KEY TOPICS FOR SCIENTIFIC SUPPORT TO THE EUROPEAN AQUACULTURE STRATEGY

AN OUTLINE OF RTDI TOPICS IDENTIFIED BY THE AQUACULTURE STRATEGIC WORKING GROUP

JUNE 2013

European Fisheries and Aquaculture Research Organisations

EFARO

Executive Summary

1. EFARO, in its role as an association of research institutes active in the field of scientific support to fisheries and aquaculture policies, proposes priorities in research that will strengthen the European aquaculture sector.
2. A strategic working group was convened that developed a list of topics relevant to support the European Aquaculture Strategy. These topics are developed with support to policy as the main driver.
3. Fisheries and Aquaculture research institute directors evaluated the topics for priority in the policy context and scored them according to:
   a. urgency/immediacy
   b. policy relevance
   c. perceived 'value for money'(VFM), and
   d. their match/relevance to the stated objectives and remit of EFARO
4. The topics identified are listed below with their overall priority rating indicated by the number of *s.

Topic 1 - Spatial planning & carrying capacity ****

Priority: *Provide the right tools for an integrated approach in management; develop decision-making tools to appraise the economic, societal and environmental costs and benefits of different uses of resources so as to inform marine spatial planning.*

Priority: *Develop environmental impact assessment of aquaculture (and other multiple human activities) and its cumulative or synergistic effects on the ecosystem functioning.*

Topic 2 - Environmental management & governance ****

Priority: *Investigate, develop and provide advice on suitable acceptable and effective governance models to facilitate sustainable aquaculture growth.*

Topic 3 - Animal diseases ***

Priority: *Develop methods to manage diseases affecting aquaculture to improve productivity and reduce risks to wild populations.*

Topic 4 - Animal welfare **

Priority: *Develop protocols and systems to improve fish welfare, focussing on reducing mortality, stresses during transport and relocation.*

Topic 5 - Escapees & biodiversity ***

Priority: *Develop technologies that will reduce escapes from aquaculture to minimise risks to the natural environment.*

Topic 6 - Food security, market & supply chains ***

Priority: *Increase the understanding of markets for fish and fish products in order to satisfy consumer demand through local production and processing for the benefit of European society and its economy.*

Priority: *Scenario studies of economics of the aquaculture sector in situations of increased demand for fish and improved fisheries management for various geographical regions in Europe.*

Priority: *Identify the key factors that can make the European aquaculture industry internationally competitive. This will include consideration of consumer preferences, price, market segments and channels, supply chain and the role of retailers on the European seafood market.*

Priority: *Identify and develop high quality, healthy, nutritious and safe fish and shellfish products that respond to consumer demand.*

Topic 7 - Sustainability & Consumer Standards **

Priority: *Develop methods to facilitate traceability of produce via certification and promote labelling as source of information to guarantee sustainability of production and safety for consumption.*

Priority: *Development of a general framework for international accepted certifications and labelling of commodities and products from an environmental, social and economic perspective.*

Topic 8 - Food safety ***

Priority: *Fundamental understanding of the kinetics viral (e.g. vibrio) uptake and removal in bivalve molluscs and other seafood. Environmental parameters to enhance virus depuration should be optimized. Novel approaches for virus removal/inactivation (e.g. high pressure treatment, ozonation) should be investigated.*

Priority: *Stocktake of newly/emerging biotoxins and toxin producing phytoplankton relevant to European waters and their method of analysis.*

Topic 9 - Genomics, breeding & hatching ***

Priority: *Investigate the potential for genetic improvements in production efficiency traits in domestic fish strains such as improving feed conversion efficiency (including the fish : fish conversion) and reducing the quantity of waste to reduce the environmental foot-print and increase competitiveness of the aquaculture industry.*

Topic 10 - Feed & nutrition ***

Priority: *Develop sustainable fish feeds with high and customized nutritional value that make aquaculture one of the most efficient producers of safe, high value food with low impact on wild forage fish populations.*

