OrAqua

European Organic Aquaculture - Science-based recommendations for further development of the EU regulatory framework and to underpin future growth in the sector

Communication Material

2nd Stakeholder Event

Rotterdam, The Netherlands

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FP7-KBBE. 2013.1.2-11 Assessment of organic aquaculture for further development of European regulatory framework
Coordinator: Åsa Maria Espmark. Funded by the EC **(Grant No: 613547)**

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Contents

1.0 Introduction

In the OrAqua project, state of the art reviews on Organic Aquaculture have been performed on:

1. Production related Issues and

2. Consumer and Socio-economic issues and Institutional Frameworks.

The production issues nutrition, welfare, health, veterinary treatments, biosecurity, productions systems, environmental impacts and interactions were provided by WP 2, and consumer aspects, socio-economy and institutional frameworks were provided by WP 3.

Based on an analysis of this information combined with feed-back from the 1st Stakeholder event in Istanbul 11th-12th October 2014, this paper is an extract and synthesis on key issues related to the current regulation on organic aquaculture. It includes conclusions, challenges and research gaps identified as basic to the discussions and issues to be addressed at the the 2nd stakeholder event in Rotterdam 19th – 20th October 2015 to underpin future growth of the European aquaculture sector.

However, since the introduction of implementing rules on organic aquaculture into the Reg. 889/2008 followed by the amending Reg. 710/2009 having been into force since 1st July 2010, the legislation has exposed unforeseen challenges and unresolved key issues which has impeded the incentive of farmers to join the EU organic aquaculture scheme.

Some of the most controversial issues have been addressed by the Expert Group for Technical Advice on Organic Production (EGTOP), and most of the advices provided by EGTOP on these specific issues have been implemented ad hoc in amending regulations.

2.0 Sourcing of feed ingredients

In consideration fish health, product quality and low environmental impact, a general concern has been expressed about the sourcing of ingredients for feed for carnivorous fish (EC Reg. No 889/2008 art. 25k). With respect to fish meal derived only from trimmings, the risk is that the levels of phosphorus contained in such fish meal might result in conflicts with national environmental legislation. Hence, to achieve nutrient balanced diets that fulfill the dietary needs for amino acids and fatty acids primarily through the natural compounds of the feed, the use of fish meal from whole fish caught in sustainable fisheries, and not commonly used for human consumption has been addressed by Comm. Implementing Reg. (EU) No 1358/2014 amending Reg. (EC) No 889/2008.

In Article 25k, § 1e has been added: "*feed products derived from whole fish caught in fisheries certified as sustainable under a scheme recognised by the competent authority in line with the principles laid down in Regulation (EU) No 1380/2013 of the European Parliament and of the Council*".

Histidine is an essential amino acid and particularly important in salmonid diets in order to prevent cataracts. This issue has as well been addressed by Comm. Implementing Reg. (EU) No 1358/2014 amending Reg. (EC) No 889/2008.

In Article 25k, the following paragraph has been added:
(5) Histidine produced through fermentation may be used in the feed ration for salmonid fish

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when the feed sources listed in paragraph 1 do not provide a sufficient amount of histidine to meet the dietary needs of the fish and prevent the formation of cataracts.

Concern has also been raised to EC Reg. No 889/2008 art. 25l, § 3 stating the maximum content of 10 % fish meal in supplemental feed for penaeid shrimps, freshwater prawns (*Macrobrachrium spp.*) and Siamese catfish (*Pangasius sp*.). However, the most important shrimp species in aquaculture have different specific needs of animal protein and lipids in their diets, including phospholipids (e.g. lecithin) and cholesterol. Although the shrimps in aquaculture are all benthivore, their feeding habits cover the range from being omnivorous benthivore (e.g. *M. rosenbergii*) to carnivourous benthivore (e.g. *P. monodon*), which is reflected in the types of enzymes in their digestive tract. Following advice from EGTOP on these issues have been addressed by Comm. Implementing Reg. (EU) No 1358/2014 amending Reg. (EC) No 889/2008.

Article 25l, § 3 is replaced by the following:
"3. Where natural feed is supplemented according to paragraph 2:

(a) the feed ration of siamese catfish (Pangasius spp.) as referred to in Section 9 of Annex XIIIa may comprise a maximum of 10 % fishmeal or fish oil derived from sustainable fisheries;

(b) the feed ration of shrimps as referred to in Section 7 of Annex XIIIa may comprise a maximum of 25 % fishmeal and 10 % fish oil derived from sustainable fisheries. In order to secure the quantitative dietary needs of shrimps, organic cholesterol may be used to supplement their diets; where organic cholesterol is not available, non-organic cholesterol derived from wool, shellfish or other sources may be used."

