Deliverable D6.2

TECHNICAL BACKGROUND BEHIND THE RECOMMENDATIONS

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SUMMARY

EXECUTIVE DOSSIER N°1. WELFARE, DISEASE PREVENTION AND VETERINARY TREATMENT

1.1. Stocking density and water quality

There is a wide literature on the physiological and behavioural responses of fish to a wide variety of physical, chemical and biological stressors, including the typical ones common in aquaculture. In contrast, information on shellfish is highly limited (Sneddon *et al*., 2014).

Water quality is a crucial factor that could affect fish health and survival. Lack of oxygen (hypoxia) may be the major challenge in organic production, since the addition of oxygen is restricted through the regulations. The waste derived from fish feed and its metabolic end products, such as uneaten feed, faeces and excreted, dissolved inorganic nutrients could seriously impair water quality.

Attention has been drawn to oxygen and ammonia as the water quality parameters generating the observed density effects (Ellis *et al*., 2002). For example, increasing densities can reduce dissolved oxygen (DO) levels and increase un-ionised ammonia (UIA) concentrations in the water, depending on the pH (Ellis *et al*., 2002). As a result, low DO and high UIA levels, the latter being toxic to fish, can act as chronic stressors to rainbow trout, elevating plasma cortisol levels (Pickering *et al*., 1991).

The demand of oxygen increases with increasing temperature. Dissolved oxygen is the first water quality variable that may limit production both in open and closed systems. Available oxygen is dependent on temperature and CO_2, but the usual recommendation for cold-water species is that they will have adequate oxygen as long as the dissolved oxygen does not fall below 80% (Wedemeyer, 1996). The threshold oxygen concentration for growth in rainbow trout has been shown to be about 75 % saturation (Pedersen, 1987). For Atlantic salmon the optimal saturation of oxygen is 80 - 100%, but they can cope with 60% for shorter periods.

Dissolved oxygen concentration is surely among the most important environmental variable also for sea bream and sea bass. Although sea bream is more sensitive to hypoxia than sea bass. Oxygen concentration of 5 mg/l is the minimum required by sea bream during grow-out (Okte, 2002). Oxygen concentration in water is a pivotal factor that contributes to modulate fish sensibility to other water quality parameters. It was demonstrated, for example, that juveniles of sea bream exhibit increased sensitivity to ammonia in case of oxygen saturation drops below 85% of saturation, while increased mortality occurs when the saturation is below 40% (Wajsbrot *et al*., 1991).

Dissolved oxygen is often low in polluted waters and many of the physiological responses of fish to chemical pollutants, at acute concentrations, are similar to those produced in response to environmental hypoxia (Heath, 1995). Hypoxia is not limited to freshwater habitats. Indeed, oxygen levels in the oceans vary with the depth, temperature, salinity and productivity (Bushnell *et al*., 1990).

The concentration of oxygen available to fish varies across different production systems. In cages, dissolved oxygen can be a limiting factor at high summer temperatures. Such problems do not normally arise in flow-through or recirculating systems except in the event of mechanical breakdown. At 40% oxygen saturation, feed intake and growth are impaired in sea bream.

In intensive fish culture systems, a reduced availability of dissolved oxygen in water is often observed. This is ascribed to a high fish density and to the feeding practices; algal blooms and elevated temperatures can contribute as well. This lack of oxygen can induce responses and the typical metabolic adjustments caused by the hypoxic stress are activated to maintain oxygen supplies in the critical organs and to reduce consumption of oxygen. Some adaptive mechanisms can change fish gene expression with the aim of saving oxygen.

Rearing density is normally defined as the weight of fish per unit volume of water and typically refers to the concentration at which fish are initially stocked in a system. Furthermore, crowding is often loosely referred to high rearing density (Ashley, 2007; Huntingford *et al*., 2006).

