OECD CO-OPERATIVE RESEARCH PROGRAMME
BIOLOGICAL RESOURCE MANAGEMENT FOR SUSTAINABLE AGRICULTURAL SYSTEMS
FELLOWSHIP SUMMARY REPORTS

Name: Adrian J. Hernandez Arias, Catholic University of Temuco, Chile

Subject title: Review of Nutritional Strategies to Develop Low-Pollution Feeds for a Sustainable Aquaculture. OECD Theme I. Managing Natural Capital for the Future

Host institution: Tokyo University of Marine Science and Technology, Japan

Host researcher: Dr Shuichi Satoh, Laboratory of Fish Nutrition

Fellowship period: June 8 to August 31, 2018

Consent: this fellowship report can be posted as material to support the Co-operative Research Programme.

1. What were the objectives of the research project? Why is the research project important?

The primary focus of this project is to conduct a structured search for relevant papers that consider the nutritional aspects of aquafeeds and their environmental impacts concerning excess nutrients loading. The literature search is based on selecting those documents working on lowering the excess nutrient content in aquafeeds and consequently the discharged amounts by modifying the formulations through the use of alternative ingredients and supplements that may improve dietary nutrient utilisation while maintaining a satisfactory growth and production.

Besides the main systematic review that will result from this project the future cooperation activities between the Laboratory of Fish Nutrition (Tokyo University of Marine Science and Technology) and the Laboratory of Fish Nutrition and Physiology (Catholic University of Temuco) will allow defining standardised protocols for conducting joint studies aiming to optimise low-pollution aquaculture feeds.

A recently published report of FAO (SOFIA, 2018) indicates that aquaculture provides around 53 per cent of all fish consumed by humans as food and while its growth has slowed it continues to grow faster than other major food production sectors and will continue to expand in the next coming decades to meet the future demand. In particular, the report stresses the fact that amount of aquaculture species produced using exogenous feed has outpaced the production of unfed aquatic species worldwide, representing almost 66 per cent of total global aquaculture production (excluding algae). Given the projected increase in aquaculture production, trends in feed use will poses threats to its sustainable development especially when we consider that the ultimate source of waste in aquaculture systems is feed. In this context, future industrial fed-species aquaculture development will need to give increased emphasis not only on the ecologically awarded use of resources but the reduction of feed related waste and nutrient discharge. Management of aquaculture wastes can be approached through improvements in nutrient utilisation and diet formulation with the aim of reducing excretion of phosphorus and nitrogen relative to fish growth performance. Thus, development of environmentally friendly aquafeeds for sustainable commercial aquaculture, together with other methods and technologies will be necessary to achieve an appropriate balance between economic, biological and environmental requirements.

2. Were the objectives of the fellowship achieved?

Most of the proposed objectives were completed during the short-term stay, but work related to the systematic review will continue, and the expected document is still in progress. Active participation on regular seminars organised by the Laboratory of Fish Nutrition allowed the discussion and the exchange of ideas with researchers and students from undergraduate and postgraduate courses.

3. What were the major achievements of the fellowship?

One of the most valuable advantages of the fellowship program was the possibility of interacting, in just one place, with professionals, scientists and students from different nationalities and institutions (Korea, Philippines, Indonesia and China) which helped to build a new network of peers and to

exchange ideas in numerous subjects related to aquaculture and with fish nutrition and feeding management. This internship was also a very valuable opportunity to gain academic experience outside of Chile.

The exchange and participation at the seminars organised by the laboratory of Fish Nutrition allowed to review and refine the working plan and the research question required to conduct a well-structured search of documents and publications.

The preliminary literature search conducted across electronic databases (AGRICOLA, PubMed and Web of Science) resulted in studies that are heterogeneous in design, which will be limiting the possibility to further conduct a meta-analysis as was envisioned in the original proposal. The researchers agreed to find the support of Dr Pamela Seron and Carlos Zaror from CIGES-UFRO (Temuco, Chile) who have extensive experience in the elaboration of Systematic Reviews and Meta-Analyses of studies that evaluate healthcare interventions. Their participation will be an asset for the purposes of this project.