Though amendments to the regulation have been implemented the following challenges and research gaps have been identified:

- Trimmings are not a well-defined product and show great variations in composition and quality (amino acids and phosphorous).
- Need to improve the diversity of the raw material basket, i.e. increase the adequate options of ingredients to better match amino acid profiles and covering the dietary needs of other essential nutrients for the full organic production cycle, i.e. brood stock, fry and for on-growing.
- Research is needed on additional types of raw materials, e.g. PAP, blood products, microalgae, insect meal, processed vegetable protein (soy protein concentrate). Supplement from fermentation e.g. histidine.
- Need to harmonize limits of pigmentation of organic fish, e.g. max. levels of dietary astaxanthin. Some national regulations allow 100 ppm, while e.g. Danish authorities have interpreted the EU regulation as max. 20 ppm dietary astaxanthin.
- Important to keep focus on human health related to eating (organic) aquaculture products, i.e. the exchange of fish oil high in omega-3 fatty acids (HUFAs) by alternative sources should be adjusted in accordance to development of vegetable or other sources producing these healthy omega-3 fatty acids in favor of keeping the good human health issue of eating seafood.
- Sourcing of feed ingredients for organic aquaculture need to be re-considered and supported by experimental data to secure compliance with the organic principles of fish health and welfare and environmental sustainability.
- Studies have indicated that not only the overall dietary amino acid profile is important for efficient utilization of amino acids, but also the timing by which amino acids from

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different protein sources appear in the blood stream after a meal. A significantly higher amount of indigestible carbohydrates have been measured in a diet based on vegetables than in a fish meal based diet, which suggested that the uptake of amino acids was affected by dietary carbohydrates. This issue also needs attention when considering ingredients in feed for organic aquaculture.

- Procedures in compliance with organic rules for removal of anti-nutrients in plant sources need to be addressed.
- Focus on natural resources of minerals and vitamins - chemically well-defined analogic substances of minerals and vitamins may be considered for use if the natural substances are unavailable.
- Focus on critical life stages, which may require specific compounds, i.e. availability of organic ctr. non-organic compounds. E.g. lecithin from organically certified sources, such as organic soybean, may be used as phospholipid source following mechanical extraction or from non-GMO natural sources?
- Crosscutting regulations create barriers regarding the use of different feed materials (plant), insects, worms, mussels in organic feed.
- Focus on lower limit value for ethoxyquin, due to analytical uncertainties/deriving from an ingredient. For GMO the limit is 0.9 %.

In particular for organic carp production the main challenges related to feed and nutrition can be summarized:

- Shortage of organic feed.
- No distinct differentiation from non-organic carp.
- Need to harmonize standards (consistency).

3.0 Production systems

Production systems in conventional and organic aquaculture include a range of topics, i.e.

- Sourcing of organic juveniles – Breeding and hatcheries
- Land based farming, cage culture and systems using recirculation technology
- Mussel/oyster culture
- Seaweed culture

3.1 Sourcing of organic juveniles – Breeding and hatcheries

Sourcing of organic juveniles is a crucial issue. Although organic trout eggs are already available, the request of 100 % organic juveniles from 1st January 2016 has been assessed not realistic, in particular for marine species such as sole, turbot, sea bream and sea bass, due to the small size of the market, and the lack of availability of organic live feed for fish larvae. Further concern was raised with respect to the restriction on the movement of live animals between countries and regions based on the *“Directive 2006/88/EC on animal health requirements for aquaculture animals and products thereof, and on the prevention and control of certain diseases in aquatic animals”.*

Furthermore, Reg. EC 889/2008 does not give any specific organic rules for managing the life cycle phase between hatching and the weaning of juveniles. Thus the regulation does not distinguish between organic and non-organic hatcheries incl. phyto- and zooplankton productions and larval rearing systems. This lack of organic regulation concerns fresh water species (e.g. stocking density, husbandry environment) and, even more, marine species (e.g.

phyto- and zooplankton production, essential nutrients in the trophic chain, stocking density during larval rearing and weaning, husbandry environment).

However, there is a potential conflict with the principles of organic production. In the organic production of terrestrial crops, it is an overall principle that plants must not be fertilized with easily soluble nutrients. Art. 4(b) (iii) of Reg. 834/2007 limits the use of fertilizers to '*low solubility* mineral fertilizers'. In the implementing rules, hydroponic production is prohibited (Art. 4 of Reg. 889/2008). This principle was obviously developed for terrestrial plants, and does not hold for aquatic production, i.e. phytoplankton, where the nutrients are only available in soluble form. In the case of vitamins and other substances, the same rules concerning GMO risk should apply as for feed of terrestrial animals.