Rearing density in aquaculture has raised concern with respect to welfare, due to public concern about the welfare of farmed fish. Indeed, rearing density encompasses a complex web of interacting factors, such as water quality, social interactions, fish to fish interaction and fish to housing interaction that can have an effect on many aspects of welfare (Ashley, 2007; Turnbull *et al*., 2008). Huntingford and Kadri (2008) suggested that a combination of welfare indices e.g. behavioural and water quality monitoring would be a better way to ensure fish welfare in aquaculture than monitoring one index. Other factors to pay attention, when considering the effects of stocking density upon welfare, is the high variability between studies on the same species due to e.g. differences in experimental design and also the choice of welfare indicator (Ellis *et al*., 2002; Canon Jones *et al*., 2011), which can confound the suitability of the recommendations to be made. Therefore, it is very difficult to make generalisations about how rearing density affects welfare for all situations (Turnbull *et al*., 2008; Ellis *et al*., 2002; Conte, 2004). However for many teleost high rearing densities induce the increase of the energetic expenditure for basal life functions, that in turn could become detrimental for growth, immune-resistance, and could also affect the social interaction between fish (Huntingford, 2004; Martins *et al*., 2012).

From a physiological point of view, high density condition increases red muscle activity leading to a rise of the global scope for activity (Lembo et al., 2007). In sea bass reared at 50 kg m^{-3}, fish muscle activity, measured as EMG activity with telemetric technologies, was on average twofold higher than in fish at 10 kg m^{-3} (Carbonara *et al*., 2013). Haematological parameters are indicators of fish oxygen demand to maintain the basal metabolism. Haemoconcentration, indeed, is reported as a strategy for increasing oxygen carrying capacity of blood during periods of high energy demand (Houston, 1990), such as a stress event or an important swimming activity. Haematocrit, haemoglobin and red blood cells count have generally the higher levels at the higher densities (Carbonara *et al*., 2013). Santos *et al*. (2010) showed that increased density levels reduced feed intake and growth and that feed intake reduction was partially compensated by a decrease in maintenance requirements for energy at the highest density. Another result is shown by Roncarati *et al*. (2006), regarding intensively reared sea bass. Plasma triglycerids, total cholesterol and transaminases were found to be always significantly higher than in semi-intensively maintained fish.

Farmed fish experience non-natural high densities within the cages, which has also been related with increase of plasma cortisol and differences of fish growth and welfare. Increasing stocking density, resulted also into an exponential increase of the escape rate from cages. Variations on fish interactions towards the net pen were found and were associated with both rearing density and the condition of the net. Particularly, sea bream increased net inspection and biting in relation with the rearing density. The overall picture arising from the studies performed to date investigating the effects of stocking density on different parameters suggests that both low and high densities are potentially detrimental to welfare. Interestingly, what is considered low density and what is considered high density appears to be quite ambiguous, as these 'definitions' vary between studies. Furthermore, the results of these studies clearly illustrate the complex nature of the interaction between stocking density and fish welfare, with several environmental factors interacting together and with density to influence indicators of welfare and performance. It is worth to highlight that most of the experiments on the stocking density reported in the cited literature are supported by the use of oxygen to adapt the water quality to the increased stocking density, which would be not in line with several principles/rules of the organic regulation (e.g. "… organic production should be as close as possible to nature …" Reg. EC 710/09, recital 11).

As a consequence, it is also a complex undertaking to model these multiple interacting and confounding influences of stocking density on measures of welfare (Turnbull *et al*., 2008), in an effort to gain an overall understanding.

1.2. Handling, transport and slaughtering

The transportation of live fish involves the transfer of large numbers (or biomass) of fish in a small volume of water. Some important environmental parameters could severely change during long transportations such as water temperature, oxygenation, CO_2 concentration (Delince *et al*., 1987). Handling and confined spaces could generate hyperactivity conditions that could result in lactate accumulation and affect blood oxygenation capacity.

Based on the Reg. EC 710/2009, the Danish authorities on inspection of organic aquaculture facilities has prepared a guideline for transport of live fish summarized below.

