European Fisheries and Aquaculture Research Organisations

Suggested Research Priorities for the H2020 2016/2017 work program.

Addendum to

KEY TOPICS FOR SCIENTIFIC SUPPORT TO THE EUROPEAN AQUACULTURE STRATEGY

An outline of RTDI topics identified by the EFARO Aquaculture Task Force

October 2014

Foreword

The EFARO Aquaculture Task Force presented in June 2013 an outline of RTDI priority topics for scientific support to the European Aquaculture strategy. http://www.efaro.eu/default.asp?ZNT=S0T1O-1P159 This is an addendum to that position paper, indicating for most of the EFARO topics the actual priorities that merits support in the 2016/17 work program of Horizon 2020. This update has been inspired by the Strategic Research agendas of several organisations (SRIA's partners, Seas ERA, JPI Oceans) and acknowledge the aspects of the priority topics that are already been adopted in the 2014/15 calls of Horizon 2020 or in other international research programmes over the last few years. We thus restrict this addendum to 6 more specific priorities within the domains of the 12 EFARO topics.

Recommended RTDI priorities for Aquaculture to be included in the H2020 2016/17 work program[1]:

From a science support to policy perspective:

2 Environmental management & governance: *Governance models to facilitate sustainable aquaculture growth*

4 Animal welfare: *Develop and implement welfare standards.*

From a science support to innovation perspective:

9 Genomics, breeding & hatching: *New challenges in Aqua-breed*

10 Feed & Nutrition: *Lower trophic level feed resources*

11 Production systems: *Efficient and effective aquaculture systems*

12 New species; *development of market specific species*

[1] The numbers refer to the topic numbers in the June 2013 document

Topic 2 - Environmental management & governance

Introduction to the topic:

Smart, inclusive and sustainable growth of aquaculture cannot be achieved without reducing unnecessary regulatory burdens affecting EU aquaculture and establishing an appropriate framework for better regulation and governance. Key actions recommended by EU Commission (229/2013) relating to better regulation, include: better implementation of EU legislation by Member States; reduction of administrative burden by continuing the programme of legislative simplification and lifting bottlenecks in national legislation; ensuring proper stakeholder participation and consultation. Regulatory requirements are a core value of the high quality production of European aquaculture but cumbersome regulatory and legal provisions can discourage investment, international trade and ultimately affect the competitiveness and the economic viability of European aquaculture, especially of SMEs.

Decision making on aquaculture regulation involves several interest groups, including fish farmers, environmental and consumer organisations, professional and recreational fishermen and other players. It is important that the institutional arrangements that manage the decision making process are optimised so that evidence based policy can be developed and conflict resolution is effective.

As a relatively new industry, aquaculture in Europe rarely has a dedicated legislation but it is often regulated within fisheries legislation and by a complex array of rules included in other laws and norms on property, licensing, access to water and land, environmental conservation, animal health and food hygiene. The legislative framework for European aquaculture includes more than 600 laws and regulations at EU, Member State, regional and local level. The implementation of this body of rules remains problematic and the potential for legislative and administrative overlaps and conflicts increase with the tiers of responsibility and decision making. Aquaculture is generally served by a combination of several DGs at EU level; in many Member States, policy, law-making and administration are split across different sectoral bodies and across different jurisdictions and administrative levels (e.g. central regional and local). Most important law and policy issues that must be addressed for an effective regulation of aquaculture regard, among others, equitable and fair assignment of property rights; procedures for licensing; taxation system; environmental and maritime law applied to aquaculture; international trade law restrictions.

Review on recent developments in this topic:

Following regulation COM/2013/229 Member States are required to develop Strategic Multi-Annual National Plans to increase aquaculture production. Member States are currently in a process of identifying bottlenecks to aquaculture production with a main focus of detecting where in the process rules and regulations hinder further development.