Accordingly, it is currently not possible to define production of "organic phytoplankton", that would be sufficiently different from conventional phytoplankton.

Hence, the Commission has considered it to be necessary to introduce specific rules for the use of plankton in the feeding of organic juveniles. Plankton is necessary for the rearing of juveniles and it is currently not produced under organic rules. By Reg. (EU) No 1358/2014 amending Reg. (EC) No 889/2008 Article 25, § la is inserted: "*In the larval rearing of organic juveniles, conventional phytoplankton and zooplankton may be used as feed*."

According to Regulation (EC) No 834/2007, Article 15, § 1a,ii non-organically produced animals may be brought onto a holding under specific conditions, when young stock from organic broodstock or holdings are not available. However, Regulation (EC) No 889/2008 gives specific restrictions as regards wild caught aquaculture animals, including the collection of wild aquaculture juveniles. Some traditional practices of extensive fish farming in wetlands, such as brackish water ponds, tidal areas and costal lagoons, closed by levees and banks, have existed for centuries and are valuable in terms of cultural heritage, biodiversity conservation and economic perspective for the local communities. Under certain conditions, those practices do not affect the stock status of the species concerned.

Therefore, the collection of wild fry for on-growing purposes in those traditional aquaculture practices is considered to be in line with the objectives, criteria and principles of organic aquaculture production, provided that management measures approved by the relevant authority in charge of the management of the fish stocks in question are in place to ensure the sustainable exploitation of the species concerned, that restocking is in line with those measures, and that the fish are fed exclusively with feed naturally available in the environment.

Taking into account the EGTOP's advisory on these issues, the Commission has implemented Reg. (EU) No 1358/2014 amending Reg. (EC) No 889/2008.

In Article 25e, § 4 is replaced by the following:
"*For on-growing purposes the collection of wild aquaculture juveniles is specifically restricted to the following cases:*

"(a) natural influx of fish or crustacean larvae and juveniles when filling ponds, containment systems and enclosures;

(b) European glass eel, provided that an approved eel management plan is in place for the location and artificial reproduction of eel remains unsolved;

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(c) the collection of wild fry of species other than European eel for on-growing in traditional extensive aquaculture farming inside wetlands, such as brackish water ponds, tidal areas and costal lagoons, closed by levees and banks, provided that:

(i) the restocking is in line with management measures approved by the relevant authorities in charge of the management of the fish stocks in question to ensure the sustainable exploitation of the species concerned, and

(ii) the fish are fed exclusively with feed naturally available in the environment."

Though amendments to the regulation have been implemented the following challenges and research gaps have been identified:

- The current regulation does not distinguish between organic and non-organic hatcheries incl. phyto- and zooplankton and larval rearing systems, as well as proper separation of organic and non-organic hatcheries.
- Specific organic rules are needed to manage the life cycle stage between hatching and the weaning of juveniles for specific fresh water and marine species, including production of phyto- and zooplankton, in order to be able to distinguish between organic and non-organic hatcheries.
- Low availability of organic broodfish and juveniles; particularly for new species not yet in the seed market.
- Need for differentiation in regulations for the specific species.
- A separate breeding program for organic juveniles with genetic selection may provide robust fry that better comply with strict rules (e.g. veterinary treatments) of the organic regulation. However, the current low critical mass of organic production does not allow for a profitable or sustainable breeding program.

In particular for organic carp production the main challenges related to production systems can be summarized:

- Sourcing of organic juveniles.
- Lack of stock fish of organic origin.
- No distinct differentiation from non-organic carp.
- Need to harmonize standards (consistency).
- Predation of wild (protected) animals.

3.2 Land based farming, cage culture and systems using recirculation technology

Landbased aquaculture includes:

- Traditional flow-through pond farms/tanks
- Freshwater farming using recirculation technologies
- Land-based saltwater farms using recirculation technologies

In traditional flow-through pond farms the water is taken in from natural water bodies (rivers, wells), then passes through the farm by gravity (i.e., without use of or only minor use of pump energy). Originally the ponds were dug directly into the soil of river valleys close to the water source, but some traditional farms have replaced earthen ponds with tanks built of concrete or another waterproof material.

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However, many traditional farms have become more technological; i.e. they use varying degrees of water cleaning treatment, re-use of water to provide free flow and fauna passage up/down stream, aeration, and oxygenation to meet the requirements of limitations of water use and waste discharge. Thus, the water intake can be reduced by a factor 20 - 100 compared to the water consumption in traditional flow-through fish farms. This involves various degrees of recirculation and advanced application of waste water treatment devices.