Topic 11 - Production systems **

Priority: *Advance aquaculture technology and systems that are economically sustainable and are sensitive to animal welfare.*

Priority: *Support technologies (such as RAS and IMTA) to decrease energy consumption and reduce the ecological footprint of aquaculture, fisheries and seafood processing.*

Topic 12 - New species **

Priority: *Development of a methodology for integrated multi criteria assessment of cultivation and market perspectives in order to identify high potential species for aquaculture given local environmental and marketing conditions.*

Our pitch

Europe requires a sustainable domestic aquaculture sector capable of contributing to the current and future global demands for seafood. With that perspective the European Community launched its Aquaculture Strategy in 2009. A sound knowledge base is foreseen as an instrument in achieving these aspirations. EFARO, in its role of an association of research institutes active in the field of scientific support to fisheries and aquaculture policies, proposes priorities in research that will strengthen the European aquaculture sector.

Background: European aquaculture in a changing world

The European seafood industry is facing challenges driven by changes in the global market, both in terms of supply as well as demand for seafood. Since the provision of fish from capture fisheries is at the best stable, but more often declining, and the global human population continues to grow, aquaculture needs to supply the additional fish necessary in the coming decades. It has been estimated that the global fish demand will increase to 40 million tonnes by 2030, an increase that should be covered with aquaculture production. The growing demand for fish and fishery products is not only caused by an increasing world population, but also by the recognition of fish as a crucial element in human nutrition. It is especially important for the diets of infants, young children and pregnant women, providing crucial protein and micronutrients.

While global aquaculture production has grown by an average 8% per year for the last decade, production within the European Union has decreased by approximately 10% during the period 2000-2010. This is mainly caused by a decrease in the production of inland fish (trout and carps) and molluscs (shellfish), that is only partly compensated for by an increase in marine fish production (sea bass, sea bream and Atlantic salmon). Significant growth of finfish culture has, for example, been realised in Norway where aquaculture increased by more than 100% over the last decade, mainly as the result of the growing Atlantic salmon industry.

If aquaculture production in the EU does not increase, the growing demand for fish can only be satisfied through an increase in imports. However, the import of seafood products from Asia to the European market is likely to diminish in the near future. Due to the economic growth in Asia, the increasing domestic consumption of sea food in Asia will reduce export volumes. Strict and expensive food safety regulations and sustainability criteria imposed by the EU further reduce the incentive to export to Europe. In order to safeguard the supply of healthy sea food and to reduce the dependency on imports, the EU needs to increase investment in the development of a sustainable European aquaculture sector.

The European Commission has acted on these developments with the publication of its paper “Building a sustainable future for aquaculture; A new impetus for the Strategy for the Sustainable Development of European Aquaculture” (2009). The paper indicates that the European aquaculture industry of the future should be at the forefront of sustainable development and take a lead role in the “blue revolution”, whether this concerns the production of aquatic food itself, technology and innovation, or the setting of standards and certification processes at EU and international level. The production of farmed aquatic animals and the development of farming equipment must be supported by the most advanced research and development (R&D), as well as innovative technology to help achieve environmental sustainability, compatibility and diversity within the European aquaculture industry. A main financial R&D instrument for the period 2014-2020 is “Horizon 2020”, in addition to national and private R&D funds. This new EU programme for research and innovation needs to strengthen the EU position in science to foster the European grand challenges with regard to a better society and competitive industries. The Biobased Economy (including food security) as well as the Maritime Development are obvious keystones in Horizon 2020, to which a vital aquaculture sector can contribute substantially in terms of a European Innovation Partnership.

The role of EFARO

The European Fisheries and Aquaculture Research Organisation (EFARO), an association of the main European Research Institutes involved in scientific support to policy and innovation in fisheries, aquaculture and their interaction with the marine environment, was founded under a consensus agreement in 1989. It was established in recognition of the need to achieve greater cohesion and coordination of science and research in support of European policy related to the marine environment, fisheries and aquaculture. In view of the above mentioned developments, EFARO has the competency and the willingness to contribute to such a comprehensive European joint research and development programme to foster the development of the European aquaculture.

