

Factsheet final findings Global Challenges Programme Call 1



Nutritious-System Pond Farming in Vietnam

Summary

Aquaculture is the farming of fish and shellfish production in freshwater, marine and coastal environment. These production systems play a central role in global nutrition security and contribute to livelihoods of millions of people around the globe. With wild fish stock declining and aquaculture production increasing at almost 8% per annum in the last decades, aquaculture has become more important than fishery as food provision. This growth is enabled by an expansion of fish and shellfish farming areas and an intensification of the production systems that provide currently roughly half of the fish and shellfish consumed worldwide. An essential component for this intensification of aquaculture is feed, which uses significant quantities of aquatic (e.g. fish meal) and terrestrial (e.g. cereals and pulses) resources. At present, the aquaculture feeding systems target the animal (e.g. fish or shellfish), of which the requirements in terms of nutrients and energy have been studied, but without considering the possible contribution of the pond ecosystem and its food web to the animal's diet. The food web (e.g. the food chain within the pond from phytoplankton, microbes, and other organisms until the fish or shrimp in the pond) is stimulated by non-eaten and non-digested feed, which acts as a fertilizer to the pond.

The objective of this GCP-project is to design a “nutritious system” pond concept that exploits the potential of the pond ecosystem to mineralize wastes and produce natural foods. The project aims to increase the contribution of natural food produced in ponds to total pond production, and to make aquaculture less reliant on fish-oil and fishmeal. The “nutritious-system” concept aims to stimulate the microbes activity that mineralizes (or “processes”) wastes in the pond and the production of high quality natural foods. Actually, *Nutritious-Ponds* search to optimize mineralization and nutrient fluxes through the food web. As such, the aim is to make pond farming more sustainable and predictable to farmers. This five-year project integrates three components: firstly, fundamental research; secondly, applied research with on-farm trials; and lastly, interactive design platforms to adapt the new feed system to the local technological, social and institutional context.

The *Nutritious-Ponds* project develops this concept using shrimp aquaculture in Vietnam as a model, and an innovation platform to design the technology in order to enable its uptake by the sector. This innovative feed-the-system concept will be developed in cooperation between industry (Nutreco - the Netherlands, Skretting- Vietnam, and Viet UC - Vietnam), universities and research organizations (Wageningen University - the Netherlands, Can Tho University - Vietnam, and WorldFish) and Vietnamese farmers. The platform fosters the dialogue between stakeholders in the sector, shares results from fundamental research and on-farm trials, and supports the inclusion of different farm types in the innovation process.

Final Research Findings

- Removing fishmeal and oil from shrimp feed did not reduce shrimp growth significantly. The same happened when replacing expensive organic nitrogen by cheap inorganic nitrogen while not changing the carbon input.
- In a controlled environment, reducing the feed load with 40% while doubling the Carbon/Nitrogen ratio did not significantly reduce shrimp production.
- Participatory analysis of the shrimp system showed that the uptake of the technology will be easier if the nutritious system ponds becomes more robust. The latter includes (i) making the nutritious feed concept less sensitive to climate change and disease than existing farming systems; (ii) relying on novel – presently underutilized – novel crop waste products, and (iii) managing diseases at the landscape level.
- Innovation system analysis of the shrimp sector demonstrated that moving towards sustainable intensification of shrimp culture will requires changes of the regulatory framework (i) to allow efficient control of input quality and wastewater management, and (ii) to stimulate better coordination between government bodies enforcing the regulatory framework.

- Research on scaling the innovation demonstrated that farmer clusters are key to (i) get access to new technologies and (ii) build trust between farmer and (novel) knowledge providers.
- An innovation platform composed of farmers, extension services, the private sector, researchers and NGOs defined experimental trials and their monitoring. The preliminary results showed that in semi-intensive and improved extensive systems, replacing about 25% of high priced ingredients with less expensive carbohydrate sources can reduce the cost of production up to 10% while reaching similar productivity than in a conventional system. Similar results were observed during the three successive years of on-farm experiments. On-farm experiments showed that using Nutritious Pond Feed makes the pond less vulnerable to disease outbreaks and reduces the cost of production, hence raising farm income.
- In intensive culture, corn starch results in higher production than molasses application as carbohydrate source.
- A nutritious pond system contributes to the highly unsaturated fatty acid dietary requirements of cultured shrimps, allowing to reduce the inclusion of this expensive resource in the diet.
- Feeding 50% less protein, while substituting the associated reduction in dietary nitrogen application with inorganic nitrogen, and the reduction in dietary carbon by carbohydrate application, did not affect shrimp production and increased farm income.

Message to

A) Actors from private sector:

Co-designing a new feed system with farmers, extension services and local authorities helped to adapt the new feed system to local context and facilitated its future uptake by farmers. Communicating innovation and novelty through farmer clusters helped in building trust towards the private sector and facilitated adoption.