4. Will there be any follow-up work?

Given the similarities and complementarities of the research programs between the Laboratory of Fish Nutrition in TUMSAT and the Laboratory of Fish Nutrition and Physiology at UC Temuco, there is growing interest, on both sides, to develop a meaningful research partnership. This internship provided an excellent opportunity to become better acquainted not only with the research programs, capabilities and research personnel of the Laboratory of Fish Nutrition but with others in TUMSAT. The research fellow was able to discuss the possibility of future collaborative projects between researchers from the UC Temuco in Chile and TUMSAT in Japan.

In this sense, another remarkable achievement of this fellowship was that both institutions aim to further strengthen future research and education cooperation through a renewal of a joint declaration of understanding. This agreement will guarantee the future research collaboration among faculty and staff members and will allow the exchange visits of researchers, professors and students. In the meantime, samples from a doctoral thesis experiment related to the effect of thermal treatment on the nutritional value of plant protein ingredients for rainbow trout will be delivered to Chile for further analysis and evaluations (phosphorus and nitrogen solubility). The researchers also agree to send joint presentations to the next Japanese Symposium of Fisheries Science to be held next year in TUMST, Japan.

5. How might the results of your research project be important for helping develop regional, national or international agro-food, fisheries or forestry policies and, or practices, or be beneficial for society?

Aquaculture is a major food production industry worldwide, but it is an especially important activity both in Japan and Chile. Notably, the salmon farming industry has been one of the fastest growing agro-industries in Chile but have been linked to bad sanitary and environmental practices. Japanese aquaculture has also faced environmental issues, as a result of uncontrolled growth in the past, but these have been appropriately regulated based on scientific research. The perspectives and experiences of both countries and research groups will be integrated into the present research collaboration. Results from this study could be useful for helping to develop more environmentally

sound and sustainable aquaculture not only in Chile and Japan but worldwide. Furthermore, this cooperative research will offer both groups an excellent opportunity to gain new research capabilities and gather systematised information that will be available to future practical research initiatives and stakeholders.

6. How was this research relevant to:

The CRP objectives: The Co-operative Research Programme's primary objective is to strengthen scientific knowledge and provide relevant scientific information and advice that will inform future policy decisions related to the sustainable use of natural resources, in the areas of food, agriculture, forests and fisheries. The field of application of the results derived from this project will be aquaculture which is one of the main foods producing industries in the world. Aquaculture requires specific strategies that ensure its sustainability by reducing any potential negative impact over the environment. The present project aims to enrich the knowledge bases in aquaculture nutrition and the manufacture of nutritionally efficient and environmentally friendly aquafeeds, which support the sustainable development of the aquaculture industry.

The CRP research theme: This project is particularly relevant to Aquaculture which is one of the main subjects within the CRP research Theme I, "Managing natural capital for the future". The project is related to the search and study of safe, sustainable solutions for the formulation and manufacture of aquafeeds. Modern aquaculture feed development will need to give increased emphasis on efficient use of resources and reduction of feed waste and nutrient discharge. To cope with this challenge, it will be necessary to reach a better understanding of nutrient bioavailability and interactions of new and commonly used feed ingredients as well as factors affecting the efficiency with which ingested nutrients are absorbed and retained within the cultured organism.

7. Satisfaction

The fellowship conformed the expectations. The International Cooperation Office at the Tokyo University of Marine Science and Technology arranged a suitable accommodation for the visiting researcher and offered direct assistance during the whole stay in Japan. The host researcher's laboratory provided a suitable working space, bibliographic material and internet access. No practical problems were encounter during the stay.

The Fellowship Programme could improve organising a periodic seminar or meeting for formal fellows that allow them to share experiences, exchange ideas and to open new opportunities of international mobility and co-operation in subjects related with the biological resource management for sustainable agricultural systems.

8. Advertising the Co-operative Research Programme

Information about the Co-operative Research Programme was available at the Chilean National Commission for Scientific and Technological Research (CONICYT) homepage, but I would suggest facilitating promotional audio-visual material to former program fellows so they can make it more "visible" in their institution and region.