Within EFARO an *Aquaculture Strategic Working Group* (ASWG) was established in 2008, mainly to act as a platform for early exchange of information amongst EFARO researchers, to share research capacities and to produce communications. EFARO undertakes these tasks in connection with other aquaculture networks such as the Federation of European Aquaculture Producers (FEAP), the European Aquaculture Technology and Innovation Platform (EATIP), the European Aquaculture Society (EAS) and the Animal Task Force (ATF). Within EFARO member institutes approximately 600 researchers and supporting staff work on aquaculture topics.

Selected RTDI topics for Aquaculture

The EFARO *Aquaculture Strategic Working Group* identified the following key topics in which gaps in R&D exist with respect to the EU Aquaculture Strategy ambitions towards sustainable development of the European aquaculture sector:

From a science support to policy perspective:
- Spatial planning & carrying capacity
- Environmental management & governance
- Animal diseases
- Animal welfare
- Biodiversity in relation to escapees

From a science support to market perspective:
- Food security, market & seafood chains
- Sustainability & Consumer Standards
- Food safety

From a science support to innovation perspective:
- Genomics, breeding & hatching
- Feed & nutrition
- Production systems including engineering
- New species

Certain topics are closely linked (e.g. improved feed efficiency that enhances economic profitability, and water quality which in turn improves fish welfare and reduces nutrient emissions in production systems), other topics might reinforce each other (e.g. a more robust fish which is better adapted to its culture environment can be produced making use of improved genomics, feed technology or system design), but there is also a potential risk for contradictory actions in the list of RTDI topics (e.g. new species may vary greatly in requirements to the more established species and their welfare issues are therefore likely to differ).

A simple scoring exercise carried out by EFARO institute directors on the basis of urgency/immediacy and relevance was performed to prioritise the main topics. The research topics were also categorised according to perceived 'value for money'(VFM), and their match/relevance to the stated objectives and remit of EFARO (i.e. to promote scientific cooperation in the area of fisheries and aquaculture specifically). The higher the number of *s the stronger the support for the topic. For each theme the main science priorities are identified.

Topic 1
Spatial planning & carrying capacity

Value for money	***
Immediacy	****
Wider benefits	****
Relevance	****
Total	****

The aquaculture sector needs access to sites where profitable and environmentally sustainable production is possible. Research should be targeted to better integrate aquaculture with other coastal activities (including shipping) using spatial planning and zoning (Integrated Coastal Zone Management). It is important that the production is in balance with the carrying capacity of the area.

The majority of the aquaculture extension is predicted to be achieved in offshore areas. This is partly because conflicts with other users/stakeholders are assumed to be lower offshore as compared to in coastal waters, and partly because most new capacity for aquaculture in Europe lies offshore.

Priority: *Provide the right tools for an integrated approach in management; develop decision-making tools to appraise the economic, societal and environmental costs and benefits of different uses of resources so as to inform marine spatial planning.*

Priority: *Develop environmental impact assessment of aquaculture (and other multiple human activities) and its cumulative or synergistic effects on the ecosystem functioning.*

Topic 2
Environmental management & governance

Value for money	***
Immediacy	***
Wider benefits	****
Relevance	****
Total	****

European aquaculture has faced stagnation in production over the last years, despite the fact that substantial support has been provided from the EC and by national governments for investments and research. The legislation framework of European aquaculture includes more than 600 laws and regulations at EU, member state, regional and local level. There is a need for simplification of environmental legislation affecting aquaculture to encourage growth and innovation. Licensing policy should be developed in such a way that the growth in production is possible with the best available methods, considering both economic and environmental aspects.

Decision making on aquaculture regulation involves several interest groups, including fish farmers, environmental and consumer organisations, professional and recreational fishermen and other players, together with the traditional players at different levels in the political system. 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.