Production in Recirculation Aquaculture Systems (RAS) is associated with minimal environmental impact; i.e. low water usage, prevention of escapes and ingress of pathogens, biosecurity, recycling of water and collection of waste (P is globally limited) - possibly valorized - and similar energy use in most situations versus flow through systems. However, in organic aquaculture intensive RAS systems are prohibited, with the exception of hatcheries and nurseries or for the production of species used for organic feed organisms, cf. Reg. 889/2008 art. 25g.

Most of traditional organic farms are open-air flow through systems. However, due to the limitations of water resources re-use of water might be a solution in line with the principles of organic production. No upper limits of the degree of recirculation are given in the regulation, but up to about 70 % recirculation for on-growing is approved by Danish authorities.

Closed recirculation aquaculture systems (RAS) have several environmental advantages. However, due to the implications of intensiveness and due to the principle that organic production should be as close as possible to nature, RAS systems for on-growing aquaculture production have, so far, not been assessed to be in line with the principles of organic production.

Land based saltwater farms using recirculation technologies are being developed as a supplement to cage farming (conventional production).

Cage culture - The production of fish in cages is increasing globally, with the technology well developed in Europe, parts of South America and China. Thus, the largest proportion of European aquaculture production takes place in cages as this is the prevailing production system in the salmonid production, including minor organic production of trout and salmon. The main benefits of cage culture are relatively low investment costs, low energy costs, utilising environmental resources and efficient use of space, and a low carbon footprint compared to other production systems. However, environmental impact on the surroundings the difficulty to control diseases (e.g. parasites) and the interactions in relation to the sea bottom below the cages have to be taken into consideration, to prevent a long term negative environmental impact.

Integrated Multitrophic Aquaculture (IMTA), which is a synergistic cultivation of various species occupying different trophic levels, or Aquaponics which combine traditional aquaculture with hydroponics, where plants are cultivated in water, are both considered as sustainable systems. Effluents from the fish rearing are used as nutrients for other species or plants in the hydroponics creating a symbiotic natural environment with maximum use of all raw materials and waste. The water from the plants is then recycled back to the fish, making the IMTA a potential productive food systems in terms of water, energy and nutrient efficiency.

Though amendments to the regulation have been implemented the following challenges and research gaps have been identified:

- Rules for use of recirculation technologies in organic farming, e.g. size of fish to be kept in intensive recirculation hatcheries.
- The use of energy (carbon foot print) in the various production systems.
- Need of knowledge on fish welfare in RAS farming.
- Knowledge is needed about IMTA and the potential use of the technologies in organic aquaculture.
- Proper separation of organic and non-organic aquaculture productions.
- What is the renewal rate (reuse of water) that would be considered acceptable for the organic principles? And what features should it have?

3.3 Mussel and oyster culture

In Europe, the main shellfish species produced are the Pacific oyster (*Crassostrea gigas)*, the blue mussel (*Mytilus edulis)* and the Mediterranean mussel (*Mytilus galloprovincialis)*. Shellfish farming requires proper shelter, water quality and availability of feed in the water. In addition, the nearby presence of spats and suitable substrate are important. These conditions are usually found in coastal waters.

Cultured shellfish and their associated rearing structures (ropes, tables, longlines) may have positive as well as negative environmental impacts. For sustainable production the stocking density should be related to the carrying capacity of the production area, i.e. considering the environmental conditions of the site, the cultivated species and the farming practices of the area. There is hardly any scientific research into organic culture of mussels and oysters. The main research topics on conventional production focus on carrying capacity of the environment and sites, husbandry and farm management. Finally, polyculture, i.e. the integration of mussel and oyster culture, algae production and cage farming of marine salmon and trout, sea bass and sea bream, combining fish production with production of algae and shellfish removing the pollutants from the fish production.

Challenges and research gaps:

- The most crucial challenge for the bivalve producers is the requirement of 100 % organic bivalve shellfish hatcheries by 31th December 2015. Organic oyster hatcheries are still not really developed, and for mussel as well, since mussel seeds are collected from natural areas.
- Prevention of introduction of invasive species and shellfish diseases.
- Assessment of the stocking density needs to be related to the carrying capacity of the specific production area.