Live fish shall be transported fulfilling the physiological needs of the fish with respect to oxygen (i.e. 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 certain period (4 – 10°C days) dependant on water temperature and fish size before transport (i.e. the stomach shall be empty). This to minimize metabolism and production of metabolites (NH_4^+) and particulate matter, that deteriorate water quality, deposits in the gills and further stress the fish. The maximum stocking density allowed is 150 kg/m^3 and duration of time placed in transportation tanks without water exchange must not exceed 6 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 h. 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.

Freedom Foods Welfare Standard for farmed salmon transport state: i) the maximum chilling rate should be 1.5°C per hour, ii) the maximum permitted drop in temperature should be no more than 50% of ambient temperatures at the start of chilling within 24h, and iii) minimum temperatures at the end of chilling should be no less than 4°C.

Debio Organic Aquaculture Standard for farmed salmon transport and Freedom Foods Welfare Standard state “As a minimum the oxygen content in the water shall be at least 7 mg oxygen per litre.”

Freedom Foods Welfare Standard for farmed salmon road transport suggest maximum stocking densities of 60-100 kg/m^3, whilst for salmon transported by well boat suggest maximum stocking densities of 40-50 kg m^3.

Debio Organic Aquaculture Standards suggest: live fish can be transported for a maximum of 6 hours by truck, without water exchange. Max density with transportation of fry is set at 10 kg/m^3. There can be at most 30 kg/m^3 in closed well boat transportation. Well boat with constant water exchange can at most have a fish density of 50 kg/m^3.

Besides the above recommendations obtained by some private and public standards, other possible suggestions could be derived by the pertinent scientific literature cited, such as:

- Monitor CO_2 levels in the water during closed transport (Tang *et al*., 2009b);
- Monitor the behaviour of the fish during transport using camera’s (Nomura *et al*., 2009; Martins et al., 2012);
- Using isoeugenol or eugenol for sedation during transport;
- Using physical enrichment materials and providing fish with access to nature-like substrates, e.g. by providing substrate or shelters to increase habitat complexity, might improve welfare by reducing aggression.

An optimal slaughter method should render fish unconscious until death, without avoidable excitement, pain or suffering prior to killing. Welfare evaluation at time of slaughter is difficult to measure because it requires a multidisciplinary approach examining various indicators such as brain functions, endocrine responses, behaviour and post-mortem tissue biochemical condition (Poli *et al*., 2005).

Unconsciousness is defined as and is measured by:

- The most secure method to determine unconsciousness is to observe brain activity using electroencephalogram (EEG) measurements (Kestin *et al*. 2002).
- A practical field approach is to pick the fish up and assess it for the presence of eye roll, then place it in water and observe it for rhythmic motion of the lower jaw or opercula. Any signs of coordinated motion, swimming or struggling to recover posture. The presence of the first two of these indicators should be considered as signs that the fish is recovering sensibility. The presence of the latter indicates a fish that has already recovered consciousness (Kestin *et al*. 2002).
- Occasional spasmodic convulsions or gasps can be observed in effectively stunned fish and should not be a cause for concern. Since electricity stimulates the muscles directly, all observations need to be made once the electricity has been removed. (Lines and Spence 2012)

When properly done the most humane stunning methods is percussive and electric stunning. The methods should be followed by killing with gill cut.

Prior to slaughter it would be advisable to avoid waiting cages, both because of crowding and bad water quality. However, realistic alternatives to waiting cages should be further investigated.

In case waiting cages are in use, monitoring water quality both with and without crowding should be done. Adding of oxygen when needed.

Pumping should be done with care. Make sure to use the correct pump dimensions for the actual fish size and amount. Make sure that the equipment is regularly checked by service

Realistic alternative methods to the ice slurry for stunning and killing marine fish needs to be further investigated. The use of electric stunning is considered as humane, but today the method is complicated and not user friendly and not easy for commercial application.