Priority: *Investigate, develop and provide advice on suitable acceptable and effective governance models to facilitate sustainable aquaculture growth.*

Topic 3
Animal diseases

Value for money	****
Immediacy	***
Wider benefits	**
Relevance	***
Total	***

Disease management is a major requirement for all farmed species, whether aquatic or terrestrial. Disease reduces productivity and may have catastrophic economic consequences for producers. In general there is a need to develop effective treatment solutions, management and practice, and to develop preventive technologies. A particular priority relates to external threats from exotic pathogenic agents which may be especially damaging unless adequate precautions are taken

Climate change will affect the environment in which aquaculture takes place and is likely to affect the outbreak and spreading of diseases. It is important to be able to anticipate how climate may affect disease outbreaks to so that appropriate mitigation measures can be developed and implemented.

The potential for the exchange of pathogens between wild and farmed aquatic animals is an important issue for the health of both populations. Wild fish may infect or be infected by farmed fish when they come into contact, or where water flows expose one population to pathogens emanating from another population. This may be especially important where farmed fish are introduced from a distant location or where wild population distributions change. Modelling studies can help identify critical control points where measures can be applied to minimise spread and impact.

Priority: *Develop methods to manage diseases affecting aquaculture to improve productivity and reduce risks to wild populations.*

Topic 4
Animal welfare

Value for money	**
Immediacy	**
Wider benefits	*
Relevance	**
Total	**

Mortality of farmed fish is often overlooked as a fish welfare issue yet the limited information available on causes, indicates that a proportion of mortality is preventable.

Transport is a key hazard point for welfare and represents a prime opportunity for pathogen transfer and uptake. The welfare of fish during and after transport, and the consequent incidence of disease merits research.

Physical damage (often fin damage) is ubiquitous in farmed salmonids and many Mediterranean aquaculture species, and is believed to be caused by behavioural interactions and poor environmental conditions.

System design may contribute to better fish welfare under farming conditions. For example, existing data on teleost fish indicates that sustained exercise at optimal speeds enhances muscle growth, has consequences for flesh quality, and strengthens health. Hence, stimulating exercise in farming systems could represent a natural, non-invasive, and economical approach to improve growth, as well as welfare of farmed fish.

Priority: *Develop protocols and systems to improve fish welfare, focussing on reducing mortality, stresses during transport and relocation.*

Topic 5
Escapees & biodiversity

Value for money	**
Immediacy	***
Wider benefits	**
Relevance	****
Total	***

The escape of fish from aquaculture facilities has the potential to cause environmental impact. Possible consequences include detrimental effects to wild fish populations through genetic interaction and changes to ecosystem biodiversity. The development of offshore aquaculture and the aspirations for future sustainable growth increase the potential for escape events and possible environmental impacts. The extent and consequences of environmental impact from escapes is poorly understood. Therefore, it is not always possible to measure or manage interactions and this presents a potential restriction to the development of aquaculture particularly with respect to wild fishery conservation and impacts within ecologically sensitive areas.

Actions taken to improve containment and reduce the risk of escapes include better bio-security, containment measures and contingency plans. With respect to seawater cage culture of Atlantic salmon, some countries have introduced a minimum standard of equipment specification. Further measures have been developed to identify the origin of escaped fish, e.g. based on behavioural or genetic characteristics. It is important to develop and implement specific rules, standards and measures for sea cage culture.

Priority: *Develop technologies that will reduce escapes from aquaculture to minimise risks to the natural environment.*

Topic 6
Food security, market & supply chains

Value for money	***
Immediacy	***
Wider benefits	***
Relevance	***
Total	***

The potential of European cultured seafood depends on the extent to which it competes with capture fisheries and with cultured seafood from other origins. Hence the future of European aquaculture is affected by the demand for fish as well as by competition with other sources.

The market potential of European cultured seafood depends on the extent to which it can compete with cultured seafood imported from outside the EU. Production costs of aquaculture in the EU are relatively high as a result of more intensive culture methods and higher costs of inputs such as feed, electricity, labour and water. The important question is how European cultured seafood can be positioned in the market in such a way that it can compete with products from outside the EU. One way to compete is price, but other ways are competition on sustainability and quality. Supply chains must be as efficient and sustainable as possible. Efficiency and sustainability should be maximized from the level of fingerling egg production up to the level of processing and marketing.