Suggested priority:

Governance models to facilitate sustainable aquaculture growth

Starting with the current analysis of the aquaculture regulatory system prevailing in the different aquaculture segments and at country, regional and local levels currently undertaken by the individual Member States it is proposed to address how legislative and regulatory measures should be implemented. Attention needs to be given to innovative models and mechanisms of governance (e.g. national lead agency, one administrative window) for aquaculture, according to the principles of better governance, also including open method of coordination through the involvement of stakeholders and the new Advisory Council in Aquaculture. A “Best Practice Framework” for European aquaculture should be developed in order to set out the principles and provide the basis for developing specific guidance on aquaculture regulation to foster industry competitiveness, mitigate environmental problems and facilitate sustainable growth of aquaculture.

Expected impact. It is envisioned that guidelines, best practices and national capacity building programs aimed at supporting the simplification of the administrative process for licensing will be produced. New governance models for aquaculture, through cooperative research programmes among the different national administrations and stakeholders, aimed at harmonizing regulatory frameworks across the multi-level governance system of the EU should be developed.

Topic 4 - Animal welfare

Introduction to the topic:

Fish welfare is a strategic issue for the sustainable development of aquaculture (COM (2002) 511; COM (2009) 162) for ethical and economical reasons. Farmed fish are covered by the scope of the EU legislation on the protection of animals during breeding, transport and at the time of killing. However there is not a dedicated legislation for welfare of farmed fish and the rules covering animal welfare in livestock productions still consider marginally fish species, without specific provisions.

The interest on the welfare of farmed fish increased in recent years, stimulated by research results suggesting the awareness of pain and suffering, and by scientific reports on farming conditions detrimental to health and welfare. Production systems where fish are reared under high standards of animal welfare should be encouraged; additional investigations are needed to improve fish welfare along the production chain and to acquire new knowledge for the implementation of the legislative framework. In particular, the Commission will consider the feasibility and the appropriateness of introducing science-based indicators based on animal welfare outcomes for farmed fish. The EU animal welfare policy for farmed fish should not threaten the economic sustainability of aquaculture sector, but it should be taken up as an opportunity to express the added value of animal welfare in economic terms and to enhance quality and competitiveness of EU aquaculture, including small aquaculture producers.

Review on recent developments in this topic:

In the last decade EU Commission has supported different research projects on animal welfare in aquaculture, focused in particular on stress response and adaptability to environmental challenges and husbandry practices, welfare indicators, product quality, strategies for disease prevention and estimation of the costs/benefits of controlling fish welfare in the production chain. Within the 7th EU Framework Program several projects have been funded on fish welfare: the Animal Health and Welfare ERA-Net (ANIHWA) aims at increasing cooperation and coordination of national research programmes on health and welfare of farm animals, including fish; the COPEWELL project established a new framework for fish welfare assessment based on the concept of allostasis, appraisal and coping styles.

In order to provide a scientific basis for welfare policies and regulations for the European aquaculture, the EFSA Scientific Panel on Animal Health and Welfare (AHAW) has released numerous scientific opinions and recommendations on welfare aspects during transport, breeding, stunning and killing for main farmed fish species. At international level, the OIE adopted specific recommendations for the welfare of farmed fish.

As reported in the EU Strategy for the Protection and Welfare of Animals 2012-2015 (COM (2012) 6), the Commission will continue to seek scientific advice on a species by species basis and to evaluate fish welfare issues in aquaculture in order to take appropriate actions on the basis of the outcome of that evaluation.

Suggested priority:

Develop and implement aquaculture welfare standards.

Proposals should address how to develop protocols and systems to contribute to enhance fish welfare, reduce physical damages and mortality under farming conditions. Transport and killing procedures that minimize stress and suffering represent key points for fish welfare which require further research. An integrated and standardized methodology should be developed to assess fish welfare on farms, aimed at meeting the expectations of consumers, farmers, industry and animal welfare policies. On the basis of approaches already in used in other livestock productions, a set of species-specific animal-based welfare indicators, together with other operational indicators, should be validated in order to enable operators or third parties to assess fish welfare in different species and farming systems. The implementation of existing code of conducts for responsible aquaculture adopting voluntary self-regulatory practices on fish welfare shared by different stakeholders (e.g. farmers, retailers, veterinarians), could represent complementary actions to turn societal concerns into market advantages, increasing the competitiveness of aquaculture sector.