1.3. Biosecurity

Biosecurity in aquaculture consists of practices that minimize the risk of introducing an infectious disease and spreading it to the animals at a facility and the risk that diseased animals or infectious agents will leave a facility and spread to other sites and to other susceptible species. These practices also reduce stress to the animals, thus making them less susceptible to disease. Good biosecurity measures will reduce the risk of catastrophic losses from infectious disease and low-level losses that, over time, can also greatly affect the bottom line. A comprehensive biosecurity plan should include the following activities (Oidtmann et al., 2011; Galli et al., 2014; Pietrak et al., 2014; Manual of Diagnostic Tests for Aquatic Animals OIE., 2009):

- A monitoring system of water quality and fish health.
- Isolating sick fish and removing dead and moribund fish.
- Knowledge which diagnostics to use and which treatments are legal and available.
- Education of personnel and visitors so that they understand and follow biosecurity protocols.
- Keeping good records. Compliance with, and documentation of, biosecurity protocols.
- Always consult product labels for appropriate concentrations, use, shelf life, and safety precautions.
- Consult with the state environmental control agency or the hazardous waste representative at the nearest EPA regional office for guidance on the proper disposal of each product.

Effective biosecurity plans must be tailored to a specific farm site, be adaptable, address local disease threats, and avoid environmental insult. The biosecurity policies and practices of an aquaculture company are controlled directly by the farmer. The goals of these policies and practices match those of the various levels of government regulated biosecurity, i.e., to reduce the probability that a pathogen will infect one or more animals under the farmer's care or negatively impact the surrounding farms or environment.

A good biosecurity plan, consistently implemented, functions as a type of insurance policy against disease. The routine use of biosecurity measures (secure water supply, healthy fish or shellfish stock, good hygiene practices for all entering and exiting the farm) can reduce the risk of introduction and economic impact of these diseases on the farm (Pietrak *et al*. 2014).

The washing and disinfection procedures should at least include the following stages:

- Removal of solid waste, etc., followed by prewashing;
- Deep cleaning and washing;
- Disinfection;
- Rinsing.

The process should be monitored throughout by a technically competent person and records need to be kept (Manual of Diagnostic Tests for Aquatic Animals OIE. 2009).

For the culture of Salmonidae, Coregonidae, Gadidae, sea bream, sea bass and croakers/drum for controlling sea lice in marine net cages, stocking with wrasse as "cleaner fishes" is recommended; for the protection of net cages against growth of algae and colonization by invertebrates, environment-friendly methods shall be employed.

Health status of animals shall be monitored and documented on a regular basis. Special efforts shall be made to detect correlation between management measures, manifestation of viral diseases, reason for mortalities, individual growth and yields/biomass development.

1.4. Veterinary treatments

The use of antibiotics in aquaculture has led to the development of antibiotic-resistant bacteria and the accumulation of antibiotics in the environment, resulting in water and soil pollution. Thus, vaccination is the most effective and environmentally-friendly approach to combat diseases in aquaculture to manage fish health.

Recently, increasing attention is being paid to the use of plant products for disease control in aquaculture as an alternative to chemical treatments. Plant products have been reported to stimulate appetite and promote weight gain, stress resistance boosters, to act as immunostimulant and to have antibacterial and anti-parasitic (virus, protozoans, monogeneans) properties in fish and shellfish aquaculture due to active molecules, such as alkaloids, terpenoids, saponins, flavonoids, phenolics, polysaccharides and proteoglycans. The use of medicinal plants in aquaculture has attracted a lot of attention globally and has become a subject of active scientific investigations (Bulfon *et al*., 2014).

In recent years experimental evidence and studies of probiotics and herbal medicine is increasing, and the first results seem to confirm their effectiveness in the prevention and management of diseases affecting aquatic animal breeding. The use of these substances is permitted in accordance with article 25(t) of Regulation 889/2008, but does not describe in what way they are to be administered and whether they are authorized. Therefore, it might be appropriate to make a list of such microorganisms and plants, which can be used in the composition of the feed, for example, as shown in the register of animal feed additives of the Annex to Regulation 2003/1831 (extracts and microorganisms).