3.4 Seaweed culture

Seaweeds are marine macroalgae of ecological importance for oxygen production and as primary function in the food chain. The largest and fastest growing species is *Macrocystis pyrifera* (giant kelp). Seaweeds are cultured for different purposes, mainly as bio-filter for the effluent water in (intensive) aquaculture systems and IMTA, as feed for other aquaculture products (e.g. sea urchins, shrimp, abalone, fish), as bio-fuel or as human food product or cosmetics. Further seaweeds can contribute to limit coastal eutrophication. Ulva (Chlorophyta) is cultivated for human consumption and can grow unattached in estuaries in high nitrogen waters, and secure a large biomass production and thus more nutrient removal.

- So far only limited attention has been paid to organic production of seaweeds. In general, seaweed production is seen as environmental friendly and sustainable.

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4.0 Welfare, Health, Veterinary Treatments and Biosecurity

4.1 Fish welfare

Fish welfare is species specific and is related to a range of parameters, e.g. stocking density, nutrious feed, substrates, light regimes, including conditions during transportation. In that context, attention should be paid to the fact, that the EU covers an extensive geographic area, which might impose climatic related challenges to organic production systems, including rural areas, to fulfil the organic rules.

Challenges and research gaps:

- Need of measures/reference values for species specific optimal environmental conditions (including water quality parameters) and for relevant indicators of welfare.
- Different from species to species (farming practices).
- Organic is a new production segment with further need to prevent disease – economy is important.
- Knowledge is needed on the potential benefits of providing fish with access to nature-like substrates or shelter (species specific).
- More knowledge is needed on the significance of light regimes requirements on the welfare and performance in organic aquaculture (different climate zones).

4.2 Water quality

Challenges and research gaps:

- Proper water quality is pivotal to all kind of aquaculture production and as well for fish and welfare.
- The optimum range of different water quality parameters is species-specific, and closely related to other production parameters, e.g. stocking density etc.
- Fish and shellfish are poikilothermic animals, i.e. close relation between temperature and their metabolism and hence rapid temperature shifts may impact welfare.

4.3 Light and photoperiod

Challenges and research gaps:

- Light represents an important environmental factor, which impact fish behaviour and physiology, i.e. sudden changes in light intensity and of the dark/light cycle can induce behavioural stress responses.
- There is evidence of photoperiod influence on changes in the immune system in sea bass, as well as in sea bream, while the welfare consequences of artificial photoperiod treatments in salmonids are not yet fully known.
- Photoperiod is actually considered as one of the most important environmental parameters triggering puberty and reproduction in fish.

4.4 Stocking density

It is a challenge to identify appropriate density limits that promote optimal welfare in fish. Firstly, this is due to a lack of understanding of how the different environmental factors interact with each other and with stocking density to affect welfare, and secondly that the effect of density measures on welfare may vary greatly between studies, due to the study-specific nature of experiments. However, high stocking density potentially increases the risk of prevalence of diseases, but incidence of disease may as well be related to water quality,

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environmental and management conditions. Even low density may compromise fish welfare. Hence, stocking density can only be considered as an appropriate fish welfare indicator in a holistic approach and linked to environmental conditions, water quality etc.

The figures in Annex XIIIa of Regulation (EC) No. 889/2008 are threshold values which, on average, represent safer fish welfare conditions and are based on practical experience. However, in the case of arctic charr there is no scientific evidence for setting the limit of the stocking density at a lower level than for rainbow trout.

Similarly, the limit densities for crayfish have adapted to the developmental stage and the rearing system used. These issues have been addressed by Comm. Implementing Reg. (EU) No. 1358/2014 amending Reg. (EC) No 889/2008, Annex XIIIa:

“(a) in the row on ‘Maximum stocking density’ in the table in Section 1, ‘Arctic charr 20 kg/m^3’, is replaced by ‘Arctic charr 25 kg/m^3’.

(b) the following section is inserted after Section 7: ‘Section 7a: Organic production of crayfish: *Astacus astacus*, *Pacifastacus leniusculus*. Maximum stocking density: For small-sized crayfish (< 20 mm): 100 individuals per m^2. For crayfish of intermediate size (20-50 mm): 30 individuals per m^2. For adult crayfish (> 50 mm): 10 individuals per m^2, provided that adequate hiding places are available.’

Challenges and research gaps:

- Adequate stocking densities of fish sp. should be considered in combination with other parameters of water quality, environmental conditions and husbandry practices. Available data on optimal stocking densities seem to be conflicting.
- Broad ranges of recommendations reflect lack of understanding of how the different environmental factors interact with each other and with stocking density to affect welfare. However, the study-specific nature of experiments, e.g. study design, water quality and use of oxygen, which is not in line with current organic rules for on-growing.
- More studies are needed about the co-variation between fish density on one hand and water quality and a multitude of operational behavioural, physiological and morphological welfare indicators on the other.