Priority: *Increase the understanding of markets for fish and fish products in order to satisfy consumer demand through local production and processing for the benefit of European society and its economy.*

Priority: *Scenario studies of economics of the aquaculture sector in situations of increased demand for fish and improved fisheries management for various geographical regions in Europe.*

Priority: *Identify the key factors that can make the European aquaculture industry internationally competitive. This will include consideration of consumer preferences, price, market segments and channels, supply chain and the role of retailers on the European seafood market.*

Priority: *Identify and develop high quality, healthy, nutritious and safe fish and shellfish products that respond to consumer demand.*

Topic 7
Sustainability & Consumer Standards

Value for money	***
Immediacy	**
Wider benefits	**
Relevance	***
Total	**

The enormous variety in produced species, applied technologies, trade chains and desired expectations by trade or NGOs, results in an increasing amount of certification programmes and labels. At present these labels strive for production certifications on different levels of operation, include overlapping or complementary ambitions and have different market access. Furthermore, there could be an overlap between voluntary certification schemes and legislation. In order to improve the coherence between the wide diversity of certification initiatives it is necessary to learn more about the respective impact logics to identify the gaps and overlaps of the different standards. In order to achieve improvement in global sustainable aquaculture, higher level, integrated concepts for standards based on novel innovative sustainability perspectives need to be developed.

Certain certification programmes have been developed and implemented, but there is no sight on the effect of the implementation on markets, dynamics in local and international trade and environmental conditions on a broader scale. There is a need for overall improvement of methodology to understand the effects of implementation of certification programmes on a European and Global level. In the case of organic aquaculture, implementation should also take into account different species and production system as basis for future revisions of EU regulations (710/2009). Technical provisions should be reassessed according to their relevance, measurability and applicability and based on scientific evidence.

Implementation of certification programmes is fragmented in size and reach, and does not directly result in (novel) innovative and broadly applicable measurement methods. Method development, validation, and application of methods to a broader view on a micro- (welfare, animal health, local environmental effects, etc.), meso- (socio-economics, environmental benefits, LCA, and economic benefits) and macro-level (global effects on seafood production chains, and certification development and needs) are therefore highly needed.

Priority: *Develop methods to facilitate traceability of produce via certification and promote labelling as source of information to guarantee sustainability of production and safety for consumption.*

Priority: *Development of a general framework for international accepted certifications and labelling of commodities and products from an environmental, social and economic perspective.*

Topic 8
Food safety

Value for money	***
Immediacy	**
Wider benefits	***
Relevance	***
Total	***

Across Europe the major microbiological health risk to the shellfish consumer is from viruses derived from human sewage contamination. Warming of European marine environments predicted in future climate change scenarios is likely to support larger numbers of pathogen populations and subsequent increase in the risk of seafood associated infections (viz. Vibrio) in many parts of Europe.

Depuration is the most common practiced purification method for bivalve molluscs that are subject to contamination by faecal material. Depuration requires that animals are held in clean seawater to enable natural purging of contaminants. This process is very efficient for the removal of bacteria but is not effective at eliminating viral pathogens since there are regular occurrences of viral outbreaks associated with consumption of bivalve molluscs that are fully compliant with the EU regulations

In the presence of toxin-producing phytoplankton in the water column, shellfish can accumulate marine biotoxins through filter-feeding and present a health risk to humans consuming seafood.

Priority: *Fundamental understanding of the kinetics viral (e.g Vibrio) uptake and removal in bivalve molluscs and other seafood. Environmental parameters to enhance virus depuration should be optimized. Novel approaches for virus removal/inactivation (e.g. high pressure treatment, ozonation) should be investigated.*

Priority: *Stocktake of newly/emerging biotoxins and toxin producing phytoplankton relevant to European waters and their method of analysis.*

Topic 9
Genomics, breeding & hatching

Value for money	***
Immediacy	**
Wider benefits	**
Relevance	**
Total	***

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 enables a faster domestication and selection of sustainable breeds.

