Expression of interest for Call: COFASP for transnational research in the sectors Aquaculture, Fishery and Seafood Processing Topic 3

Topic 3: Improved aquaculture

- New and improved aquaculture systems
- Feed and nutrition in aquaculture
- Application of the improved capacity in genomics in aquaculture

Deadline for pre-registration	15 April, 2014
Deadline for submission of full proposals	15 June, 2014 - 13:00

The objectives of this expression of interest are "**New technologies such as Recirculation Aquaculture Systems (RAS) or closed or semi-closed systems**" with particular focus on animal welfare and performance in such systems, and also "**Application of the improved capacity in genomics in aquaculture**", with particular reference to our observation that stress and disease resistance is in fact associated with higher feed utilization and reduced feed waste, a trait of both economic and ecological significance. A brief description of these two projects, their scope, potential, and limitations is given on the following pages, focusing on the type of complementary expertise currently needed to form an effective consortium. As it will become clear there is overlap between the two topics mentioned above, and **potential participants** and **project officers** are encouraged to consider whether it is wise to merge the two into one approach, i.e. simultaneously considering both new technologies and genomics of the breeding stock to ensure animal welfare and performance and thus better integrate and develop the aquaculture sector in the emerging bioeconomy.

1) Welfare and performance of fish in Recirculation Aquaculture Systems (RAS) or closed or semi-closed systems

Goal:

Develop functional animal based welfare and performance indicators for RAS and closed systems aquaculture operations

Background and challenge:

Recirculating aquaculture systems (RAS), in which fish tank water is recirculated and cleaned by biological and mechanical filters, offer many advantages over traditional flow-through (FT) systems regarding sustainability of aquaculture production. The main advantages concern reduced demand for water, a limiting resource in many European areas, and reduced ecological footprint regarding waste discharge. Closed-containment systems in the sea or in lakes is another approach considered for fish

production, to reduce the incidence of escaped farmed fish and the level of parasite and disease infection from farmed to wild organisms.

The welfare and performance of fish in such production systems must be secured, and both researchers and stakeholders are realizing that this will require close collaboration between experts in biology and technology alike. Animal welfare is a highly complex subject and it is still intensively discussed to what degree fishes experience discomfort and awareness. A consensus is however emerging that the ability to experience emotions are evolved, and are thus potentially relevant for animal welfare throughout the vertebrate lineage. Such capacities cannot be assessed directly by humans, but give rise to coinciding changes in behavior and physiology which in turn are precisely measurable in biological science.

It is a considerable challenge for the human research community to assess and interpret behavioral and neurobiological measurements in terms of relevance to the animals in concern. Presently, successful projects depend on the fact that neuroendocrine mechanisms involved in stress coping and negative affect appear to be strongly conserved by evolution (Winberg and Nilsson, 1993; Sørensen et al., 2012, 2013). Several studies on fish have focused on the role of the brain serotonergic (5-hydroxytryptamine, 5-HT) system, which conveys physiological and behavioral responses to stress and sub-optimal rearing conditions. Elevated brain serotonergic activity is a general response to aversive experience in all vertebrates, and has in fishes been shown to occur after social stress and chemical distress signals, exposure to toxins, predators and predator olfactory cues, and confinement stress. The present project will develop 5-HT and other neurobiological indicators such as brain structural plasticity and neurogenesis (see Sørensen et al., 2013) as markers of animal welfare in emerging technology aquaculture systems.

Vision:

Partners with close knowledge of state of the art technological systems are needed to conduct valid experiments. The competence of the Norwegian aquaculture sector is low in this field, given the resource situation and the focus on flow through and net-pen salmon aquaculture. Strong fundamental competence in neurobiology and fish physiology exists, and will be coupled to developers of functional on-farm measurements and existing industry sector systems for quality and production control.

2) Application of the improved capacity in genomics in aquaculture

Goal: Implementation of an integrative genomics approach for sustainability and production in aquaculture

Background and challenge

Growth and sustainability of aquaculture internationally will be crucial to meet the needs of protein for human consumption in the future. Several challenges must however be overcome, mostly related to the biology of the cultured species and their interaction with a changing environment. Examples of these challenges include early sexual maturation, feed meal replacement, immune response to infectious diseases and parasites, and temperature and salinity tolerance.

The implementation of breeding schemes aimed at improving productive traits have had significant economic impact. By far the most economically relevant trait is growth rate, which can be efficiently improved by conventional genetic selection (i.e. based on breeding values of selection candidates). However, there are other important traits that cannot be measured directly on selection candidates, such as resistance against infectious and parasitic agents and quality traits such as fillet yield and meat color. Such traits can be more efficiently improved using molecular tools to assist breeding programs by means of marker-assisted selection, using a few markers explaining a high proportion of the trait

variation, or genomic selection, using thousands of markers to estimate genomic breeding values. The development and implementation of new technologies applied to molecular biology and genomics, such as next-generation sequencing methods and high-throughput genotyping platforms, are allowing the rapid increase of availability of genomic resources in aquaculture species. In this regard, it is important to establish discussion in terms of which strategies will be more efficient to solve the primary challenges that are affecting aquaculture systems in Europe. The challenge now is to convert new genomic information into biological understanding by using biotechnology tools and expertise. It is a serious flaw that virtually all projects presently concentrate on understanding the genetic background for a limited set of traits (such as e.g. disease resistance or sexual maturation), instead of studying their inter-dependence. As an example, if the immune system is strengthened, another energy demanding process such as growth has to be diminished. Also, sequencing genes and understanding where they are on the chromosome, does not necessarily mean sufficient knowledge of the function of the proteins that those genes encode.

Vision:

Here we propose an integrative approach studying how selection affects the whole fish and it's performance throughout the breeding cycle. We will also take into account that some phenotypes of a given species may be fitted for one region, but perhaps not optimal for another type of production. We aim for a project that fully maps the pleiotropy of important traits. As an example selection for increased stress resistance will be utilized, which available literature indicates will create a phenotype which is both more disease resistant and shows better feed conversion efficiency and reduced feed waste. The utilization of such phenotypes in sub-optimal environments such as challenging climates or environments such as recirculating systems will be a possible spin-off and/or integration with other topics in the present COFASP call. Partners with a thorough understanding of the biological challenge facing the aquaculture industry in each participating country are needed.

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