4.5 Transport, handling and behavioural interactions

Based on interpretation of Reg (EC) No 710/2009 guidelines for transport of live fish have been prepared to secure good water quality and fulfilling the physiological needs of the fish:

Challenges and research gaps:

- The oxygen content of the tank water shall be in the range of 65 – 120 % saturation.
- The temperature of the water in the transport basins should be the same as the water temperature in the tanks where the fish were reared.
- The fish shall be starved for a number of days prior to transport dependant on water temperature and fish size, i.e. the stomach shall be empty.
- Maximum stocking densities reported are in range from 10 kg/m^3 (fry) to 150 kg/m^3 given fish welfare in terms of optimum water quality parameters is fulfilled.
- Duration of time placed in transportation tanks without water exchange must not exceed six hours. Water exchange shall exclusively be taken directly from an approved bore hole or spring.

- Total retention time in transportation tanks must not exceed 12 hours.
- Total retention time in transportation tanks and concomitant storage in tanks at the slaughter should not exceed 24 hours.
- In case of transportation by boat, exchange water shall be pumped from a distance of at least 500 m from possible point sources to pollution.
- Excessive changes in water temperature and pH (CO_2 should be removed) during transportation must be avoided.
- The effects of isoeugenol on large scale transport of smolts need further investigation.

4.6 Slaughter

Challenges and research gaps:

- Throughout storage, including waiting cages, prior to slaughter water quality should be monitored and continuously adjusted accordingly.
- When properly done by trained and skilled staff, the most humane stunning methods are currently percussive and electric stunning followed by killing with gill cut.
- Alternatives to waiting cages should be investigated.

4.7 Veterinary treatment

The development of non-antibiotic and environmentally friendly agents is one of the key factors for health management in aquaculture. Hence, the use of probiotics, i.e. a bacterial supplement of a single or mixed culture of selected non-pathogenic bacterial strains, is a viable alternative for the inhibition of pathogens and disease control in aquaculture species.

Regarding cleaning and disinfection only limestone and dolomite was originally allowed to use in presence of aquatic animals. However, as this limitation showed to be a crucial challenge for sustainable performance of organic aquaculture, the Commission followed advice from EGTOP to extend the list with named substances that was assessed to be in line with objectives, criteria and principles of organic farming. Hence, the issue was addressed by Implementing Reg. (EU) No 1358/2014 amending Annex VII to Reg. (EC) No. 889/2008 accordingly. Among substances added to the list to be used also in presence of aquatic animals were e.g.: Hydrogen peroxide, sodium percarbonate, peroxyacetic acids, peracetic acid, and peroctanoic acid.

Challenges and research gaps:

- There seems to be a conflict between the current and future regulation of VMPs (all kind of Veterinary Medicine Products) and the organic regulation. The substances of preference in EU Reg. 710/2009 art. 25t a/b/c should be considered as feed raw materials or additives, though no guidelines on how to be administered. Further, due to a limited market there is a need for more adequate procedure of authorization of relevant substances for aquatic animals according to the new regulation of VMPs.
- Anaesthetic treatment should be considered not be included in the number of restricted allopathic treatments.
- Development of efficient vaccines is needed.
- Reconsideration is needed on the setting of with-drawal period after medication according to the VMP regulation.
- Herbal medicine should be further investigated as it may play a significant role as immunostimulant and as treatment tool in future organic aquaculture.

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4.8 Biosecurity

Good hygiene practices and farm management prevent the onset of diseases. However, currently no European guidelines on biosecurity in animal husbandry are available, though at national level for certain species.

Challenges and research gaps:

- Appropriate to address biosecurity/consumer protection measures at Community level.

5.0 Environmental impacts

Environmental impact from aquaculture has been an area that has been addressed for decades. This in terms of research and development in water recirculation technologies to meet the requirements of limitations of water use, waste discharge – and in the long term disconnecting the production from the environment. Off-shore activities are closely related to environmental impact on the sea bottom and the water body.

5.1 Recycling of waste

In line with the overall organic principles, actions should be taken to recycle waste of the production although there is a gap of knowledge for recycling of nutrients from aquaculture.

- Need of more knowledge and technology for recycling of nutrients from aquaculture.
- Need of more investigations of solutions for collection, de-watering and re-use of waste from aquaculture production, including cage farming.

5.2 Energy use – Life Cycle Analysis

Though the organic principles encourage the use of renewable energy, the regulations give no rules for release of CO_2 (carbon footprint) and global warming potential (GWP), which is closely related to the use of fossil energy. Currently, most of the energy used for production is fossil energy for growing, harvesting and processing of feed ingredients. Biodiesel may be an alternative in the long term.