Priority: *Investigate the potential for genetic improvements in production efficiency traits in domestic fish strains such as improving feed conversion efficiency (including the fish : fish conversion) and reducing the quantity of waste to reduce the environmental footprint and increase competitiveness of the aquaculture industry.*

Topic 10
Feed & nutrition

Value for money	****
Immediacy	***
Wider benefits	***
Relevance	***
Total	***

Feed accounts for more than 50% of production cost 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.

Priority: *Develop sustainable fish feeds with high and customized nutritional value that make aquaculture one of the most efficient producers of safe, high value food with low impact on wild forage fish populations.*

Topic 11
Production systems

Value for money	***
Immediacy	**
Wider benefits	**
Relevance	***
Total	**

The potential for substantial growth in European aquaculture is faced with the requirement for reducing environmental impact. The actual limiting environmental parameter for the aquaculture production is the discharge of organics and nutrients, especially nitrogen. A solution can be provided through Recirculating Aquaculture Systems (RAS) technologies although with the drawback of increased energy consumption.

Most cage farming is presently taking place in fjords, sea lochs and sounds sheltered from heavy weather conditions. Environmental constraints are limiting the potential for production increase and new locations in the coastal zones are rarely available and acceptable. Important alternative technologies in this respect are Integrated Multi-Trophic Aquacultures (IMTA). With IMTA the farming of fin fish is combined with seaweed and shellfish which offers great potential for increased production of food in a limited space, but also increased utilization of nutrients and feed resources, as well as for some areas an potential environmental solution to nutrient discharges.

Priority: *Advance aquaculture technology and systems that are economically sustainable and are sensitive to animal welfare.*

Priority: *Support new technologies such as RAS and IMTA to decrease energy consumption and reduce the ecological footprint of aquaculture.*

Topic 12
New species

Value for money	**
Immediacy	**
Wider benefits	*
Relevance	**
Total	**

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 sustainabledomestication of the species in order to grow it economically profitable.

Priority: *Development of a methodology for integrated multi criteria assessment of cultivation and market perspectives in order to identify high potential species for aquaculture given local environmental and marketing conditions.*

AZTI	Marine and Food Technological Centre
BIOR	Institute of Food Safety, Animal Health and Environment
CEFAS	Centre for Environment, Fisheries & Aquaculture Science
CNR ISMAR	Institute of Marine Sciences
DFMR	Department of Fisheries and Marine Research
DTU Aqua	National Institute of Aquatic Resources
EMI	Estonian Marine Institute
FOI	Institute of Food and Resource Economcis
HCMR	Hellenic Centre of Marine Research
IEO	Instituto Espanol de Oceanografia
IFM	Innovative Fisheries Management
IFREMER	French Research Institute for Exploration of the Sea
ILVO	Institute for Agricultural and Fisheries research
IMARES	Institute for Marine Resources & Ecosystem Studies, Wageningen UR
IMR	Institute of Marine Research
IPIMAR	Instituto de Investigação das Pescas e do Mar
IRD	Institut de recherche pour le développement
ISPRA	The Institute for Environmental Protection and Research
LEI	Agricultural Economics Research Institute, Wageningen UR
Marine Scotland	Marine Laboratory
MI	The Marine Institute
MRI	Marine Research Institute
NMFRI	National Marine Fisheries Research Institute
NOFIMA	Norwegian Institute of Food, Fisheries and Aquaculture Research
RKTL	Finnish Game and Fisheries Research Institute
SINTEF	SINTEF Fisheries and Aquaculture
SLU	Swedish University of Agricultural Sciences, Department of Aquatic Resources
TI	Baltic - Thünen Institute of Baltic Sea Fisheries
TI	Sea Fisheries - Thünen Institute for Sea Fisheries

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