B) Civil society and practitioners organizations:

Yield and profit from semi-intensive systems can be improved by reducing the feed amount and feeding both the shrimp and the pond. This improves the within pond nutrient cycling and raises the contribution of natural food to the total pond production.

C) Policy makers:

- To be sustainable, intensification of aquaculture production for smallholders should be based on ecological processes and should aim to reduce production costs and environmental impact.
- Reducing risk of disease and production cost while increasing yield and return for smallholder farmers is possible by feeding both the shrimp and the pond.

Knowledge products

Posters in conferences

- Two posters presented at the International Fisheries Symposium, held in Phu Quoc, Vietnam (October 31 - November 2, 2016):
 - Innovation Platform In Aquaculture, The Case Of The Nutritious Pond System Project
 - In situ production of omega-3 polyunsaturated fatty acids (PUFA) in shrimp ponds.

Oral presentations in international conferences

- Nutritious Pond Project: New Steps in Developing a Sustainable Aquaculture Production System Through Diet Formulation. World Aquaculture 2017 held in Cape Town, South Africa from 27 to 29 June 2017
- A paradigm shift for sustainable intensification of aquaculture system: co-innovation for a Nutritious Pond System. First International Sustainable Agricultural Intensification and Nutrition Conference, Phnom Penh 10-13th Jan 2018
- Is Shrimp Farming Like Gambling? A Behavioural Analysis of Farmers' Decision Asia Pacific Aquaculture Conference, April 23-26 2018 Taipei, Taiwan
- Value Chain Innovation Research in Aquaculture. World Aquaculture, Monday 27th August, 2018 Montpellier
- Nutritious Pond Concept, A Pathway to Sustainable Intensification of Aquaculture Systems? World Aquaculture, Monday 27th August, 2018 Montpellier
- To cluster or not to cluster farmers? Influences on network interactions, risk perceptions, and adoption of aquaculture risk management practices. Systemic Risks: From Natural Hazards to Cyber Risks. Society for Risk Analysis, June 23-26, 2019, Postdam Germany
- Do we feed ponds wisely? Food for thought presentation, WorldFish, 26 February 2019, Penang, Malaysia.
- Challenges to pond aquaculture. Keynote presentation in Aquaculture in Silk Road Countries, 25-27 September 2019, Qingdao, China.
- Design and scaling a novel approach to feed aquaculture systems. Aquaculture Ecological Intensification, 28-30 October 2019, Bogor, Indonesia.
- Using the Pond Ecosystem to Make Aquaculture More Sustainable. Keynote presentation in Ecological intensification: A new paragon for sustainable aquaculture, 28-30 October 2019, Bogor, Indonesia

Special Session Innovation for Seafood Sustainability and Nutrient Security in Southeast Asia at the Asian Forum for Aquaculture & Fisheries; Iloilo, Philippines April 2019.

https://www.wur.nl/upload_mm/f/7/1/fc5c0151-f430-4feb-bb65-8e48ddd2c5c4_AnnexSSFS-AFAF.pdf

- 5 oral presentations
 - Nutritious Pond Concept, A Pathway to Sustainable Intensification of Aquaculture Systems?
 - Aquaculture Innovation Research : What (or who) are we missing?
 - Challenges for pond aquaculture

- Effects of Carbohydrate Sources on Biofloc Culture System for White Leg Shrimp (*Penaeus vannamei*)
- New steps in developing sustainable pond farming through diet formulation. A focus on HUFA

Six peer review journal articles published:

- How is innovation in aquaculture conceptualized and managed? A systematic literature review and reflection framework to inform analysis and action. *Aquaculture*, 470, pp.129–148 (December 20, 2016);
- Joffre, O.M., Klerkx, L., Khoa, T.N.D., 2018. Aquaculture innovation system analysis of transition to sustainable intensification in shrimp farming. *Agron. Sustain. Dev.* 38. <https://doi.org/10.1007/s13593-018-0511-9>
- Joffre, O.M., Poortvliet, P.M., Klerkx, L., 2018. Are shrimp farmers actual gamblers? An analysis of risk perception and risk management behaviors among shrimp farmers in the Mekong Delta. *Aquaculture* 495, 528–537. <https://doi.org/10.1016/j.aquaculture.2018.06.012>
- Joffre, O.M., Poortvliet, P.M., Klerkx, L., 2019. To cluster or not to cluster farmers? Influences on network interactions, risk perceptions, and adoption of aquaculture practices. *Agric. Syst.* 173, 151–160. <https://doi.org/10.1016/j.agsy.2019.02.011>
- Kabir, K.A.; Verdegem, M.C.J.; Verreth, J.A.J.; Phillips, M.J.; Schrama, J.W., 2019. Effect of dietary protein to energy ratio, stocking density and feeding level on performance of Nile tilapia in pond aquaculture. *Aquaculture* 511. DOI: 10.1016/j.aquaculture.2019.06.014
- Kabir, K.A.; Schrama, J.W.; Verreth, J.A.J.; Phillips, M.J.; Verdegem, M.C.J., 2019. Effect of dietary protein to energy ratio on performance of Nile tilapia and food web enhancement in semi-intensive pond aquaculture. *Aquaculture* 499. - p. 235 - 242. DOI: 10.1016/j.aquaculture.2018.09.038