Challenges and research gaps:

- Lack of identified criteria and reference points to characterise an environmental friendly food production in relation to climate aspects.
- Need of more research on Life Cycle Analysis (LCA) methods to evaluate properly environmental impact and carbon footprint.

5.3 Escapes from cage culture

Challenges and research gaps:

- Attention should be given to prevent escapes from aquaculture to better protect wild fish stocks from impact from farmed species.
- Efforts are needed on species-specific escapes of fish, preventing tearing/biting of net and escapes of viable gametes.
- Knowledge is needed about curtain-like egg collectors to mitigate egg escapee in cages with potential spawners (Atlantic cod and gilthead seabream).
- Research is needed to improve existing recapture methods and practices.

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6.0 Consumer perception

The consumers' perception of what is organic seafood is vague and not in line with the priorities in the EC regulation due to general lack of knowledge of aquaculture production systems. However, cultural effects should also be taken into account when considering the organic logo as national labels carry an image of local control, which may be important for developing the European organic aquaculture sector.

Challenges and research gaps:

- The recognition of the EU leaf logo is low and the large number of organic and sustainability labels (Fair-trade, ASC, MSC etc) in the market cause confusion among the consumers, incl. linguistic confusion among languages in EU.
- One crucial difference is that EU organic certification has the lowest standards, in order to ensure that all nationally certified products can be included. This in itself introduced a system with requirements that are further from the organic principles than other certification schemes.
- Consumers who have a positive perception about aquaculture are also positive about organic aquaculture, while if they are negative, they remain negative.
- Consumers who have positive perception about organic production are also willing to pay more for organic products. This link is however stronger when consumers have high education, high income, high knowledge about organic and if they have young children.
- Fish welfare seems not to be a main concern among most consumers, though a group of consumers pays attention to the issue mainly in terms of how the fish are treated by humans.
- Additional issues that positively influence the acceptance and consumption of organic fish are the health benefits of such fish, the naturalness of the production, that the production is local or at least domestic and the food safety associated with such a production method.
- There is a need of distinct transparent, proactive, tangible and tailor made communication and marketing strategies to provide the stakeholders with reliable knowledge on key issues of organic aquaculture, including protection of wild stocks as well as considering local economies, environmental, health and welfare issues.
- Appropriate communication strategies may expose awareness about the EU organic logo and its powerful political image; i.e. being of EU origin and unifying scattered certification schemes. Further improvement of purchase of organic aquaculture products may be achieved through structured cooperation and dissemination of knowledge throughout the whole chain.
- In particular for carp, there is a need for reposition carp in the market and produce more fillets rather than just whole fish.

7.0 Farm economics

The farm economics modeling is based on data from conventional aquaculture (mostly from the Scientific, Technical and Economic Committee for Fisheries (STECF) database), simulated transition from conventional to organic aquaculture, extensive data for organic aquaculture and sector specific expert knowledge and experience. This means that given outcomes are calculated best estimates indicating relative differences between conventional and organic aquaculture based on available information. On the same basis, cost and benefit analyses were performed for the farm and chain and how these affect the competitiveness of European organic aquaculture.

Challenges and research gaps:

- It seems obvious that the production costs per kg fish in organic production systems are substantially higher compared to conventional production, mainly due to the lower production volume, higher price of feed and juveniles, lower stocking density and relatively more labour cost.
- The calculations showed higher production costs for organic salmon of 25-40 %, for trout of 15-20 %, for sea bass and sea bream of 30-40 % and for carp 30-80 % compared to conventional.
- The price of feed was estimated 12 % (Salmon), 30 % (Trout), 50 % (sea bass/bream) and 100 % (carp) higher for organic than for conventional.
- Generally, the feed costs were responsible for the largest contribution to the higher cost price of organic production (~ 50 %), followed by the costs for juveniles (~ 25 %) and other costs.
- However, the nutritional value of the feed may be lower due to strict rules of sourcing nutrients and limited choice of ingredients, which cause it difficult to produce competitive high protein organic feed. This causes reduced feed utilization and growth, longer production time and increased environmental impact.
- The estimated consumer prices for organic fish was approximately about 50 % higher compared to conventional farmed fish products, due to higher purchase price, insufficient match of demand and supply, small selling volume and slow turnover rates in the supermarkets.
- There is an urgent need of statistics within organic aquaculture production.