Plants and plant bio-actives might be proposed in aquaculture primarily as feed additives or immuno-stimulants, rather than therapeutics, because the registration of herbal remedies to be used in this field is a time-consuming process and implies higher economic costs.

The extracts of several plants have been tested to prove their effectiveness against diseases, particularly if they are effective against bacteria, such as *Aeromonas* sp., *Vibrio* sp., other microorganisms, viruses, fungi and parasites. The main plants tested are: *Solanum trilobatum, Andrographis pani culata, Psoralea corylifolia, Astragalus membranaceus, Portulaca oleracea, Sophora flavescens, Zingiber officinale, Allium sativum, Origanum vulgare, Azadirachta indica*, marine algae, *Rhodophyceae, Achyranthes aspera, Angelica sinensis, Cynodon dactylon, Echinacea purpurea, Massa medicated, Punica granatum, Solanum nigrum, Whitania somnifera, Zataria multiflora*.

The most tested probiotics which have given the best results in the trials were microalgae (*Tetraselmis*), yeasts (*Debaryomyces, Phaffia, Saccharomyces*), Gram-positive bacteria (*Bacillus, Lactococcus, Micrococcus, Carnobacterium, Enterococcus, Pediococcus, Lactobacillus, Streptococcus, Weissella*) and Gram-negative bacteria (*Aeromonas, Alteromonas, Pseudomonas, Vibrio*).

1.5. References to international standards of organic farming

In this chapter are reported the main rules on welfare, disease prevention and veterinary treatment applicable to the organic aquaculture, as they have been defined in various international standards. For each standard/regulation it is also reported the issue date and the Country of origin.

1. Australian Certified Organic Standard - ACOS (2016)

7.7.19. Disease and pest control shall take the form of proactive management practices rather than substance use. Appropriate fallowing activities shall be documented, carried out, and recorded. In the event of critical (non-routine) prohibited input use, treated sections and stock shall be decertified. It is not possible to re-certify treated sections and stock. Treatment with prohibited substances shall not affect certification of entire operation only in instances where no transmission to other stock occurs.

7.7.20. Uneaten fish-feed, faeces and other waste shall be appropriately removed to minimise risk of environmental damage or disease, and to avoid attracting insects or rodents.

7.7.21. Aeration is permitted where required for animal welfare and health, practices are to be included in the SAMP or OMP, and recorded.

7.7.22. The use of oxygen is restricted to exceptional cases, such as sorting, stress, or where risks to animal welfare exist.

7.7.23. The use of UV light, ozone, artificial heating or cooling or water, or closed recirculation systems is only allowed in hatcheries and nurseries.

7.7.24. Artificial lighting, if used, should be appropriate to the species, and is limited to 16 hours per day. Abrupt changes to light intensity should be avoided.

7.7.25. Aquatic animals shall not be exposed to undue levels of stress during farming, harvesting, transport or slaughter, and shall not be allowed to escape into the surrounding environment. Should escape occur, appropriate action should be taken.

7.7.45. Live fish shall be transported in suitable clean tanks with clean water with suitable temperature and dissolved oxygen levels.

2. Instrução Normativa Interministerial n° 28, de 8 de Junho de 2011.

Ministro de Estado da Agricultura, Pecuária e Abastecimento e a Ministra de Estado da Pesca e Aquicultura do Brasil.

CAPÍTULO VII

DO BEM-ESTAR DOS ORGANISMOS AQUÁTICOS

Art. 21. Os sistemas orgânicos de produção aquícola devem ser planejados de forma que sejam produtivos e respeitem as necessidades e o bem-estar dos organismos aquáticos.

Art. 22. Deve-se dar preferência por organismos aquáticos de espécies adaptadas às condições climáticas e ao tipo do manejo empregado.

Art. 23. Devem ser respeitadas:

I - a liberdade nutricional: os organismos aquáticos devem estar livres, fome e desnutrição, conforme níveis de exigência de cada espécie;

II - a liberdade sanitária: os organismos aquáticos devem estar livres de feridas e enfermidades;

III - a liberdade de comportamento: os organismos aquáticos devem ter liberdade para expressar os comportamentos naturais da espécie;

IV - a liberdade psicológica: os organismos aquáticos devem estar livres de fatores estressantes; e

V - a liberdade ambiental: os organismos aquáticos devem ter liberdade de movimentos em instalações que sejam adequadas a sua espécie.