Two peer review journal articles submitted:

- Devi papers? In-situ fatty acid production supports shrimp yields in diets lacking fish oil and fishmeal." *Aquaculture*
- Joffre, O.M., de Vries, J., Klerkx, L., Poortvliet, P.M., Why are cluster shrimp farmers adopting more aquaculture technologies and practices? The role of trust and frequency of interaction within farmers' networks. Submitted to *Land Use Policy* October 2020

Magazine articles

- O.M. Joffre; M. Verdegem. 2019. Feeding both pond and fish: a pathway to ecological intensification of aquaculture systems. INFOFISH. <https://www.worldfishcenter.org/content/feeding-both-pond-and-fish-pathway-ecological-intensification-aquaculture-systems>
- Aquaculture in action: reducing the need for feed. <https://thefishsite.com/articles/pond>
- New feed technology to offer more nutritious and sustainable aquaculture in Vietnam. <https://www.wur.nl/en/Research-Results/Chair-groups/Animal-Sciences/Aquaculture-and-Fisheries/News-Agenda/Show/New-feed-technology-to-offer-more-nutritious-and-sustainable-aquaculture-in-Vietnam.htm>
- A quarterly project newsletter is available on [Research Gate](#) and the [F&BKP website](#) (#10 issues)

Extension material

Leaflet produce for the Field Day in Soc Trang province, Vietnam May 2019. Event reported in local media: https://tuyengiao.soctrang.gov.vn/Default.aspx?sname=bantuyengiao&sid=1281&pageid=30600&catid=54197&id=282802&catname=Mo-hinh-hay&title=Thuc-an-tu-nhien-trong-nuoi-trong-thuy-san---giai-phap-giam-chi-phi-va--moi-truong-ben-vung&utm_source=zalo&utm_medium=zalo&utm_campaign=zalo&zarsrc=30
Master Class on the Nutritious Pond concept. Can Tho University, May 2019.

Knowledge networks

- The project initiated the Nutritious Pond Innovation Platform that includes farmers (extensive and intensive), private companies, feed producers, aquaculture certification bodies, research institutes, universities, and extension services.
- The project used WorldFish, Skretting and Wageningen University network to scale the concept and experiments in other research funded project in Bangladesh, Zambia. The informal Nutritious Pond network now include researchers in Bangladesh, private and public sector in Zambia and a research Center in Egypt.

Co-creation

The Innovation Platform contributed to the design and the organization of the experimental trials. This multi-stakeholder approach helped to share results and ideas and discuss the implementation and responsibilities of each stakeholder's groups for the trials. Research findings were integrated into the design of the new feed system by using the Innovation Platform as a tool to foster knowledge sharing. The platform also created linkages and dialogue between stakeholder groups in Vietnam, the latter usually not facilitating dialogue between small scale farmers and companies. The platform was also used to support the Rapid Appraisal of Aquaculture Systems where different stakeholder groups have identified constraints and opportunities for sustainable intensification of the shrimp aquaculture sector. It has supported lively debates between different stakeholder groups to identify future solutions for shrimp aquaculture development.

Future research and activities

The knowledge generated by experiments in a controlled environment are and will be published in peer review articles. Research findings were also presented in conferences to reach the scientific community. At the local level, research findings were presented during a Master Class in Can Tho University, while recommendations to deploy the new feeding system were presented to farmers and extension services in Hoa De Cooperative, Soc Trang province.

Research will continue with additional PhD projects looking at energy evaluation of pond diets based on locally available plant-based novel feed ingredients and nutritious feed utilization efficiency in tilapia & carp polyculture systems in south east Asia. In addition, the technology will be piloted and scaled in Zambia, Bangladesh and Egypt for tilapia culture. Design of new feeds will continue with Skretting, Aller Aqua and de Heus as feed company partners to commercialize “*nutritious pond diets*”.

**Consortium
Partners**

- Can Tho University
- My Thanh shrimp association
- Hoa De farmer group
- [Wageningen University](#)
- [WorldFish](#)
- [Skretting Vietnam](#)
- [Nutreco](#)
- [Viet UC](#)

**Contact
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**Project
website**

[F&BKP Research Project page](#)