg/l in “extensive” ponds, between 24 and 293µg/l in “semi-intensive” ponds and between 4 and 106µg/l in “coupled” ponds. All along the experiment, Total N (TN) concentrations ranged 0.18 to 2.55mg/l in “extensive” ponds, 0.91 to 4.55mg/l in “intensive” ponds and 0.70 to 4.80mg/l in “coupled” ponds. Total P (TP) concentrations ranged 0.05 to 0.25mg/l in “extensive” ponds, 0.05 to 0.93mg/l in “intensive” ponds and 0.04 to 0.55mg/l in “coupled” ponds. Mass balance calculation indicated that in all treatments, draining water released less TN from ponds than input water whereas it was the opposite for TP. In “semi-intensive” treatment, more than 75% of the TN inputs (in feed, input water and young fish) was recovered in fish biomass produced whereas it was about 50% in “coupled” treatment and 25% in “extensive” treatment. Regardless of treatment, TP inputs were lower than the ones exported with fish and water.

Discussion-Conclusion

Feed clearly enhanced fish production. It seems that in planted ponds a competition exists between primary producers for nutrients to the benefit of macrophytes. In parallel, system with planted pond enhanced water quality in decreasing average TN and TP in water, and avoided phytoplankton bloom, especially *Cyanophyceae* development. It seems that planted ponds buffered TN and TP variations in time but failed to reduce P released in downstream water bodies at draining and limit fish growth potential. Mass balance calculation shows a clear use of TN and TP from the pond mud stock, may be due to fish activity and water circulation. In an ecological intensification perspective, this work partially showed the ability of “coupled” ponds system to improve fish production compared to extensive practices and to enhance water quality compared to intensive practices. Planted ponds present also potential for supporting biodiversity and producing plants of market value, which needs to be evaluated in the future. Further investigations will be carried out in the IMTA Effect project framework.

Reference

Aubin J., Rey-Valette H., Mathé S., Wilfart A., Legendre M., Slembrouck J., *et al.* 2014. Guide for implementing ecological intensification of aquaculture systems, INRA, Rennes, France, 131 p..