Consumers and the public should be provided with transparent and adequate information on fish welfare to better address their purchase choices.

Staff training has a fundamental role to improve fish welfare and to ensure the application of best aquaculture practices.

Topic 9 - Genomics, breeding & hatching

Introduction to the topic:

Robustness of farmed fish and shellfish with high fitness, better reproduction performance and better resistance to specific diseases are needed to ensure a healthy and more sustainable industry. In most cases, traditional breeding schemes do not fully exploit the available genetic variation for these traits, and marker-assisted or genomic selection has great potential to dramatically improve this. Advances in DNA sequencing and genotyping enable a faster domestication and selection of sustainable breeds.

Review on recent developments in this topic:

With the increasing worldwide demand for aquaculture products, expansion in diversity and in production volumes is expected, both for fish and shellfish. The increase of aquaculture products can to a large extent be facilitated through the initiation of new breeding programs and by improvement of currently running breeding programs.

To improve stability of production, selection lines should be able to perform in a wide range of, possibly suboptimal, rearing conditions in diverse production systems. Therefore, selection may focus on robustness of animals. Moreover, in a world with limited resources for protein production, selected breeds should be improved for feed conversion rates of existing fish feeds, but also of plant based diets or other alternative protein sources.

While benefits of breeding programs are clear, costs for infrastructure are and will remain high. This is particularly true for the development and use of genomic information in breeding programs as is done in terrestrial animals (e.g. genomic selection in dairy cattle). For many aquaculture enterprises it may not yet be possible to invest in genomics. Also, costs for separate family rearing systems, testing environments, extensive tagging etc. are often limiting. It is therefore clear that for effective implementation of advanced breeding programs, including above mentioned traits as robustness and feed conversion rates, there is a special need for SME's to lower barriers for selective breeding through optimisation of breeding programs by e.g. reduction of scale and costs. A second challenge relates to the reproduction. For many species (e.g. soles, sea bass, sea bream), natural mating of parents in groups is more efficient or even the only way to obtain offspring. To facilitate genetic improvement of such populations, cost-effective hatching and breeding methods should be developed further.

Suggested priority:

New challenges in Aqua-breed

Lower barriers for SME's to start selective breeding programs through optimisation of breeding programs by e.g. optimising the breeding techniques for fish, reduction of costs through upscaling, including cost-effective hatching and breeding methods to facilitate genetic improvement of natural group mating species, and facilitating cooperative initiatives.

Investigate the potential for genetic improvements in production efficiency traits in fish strains such as improving robustness, feed conversion efficiency (including the fish:fish conversion), social behaviour in intensive systems and reducing the quantity of waste to reduce the environmental footprint and increase competitiveness of the aquaculture industry.

Topic 10 - Feed & nutrition

Introduction to the topic:

Feed accounts for more than 50% of the production costs in European intensive finfish aquaculture, so cost effective feeds are decisive for economic sustainability. The growth of the industry is highly dependent on a broad and sustainable raw material base for developing feed that meets the animals need for nutrients to obtain good growth, health and product quality.

During the last decade marine [fish] ingredients have been replaced to a large extent by plant based proteins and oil.

Nutrition is an important tool to improve the robustness of farmed fish in critical (early) life stages such as strong disease resistance against viruses, bacteria and parasites, good ability to cope with environmental constraints and the capability of combining fast growth with normal organ development.

Ultimately, all nutrient discharges in intensive fish farming originate from the feed and are closely linked to feed composition and feeding practise. The discharges from fish farming affect the carrying capacity of different farming environments.

