Pond aquaponics: new pathways to sustainable integrated aquaculture and agriculture

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Rising environmental concerns and growing demand for different uses of production inputs set new challenges for aquaculture development. Increased productivity with reduced ecological impact, integration between production systems and reduced use of chemicals are just some of the leading principles that more sustainable fish production needs to follow.

In developed countries concerns about pollution issues have raised interest in aquaponics as a valid option to get rid of aquaculture wastes through the production of high value vegetables (Rakocy *et al*, 2006; Diver, 2006). However in developing countries this technology, run mainly in recirculation systems, is not often applicable to local aquaculture systems.

In Southeast Asia freshwater fish production is mostly carried out in ponds where constant fertilisation occurs to sustain phytoplankton and zooplankton growth. The presence of green algae and micro organisms helps maintain adequate oxygen levels and to sustain in-pond feed availability. However, if on one hand green algae help in enriching pond water on the other hand they prevent plant nutrient build up.

Research in Thailand implied the use of alternative strategies for pond fertilisation that allow plants to take up nutrients both from water and from supplied growing media.

Fig. 1 Floating garden made with water hyacinth

The floating garden concept

A key idea for developing such systems arose by studying the Bangladeshi "Dhats", rafts made with floating water weeds, mostly water hyacinth (*Eichhornia crassipes*) (Practical Action, 2007). This indigenous growing system is nowadays rediscovered by farmers living in flood prone areas and allows for vegetable production all year round. Their use is pretty simple since weeds are piled together in water bodies. When the mass of vegetables reaches a critical volume they can physically sustain vegetable growth and supply nutrients through biomass decay.

Trials carried out in Nam Sai Farms, Thailand used manure, composted water weeds or rice husk ash as growing media, which were left floating on water in boxes or trays. No external energy or mechanical inputs (pumps or filters) were used. Plants were left to grow in a catfish (*Clarias* sp) pond, in tilapia (*Oreochromis* sp) ponds and a river with different growing media. Assessments determined yields under different nutrient levels supplied both by water and by growing media. Comparisons were also carried out against traditional production methods such as hydroponics (raft system) and soil-based agriculture under high fertilisation rates.

Very interesting yields have been noticed in catfish ponds where plants can simply take advantage of high nitrogen levels in the water, even at low dissolved oxygen levels. On the other hand wherever water nutrients were the limiting factor, nutrient supplement from growing media allowed results close to soil-based growing systems.

Fig. 2 Trials in catfish farm

Advantages in integrated production

Higher revenues can be achieved by farmers who can increase farm productivity and differentiate production with limited investment. Free availability of water weeds guarantees cheap supplies and keeps channels clear of clogging vegetation, thus providing an important environmental service. Decaying organic material can help fertilise ponds and at the same time provide a plant growing environment less prone to diseases and to soil pests. Reduction of chemical inputs allows farmers to get premium prices from soilless (hydroponic) or organic vegetables in a market quite sensitive to pesticide use in agriculture. Surveys carried out in the Bangkok area suggest that nearly all the vegetables sold in supermarkets (conventional, hydroponic or organic), show some degree of certification and traceability. In addition hydroponic and organic product prices are 100-600% higher than those of conventional agriculture (from 0.75-1.1 €/kg for conventional up to 4-7.6 €/kg for hydroponics and organic lettuce).

Future perspectives

Simplicity in design and management with almost no energy and low equipment costs makes these systems an interesting solution wherever land availability, flooding, productivity and ecological footprint are an issue. In addition the use of water weeds as a resource can indeed increase livelihoods opportunities in all those areas affected worldwide.

Further research needs to address the nutrient dynamics of different growing media and to optimise system design and nutritional requirement of vegetables in those water bodies with limited dissolved nutrients. The possibilities of this integrated system are quite high and can provide sensitive benefits to smallholders as well as big aquaculture enterprises.

The potential of these systems is however not fully acknowledged and interdisciplinary links and research can undoubtedly address many of the issues that are still unattended.

References

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Fig. 3 Water weeds in tropical areas can easily double their biomass in just a few days

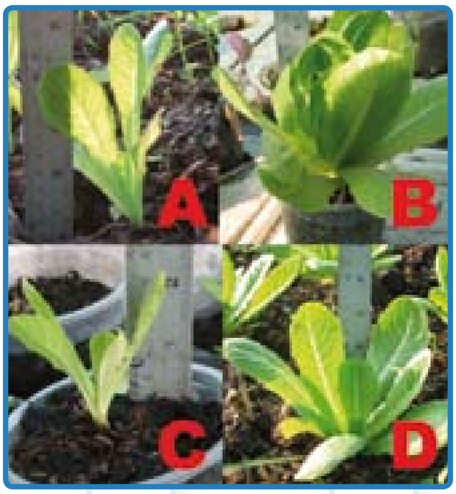

Fig. 4 Growth comparison for romaine lettuce. A on raft made with water hyacinth; B on ash pots in a catfish farm; C on ash with zero nutrients (control); D on soil with full use of fertilizer