Art. 24. As instalações devem ser projetadas e todo manejo deve ser realizado de forma a não gerar estresse aos organismos aquáticos em cultivo, sendo que qualquer alteração persistente de comportamento detectada deverá ser objeto de avaliação e possível redefinição pelo OAC e OCS de procedimentos de manejo e densidades dos organismos sob cultivo.

Art. 25. As etapas de recria e engorda em sistemas intensivos não serão permitidas na produção

orgânica.
CAPÍTULO III
DA SANIDADE
Art. 39. Somente poderão ser utilizadas na prevenção e tratamento de enfermidades ou pragas as substâncias e práticas constantes dos Anexos I e VI desta Instrução Normativa Interministerial.
Parágrafo único. Os produtos veterinários ou agrícolas devem atender ao disposto nas legislações específicas.
Art. 40. É obrigatório o registro em livro específico, a ser mantido na unidade de produção, de toda terapêutica utilizada nos organismos aquáticos, constando, no mínimo, as seguintes informações:
I - data de aplicação;
II - período de tratamento; III - identificação do lote; e IV - produto utilizado.
Art. 41. Todas as vacinas e exames determinados pela legislação de sanidade aquícola serão obrigatórios.
Art. 42. No caso de doenças ou ferimentos em que o uso das substâncias permitidas no Anexo I desta Instrução Normativa Interministerial não estejam surtindo efeito e o animal esteja em sofrimento ou risco de morte, excepcionalmente, poderão ser utilizados produtos quimio-sintéticos artificiais.
§ 1o No caso de uso dos produtos mencionados no caput deste artigo, o período de carência a ser respeitado para que os lotes tratados possam voltar a ter o reconhecimento como orgânicos deverá ser: I - duas vezes o período de carência estipulado na bula do produto; e II - em qualquer caso, de, no mínimo, 96 (noventa e seis) horas.
§ 2o A utilização de produtos químio-sintéticos artificiais deverá ser sempre informada ao OAC ou OCS, no prazo estabelecido por eles, que avaliarão a pertinência de sua excepcionalidade e justificativa.
§ 3o Cada lote poderá ser tratado apenas uma vez por ciclo de produção com medicamentos não permitidos para uso na produção orgânica.
§ 4o Para reprodutores, o uso dos produtos mencionados neste artigo é de, no máximo, três tratamentos ao longo da sua vida, sendo proibida a venda desses organismos aquáticos como orgânicos ou a consumo alimentar humano ou animal.
§ 5o Se houver necessidade de aumentar a frequência dos tratamentos, estipulada no § 3o deste artigo, o lote deverá ser retirado do sistema orgânico.
§ 6o Durante o tratamento e durante o período de carência, o lote deverá ser identificado e alojado em ambiente isolado, obedecendo à densidade estabelecida por este regulamento para cada espécie animal, sendo que ele e seus produtos não poderão ser vendidos como orgânicos.
Art. 43. Todas as disposições e exigências para critérios de coleta de amostras, tratamentos emergenciais, prevenção, controle e erradicação de doenças, assim como a notificação de e doenças devem seguir as normas dos programas sanitários instituídos pelo órgão competente.
CAPÍTULO IV
DO AMBIENTE DE CULTIVO E DO BEM-ESTAR
Art. 44. Sempre que for necessária a redução do sofrimento do organismo aquático em procedimentos essenciais ao manejo será permitido o uso de sedativos ou anestésicos aprovados pela OAC e OCS.
Art. 45. Práticas de manejo devem minimizar o estresse e injúrias.
Art. 46. Os organismos aquáticos sob cultivo deverão ser mantidos em unidades de produção nas quais os parâmetros físicos, químicos e biológicos da água e solo atendam as necessidades de conforto dos mesmos.
Parágrafo único. No caso de moluscos bivalves, os parâmetros de qualidade de água devem contemplar os possíveis riscos para a saúde pública, atendendo a regulamentação específica.
Art. 47. Devem ser monitorados e controlados os parâmetros físicos, químicos e biológicos da água, tanto na entrada como na saída, seguindo as normas vigentes.
Art. 48. A taxa de renovação diária de água nas unidades de recria e engorda deve garantir o conforto fisiológico dos organismos aquáticos.