Review on recent developments in this topic:

There is an enormous lack of knowledge on both qualitative and quantitative nutrient requirements for maximum growth and/or optimal health of all fish species cultured, especially at early life- and larval stages. This practically accounts for all nutrient groups. Moreover, with the replacement of fishmeal and/or fish oil with non-marine or plant ingredients, the introduction of deficiencies or imbalances of specific nutrients related to marine ingredients is often underestimated; in particular for feed for organic aquaculture. Not even to mention the introduction of anti-nutritional factors (phytic acids, phytosterols), toxins (mycotoxins) or unknown compounds. Currently, pre-mixes based on requirements of mostly salmonids, are added to diet formulations regardless of target species, life stage and ingredients used in the formulation. Progress in fish feed relies on profound knowledge of the nutritional requirements of a specific species in a specific life cycle stage, the composition and nutritive value of the feed ingredients, feed additives and their interactions.

Suggested priority:

Lower trophic level feed resources.

The proposed action is aimed at developing scientifically based practical knowledge on the nutritional requirements of specific species at their specific early life cycle stage (with effects on later stages).

In this, specific attention will be rendered to possibilities of the replacement of fishmeal and/or fish oil with non-marine or plant ingredients. A particular area of interest to be developed is the utilisation of organisms from lower trophic levels (e.g. micro and macro algae, krill) as replacement of fish meal and fish oil. To facilitate cultivation and harvesting of these organisms innovative technology needs to be developed addressing (1) predictable and cost-effective production and (2) sustainable harvesting of organisms.

In particular the relation between feeds and feed composition on one hand and its potential modulatory effects on the health of the organism; pro-biotics, pre-biotics, anti-oxidants and generally all compounds that have an immunomodulatory effect need to receive more attention, in particular the mechanisms of their action and their possible synergistic or antagonistic actions.

Expected impact. For important cultured species and relevant new species in European aquaculture an analysis of nutritional requirements at their specific life cycle stage will be performed. In addition an analysis of the potential utilisation of organisms from lower trophic levels will be implemented.

Sharing the results with SME's is a prerequisite to develop viable harvesting and production technology and practices.

Topic 11 - Production systems

Introduction to the topic:

The potential for substantial growth in European aquaculture is faced by the requirement for improving the efficiency of the production processes and reducing their environmental impact. The actual limiting factors for the aquaculture production are (1) the availability and utilization of suitable water and space and (2) its environmental impact through the discharge of organic solids and nutrients due to the feed utilization, fish growth and metabolism. Recirculation systems (RAS) decrease drastically water consumption and facilitate waste bioremediation. Their economic feasibility is demonstrated and their current energy consumption sharply decreasing. Most cage farming is presently taking place in fjords, sea lochs and ponds sheltered from heavy weather conditions. Farming equipment for offshore cages are developing fast, as well as the operational procedures to identify suitable farm locations and to minimize their ecological footprint. Whatever the rearing system, a large part of the nutrients are discharged as wastes into the environment. Integrated multitrophic systems, combining fish farming with seaweed and shellfish, allow to convert those nutrients into algae, molluscs or fish and to release purified water to the environment. Though still practical challenges they offer a great potential for increased production of food in a limited space, but also increased utilization of nutrients and feed resources.

Review on recent developments in this topic:

There are many publications on the various aquaculture production systems and the most complete integrative publication is the FAO review on integrated aquaculture published in 2009 (Fisheries and Aquaculture technical paper 529).

The call BG-2-2015: Forecasting and anticipating effects of climate change on fisheries and aquaculture for investigating the potential effects and consequences of climate change on aquaculture taking into account the diversity of aquaculture practices, species and regional specificities, farming technologies and specific requirements of established and emerging European farmed species could provide relevant information on production system evolution.

The call BG-5-2014: Preparing for the future innovative offshore economy, aimed at analysing and identifying the social and economic developments in the offshore economy and the most promising, environmentally sustainable and economically feasible business models includes offshore aquaculture facilities and multi-use offshore platforms projects and their business models, as well as issues of competing access to marine space between different activities and, more broadly, all social and environmental impacts.

