The *Special Session on Advancing Integrated Agriculture Aquaculture through Agroecology* was convened by FAO with support from Cirad (Centre de Coopération Internationale en Recherche Agronomique pour le Développement) and NACA (Network of Aquaculture Centres in Asia Pacific) during the joint World Aquaculture Society–European Aquaculture Society's International Conference AQUA 2018, in Montpellier, France, on 25 August 2018[1]. The objectives were to clarify how an integrated agriculture-aquaculture (IAA) system implemented within an agroecological approach could help alleviate poverty and hunger, and to identify the knowledge gaps to be filled to ensure the sustainability of IAA. Twenty five speakers presented background information and case studies in front of a full room. The following article won an audience vote for best presentation.

Ecological Approaches for Better Microbial Management in Intensive Shrimp Farming

At the FAO Global Conference on Aquaculture in Phuket, Thailand, in 2010, it was postulated that modern aquaculture requires a turning point (Sorgeloos, 2013). In other words, although the farming of aquatic plants and animals has evolved into a mature industry, too much of the technology is still based on empirical approaches; therefore, knowledge-based developments are required to make aquaculture the blue biotechnology of the future. "More microbial management for more sustainable production" and "More integrated production systems for plant and animal farming" were identified as top priorities.

Today, it is already possible to report significant progress, mainly based on novel insights regarding the role of the microbiota in aquaculture. The traditional approaches of plate count analysis and microscopy have been instrumental for increasing awareness of the huge numbers of bacteria that may interfere in aquaculture systems. Yet, these methods have been inadequate for truly understanding and showing the diversity and functionality of bacteria in aquaculture systems. This could only be achieved by application of innovative microbial research platforms, such as next generation sequencing and gnotobiotic animal models. An example of a crucial finding was that certain bacterial pathogens in aquaculture systems can regulate virulence in function of population density by means of quorum-sensing mechanisms, and as such can organize infection in fish or shrimp (Defoirdt *et al*., 2011). This immediately explained why detection of pathogens should not be used as a sole predictor of problematic animal performance, and that the overall status of the bacterial community must be considered.

The randomness in performance that is observed in aquaculture, particularly in marine fish larviculture systems, despite "full control" over the system, remains problematic. When referring to "full control", it must be admitted that this does not include microbial control. Indeed, up until now, we have operated our production systems as microbial black boxes, and we have tried to control obligate and opportunistic pathogen interference merely by repressive methods. However, based on recent microbial insights, it appears that repression is not the best approach for minimizing pathogenic disease risk (Vadstein *et al*., 2018). A targeted non-selective reduction of unwanted bacteria by disinfection to maximize biosecurity should always be followed by a selective enhancement of *wanted* microbes. By specific niche creation resulting from increased removal of nutrients and increased water retention times, K-strategic bacterial populations can be strengthened to outcompete r-strategic bacteria, the latter often being the ecology of opportunistic pathogens. The use of probiotics may be complementary to this approach, but their success can

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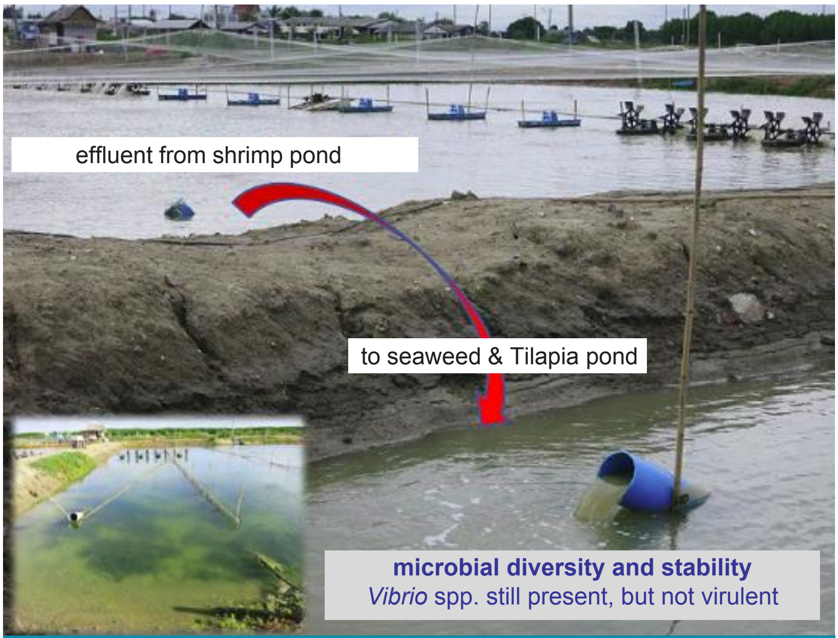
1. FAO 2019. *Report of the Special Session on Advancing Integrated Agriculture-Aquaculture through Agroecology*. Montpellier, France, 25 August 2018. FAO Fisheries and Aquaculture Report No. 1286. Rome. (also available at: **www.fao.org/3/ca7209en/CA7209EN.pdf**).

substantially be increased when applied in system settings that support their ecology. The result is a substantially lower disease risk as compared to one derived from a repression approach alone.

Our belief in this approach is strengthened by the empirical observations of improved performance made in biofilter-containing recirculation systems for hatchery and nursery production of marine fish and shrimp, as well as in the new concepts of intensive shrimp farming, such as zero water exchange ponds with shrimp toilets for increased waste removal and connected with extractive ponds stocked with tilapia or Caulerpa seaweed in recirculation models. In such systems, there seems to be an intrinsic microbial selection mechanism that counteracts the (development and) dominance of opportunistic pathogens such as *Vibrio* spp., and hence lowers the risk of opportunistic – and unpredictable – pathogen interference by maintaining their densities below the critical quorum-sensing density.



Zero water exchange system for intensive shrimp farming in Thailand

Treatment ponds in zero water exchange system for intensive shrimp farming in Thailand: sedimentation pond (shrimp toilet), brackishwater 'red' Tilapia and *Caulerpa* seaweed

Through more collaborative research regarding the microbiome and its functionality in the variety of aquaculture systems mentioned above, empirical observations can form the foundation of science-driven and more knowledge-based aquaculture. The use of novel upcoming methods, such as flow cytometry coupled to cell sorting and next generation sequencing, will surely amplify the current level of understanding substantially, and as such contribute to more predictable aquaculture performance.

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