Art. 49. Os taludes dos viveiros devem estar recobertos com vegetação adequada, preferencialmente nativa para fins de controle de erosão.
Art. 50. Medidas de prevenção e remoção de predadores e competidores poderão ser adotadas nas instalações de cultivo desde que não causem injúrias aos mesmos.
Art. 51. A unidade de produção orgânica deverá ter seu perímetro delimitado.
Art. 52. As fazendas de cultivo devem adotar medidas de prevenção para evitar a contaminação por fontes externas e produtos que estejam em desacordo com esta norma.
Art. 53. O transporte, o pré-abate e o abate dos organismos aquáticos, inclusive ismos aquáticos doentes ou descartados, deverão atender ao seguinte:
I - princípios de respeito ao bem-estar dos organismos aquáticos;
II - redução de processos dolorosos;
III - procedimentos de abate humanitário; e IV - a legislação específica.
Parágrafo único. No caso de organismos aquáticos que necessitem ser sacrificados, o uso de anestésico poderá ser utilizado.
Art. 54. Nas exposições e aglomerações, nos mercados e outros locais de venda deverão ser atendidos os princípios de bem-estar de cada organismo aquático vivo, atendendo legislação específica.
Art. 55. Somente é permitida a utilização de fertilizantes, corretivos e inoculantes que sejam constituídos por substâncias autorizadas no Anexo III desta Instrução Normativa Interministerial e de acordo com a necessidade de uso prevista no Plano de Manejo Orgânico.
Parágrafo único. A utilização desses insumos deverá ser autorizada especificamente pelo OAC ou pela OCS, que devem especificar:
I - as matérias-primas e o processo de obtenção do produto; II - a quantidade aplicada; e III - a necessidade de análise laboratorial em caso de suspeita de contaminação.

4. The IFOAM NORMS for Organic Production and Processing (2014) (international)

6.6 Aquatic Animal Health and Welfare
General Principles
Organic management practices promote and maintain the health and well-being of animals through balanced organic nutrition, stress-free living conditions appropriate to the species and breed selection for resistance to diseases, parasites and infections.
Requirements:
6.6.1 Operators shall comply with relevant requirements of section 5.7.
6.6.2 Prophylactic use of veterinary drugs is prohibited.
6.6.3 Operators must use natural methods and medicines, as the first choice, when treatment is necessary. Use of chemical allopathic veterinary drugs and antibiotics is prohibited for invertebrates.
6.6.4 Synthetic hormones and growth promoters are prohibited for use to artificially stimulate growth or reproduction.
6.6.5 Stocking densities do not compromise animal welfare.
6.6.6 Operators shall routinely monitor water quality, stocking densities, health, and behavior of each cohort (school) and manage the operation to maintain water quality, health, and natural behavior.
6.7 Aquatic Animal Transport and Slaughter
General Principle
Organic aquatic animals are subjected to minimum stress during transport and slaughter.
Requirements:
6.7.1 Operators shall comply with relevant requirements of section 5.8.
6.7.2 The operator shall handle live organisms in ways that are compatible with their physiological requirements.
6.7.3 Operators shall implement defined measures to ensure that organic aquatic animals are provided with conditions during transportation and slaughter that meet animal specific needs and minimize the adverse effects of:

a. diminishing water quality;
b. time spent in transport;
c. stocking density;
d. toxic substances;
e. escape.