A wide variety of production technologies are currently being used, ranging from cage culture, RAS, pond culture and extensive shellfish cultures to IMTA (Integrated Multitrophic Aquaculture). Some studies demonstrated the benefits of IMTA on the global productivity of the systems or on the reduction of the wastes released into the local environment, but some other did not show significant advantages. Therefore, it is essential to understand the key ecological functions that may guarantee the development of equilibrated and efficient production systems in the long term.

Suggested priority:

Efficient and effective aquaculture systems

In order to progress towards more effective, efficient and more sustainable aquaculture systems there is a need to determine which of the potential production systems are most viable under different circumstances. However, efficient use of water, feed and further improvement of waste water treatment using intensive recirculation technologies (RAS) is the key to a significant increase in European aquaculture production. Though, a comparison between currently used production systems (RAS, cage culture, pond culture and extensive shellfish cultures) and land based IMTA as well as off-shore IMTA should be performed with regard to productionvolume, ecological and environmental impact and economic aspects. Based on a bibliographical review, a meta-analysis on both the economical as well as the nutritional scenario's (the dynamics of the main nutrients (C, N, P) in different systems operated in diverse environments and the quantification of the role of each trophic compartment on their recycling) would be a first step. These data will allow to calibrate IMTA models for identification of onshore IMTA systems (integrating recirculating or flow through production system as core economic activity) and offshore IMTA systems (integrating offshore cage culture as the core economic activity), that are adapted to the diverse local geographical and socio-economical environments of EU countries, taking into consideration environmental sustainability, profitability, local regulations, employment and social acceptability in coastal regions.

Topic 12 - New species

Introduction to the topic:

In the Mediterranean aquaculture diversification was identified as a preferential strategy for overcoming the limitations facing the sea bass and sea bream sector and for exploiting new markets. It is recognized also in Northern Europe that salmon and rainbow trout production need alternatives. There are two basic requirements for diversification of aquaculture by growing new species: sufficient market potential, and perspectives for sustainable domestication of the species in order to grow it economically profitable.

Review on recent developments in this topic:

The European demand for low-cost white fish fillets is currently covered by imports from South East Asia, mainly by pangasius and tilapia spp from China and Vietnam. This situation however, will most likely change drastically in the near future as within the next 5 to 10 years domestic markets in South East Asia can be expected to absorb the bulk of its own aquaculture production due to increased seafood demand. South East Asia may even become a net seafood importer. Such developments challenge Europe to become a more self-sufficient producer of low-cost white fish fillets in order to meet its own seafood demand in the future. Sustainable low-cost bulk production of tilapia and catfish species in Europe in land-based systems, though technically feasible but currently unable to compete with Asian imports and therefore virtually non-existent, will become an economically feasible opportunity for the European aquaculture industry. This provides Europe to develop an industry that produces high quality, yet low-cost, sustainable seafood that covers a large proportion of European seafood demand.

Next to the markets for high-end niche seafood products, Europe demands a large volume of low-cost, yet high quality and sustainable seafood. The product, an anonymous white fish fillet, is rather fish species independent. To ensure fish meal and oil independence, net fish protein production and a low carbon foot-print, research should be directed to low-trophic non-piscivorous species. Catfish and tilapia spp are likely candidates. High-end products from seriola spp, pike-perch and meagre are three promising species for European aquaculture. They are robust marine and freshwater fish that have a high growth rate, a low feed conversion rate and a closed life cycle. For Seriola and pike-perch, grow-out in RAS to slaughter weight has proven to be possible. Seriola, meagre and pike-perch are also considered to be premium quality products, especially in the growing sushi market in Europe, though meagre appears as well to be suitable for bulk production.

Suggested priority:

Development of market specific species

Develop market segment specific production chains on specific fish species relating to both markets for high-end niche seafood products as well as large volume of low-cost, yet high quality and sustainable seafood. To ensure lower fish meal and oil independence, net fish protein production and a low carbon foot-print, research should be directed to low-trophic non-piscivorous species such as catfish and tilapia spp. as likely candidates for the more bulk segment. Seriola, pike-perch and meagre are candidates directed towards the high–end of the market.