An analysis of the competitiveness of European Organic Aquaculture indicated:

- Entry of new large-scale organic aquaculture business in the market in near future is not likely.
- Increased market pressure for certification, important for organic to keep high reputation.
- High threat of substitution as seafood from traditional fisheries competes with products from organic aquaculture due to confusion about the organic label ctr. ASC and MSC.
- Organic aquaculture producers have low power in marketing themselves for retailers; hence, joint arrangements to attract consumers might create a pull effect.
- Highly competitive rivalry from organic aquaculture products imported to the EU. There is much more competition at a global level due to lower production costs compared to higher costs of organic production in EU due to the current EU regulation for organic aquaculture. Further, due to mismatches of supply and demand European organic products may be sold on the conventional market, which further reduces the competitiveness of the organic aquaculture sector.

8.0 Institutional framework

Critical development constraints and potential improvements of the institutional system have been explored to provide input to regulatory bodies for an increased organic aquaculture production. However, little scientific literature was available on the issues. Hence, the work was based on governmental and non-governmental documents and reports, grey literature, information from partners and platform participants in the OrAqua project, though information on experience of implementation, statistics on European organic aquaculture production, national control tasks and sanctions were generally lacking.

Challenges and research gaps:

- An important challenge of the institutional framework seems to be a too complex and fragmented management and control regime.
- The uncertainty and unclarity of the production rules, control provisions and exception deadlines create a lack of trust and investments; i.e. impeding the transition to organic production.
- Lack of clarity in the regulation has resulted in differences in interpretation and practice and hence variations in national implementation.
- There is more than one set of objectives and these are not always possible to attain at the same time, i.e. the balancing between minimal environmental impact, animal welfare and health, and product quality/"pure product".
- The European Maritime and Fisheries Fund (EMFF) is supposed to stimulate organic aquaculture production in the European Union 2015 – 2020. However, since a new regulation on organic aquaculture is expected to come into force in 2017, farmers will have to apply for support without knowing the future rules of organic production.
- Support policies are needed to develop the organic aquaculture industry.
- Some regulations and standards seem to be devised without reference to practical and economic realities, necessitating amendments extending deadlines. This means low predictability and uncertainty, making the regulations a "moving target"; and creates constraints for the future development and expansion of the industry.
- Organic aquaculture production may be challenged by stricter regulation of conventional production, which may wipe out some of the differences between organic and conventional production.
- Lack of decision whether the production rules and control provision shall be focused towards the "organic production system" or towards the "organic product".
- The regulation is easier to comply with for big, industrial producers compared to small-scale producers, because of cost of certification, control provisions, bureaucracy etc.
- Lack of statistics and information on national implementation makes it difficult to identify bottlenecks related to the rules, procedures and control measures, hence hard to make corrective action to improve the management and control system

9.0 Ethics

One of the main issues for consumers is related to their perception of organic production systems as closer to nature than conventional systems. This idea is well connected to a fundamental concept in IFOAM basic principles, naturalness, and calls for enabling fish in organic aquaculture to have a more natural life than fish in conventional farming.

The ethical analysis and evaluation revealed a range of potential conflicting interests, challenges and research gaps related to the current framework for organic aquaculture:

- The classical dilemma in organic standard setting is faced by increasing differences to conventional by stricter standards, taking the risk of losing farmers/producers, or keep differences at a lower level, not necessarily minimum, but closer to conventional, in order to keep, or increase, the number of certified producers.
  The critical point is to identify the break even with regard to the levels of the three parameters: 1) Standards, 2) Engaged producers and 3) Consumer trust, which includes:

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► How to gain consumer trust in organic aquaculture if the differences to conventional systems are low?

► How to ensure an increase in organic aquaculture if large differences to conventional production leads to few producers are being interested?

► On the other hand, how to keep or create an interest among those organic producers who strive for a substantial difference and contribution?

Additional challenges and research gaps:

- Fish welfare and specific measurable welfare indicators need attention, taking fish as sentient beings.
- Stocking density includes several interconnected rearing parameters (water quality), which addresses welfare as well as other ethical issues.
- Impact of stocking density on fish welfare is difficult to measure, and opens for a range of ethical considerations.
- The definition of 'unnecessary suffering', as related to rearing systems, consumer perceptions and regulations, needs further clarification.
- Stunning followed by slaughter can be performed without causing (much) stress and pain. The issue needs to be further addressed.
- Additional ethical issues to consider related to organic principles are e.g. use of global resources and utilization of marine food resources, fair labor conditions, economic viability in small and large scale production systems, local production versus global trade and transport, and the general ecological issue of using carnivorous species for food production.

10.0 Co-authors of the reviews of WP 2 and WP 3

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