6.7.4 Aquatic vertebrates shall be stunned before killing. Operators shall ensure that equipment used to stun animals is sufficient to remove sensate ability and/or kill the organism and is maintained and monitored.

6.7.5 Aquatic animals shall be handled, transported and slaughtered in a way that minimizes stress and suffering, and respects species-specific needs.

5. KRAV Standards (2016) (Sweden)

The area of the organic aquaculture standard comply completely with the EU regulation for organic production.

6. NASAA Organic & Biodynamic Standard (2016) (Australia)

7.30 BASIC CONDITIONS and AQUATIC SYSTEMS

GENERAL PRINCIPLES

Management techniques are governed by the physiological and behavioural needs of the organisms in question and the demands of the ecosystem. Management techniques, maintain and protect the good health and welfare of the organisms and the environment.

When introducing non-native species, special care is taken to avoid unnecessary permanent disruption to natural ecosystems.

RECOMMENDATIONS

Production should maintain the aquatic environment and surrounding aquatic and terrestrial ecosystem, by using a combination of production practices that:

- encourage and enhance biological cycles
- use a wide range of methods for disease control
- prohibit synthetic fertilisers and avoid chemotherapeutic agents
- provide for polyculture where possible
- minimise the impact of surplus nutrients and avoid eutrophication

Converting material of plant and animal origin into animal production results in nutrient and energy losses. For this reason feed sources based on by-products and waste materials of biological origin not suitable for human consumption should be encouraged.

STANDARDS

7.30.1 Aquatic ecosystems shall be managed to comply with the relevant requirements of Sections Two and 3.5 of this Standard.

7.30.2 All non-indigenous fish must be thoroughly contained so as to ensure that they are not released into the wild and the operator must document any escapes that are known or suspected to occur.

7.30.3 Stocking densities shall permit fish to form shoals and must not negatively impact on fish welfare.

7.30.4 One hundred square metres is the minimum cage area with a minimum of 9 metres depth in estuarine systems. The density of fish must not exceed 10 kilograms per cubic metre in any system.

7.30.5 Construction materials and production equipment shall not contain paints or impregnating materials with synthetic chemical agents that detrimentally affect the environment or the health of the organisms in question.

7.30.6 Adequate measures shall be taken to prevent escapes of farmed species from enclosures and any known or suspected escapes must be documented.

7.30.7 Adequate measures shall be taken to prevent predation on species living in enclosures.

7.30.8 Water use must be monitored and controlled to permit minimum use and discharge of water and nutrients into the environment.

7.30.9 Fertilisers and pesticides used must be in conformity with products listed in the Annexes 2 of this Standard.

7.34 HEALTH AND WELFARE

GENERAL PRINCIPLES

Management practices achieve a high level of disease resistance and prevention from infection. All management techniques, especially when influencing production levels and speed of growth, maintain the good health and welfare of the organisms. Living aquatic organisms are handled as little as possible. The well-being of the organism is paramount in the choice of treatment for disease or injury.

RECOMMENDATIONS

The cause of outbreaks of disease or infection should be identified, and management practices implemented to prevent the causative events and future out-breaks. When treatment is necessary the use of natural methods and medicines should be the first choice. Disease treatment should be carried out in a way that minimises harmful effects on the environment.

STANDARDS

7.34.1 Operators shall comply with all the relevant requirements of Section 6.6 of this Standard

7.34.2 In the event of the use of non-permitted veterinary drugs, the organism, or generation of organisms treated will lose certification and conversion of the operation or specific enclosure may be required to begin once again.

7.34.3 The prophylactic use of veterinary drugs, except vaccinations, is prohibited.

7.34.4 Vaccinations are permitted if diseases that cannot be controlled by other management techniques are known to exist in the region. Vaccinations are also permitted if they are legislated. Genetically engineered vaccines are prohibited.

7.34.5 Synthetic hormones and growth promoters are prohibited.

7.34.6 Current accurate disease management records must be kept where applicable. The records shall include:

- identification of the infected and infecting organisms concerned
- details of treatment and duration, including application rate, method of application, frequency of repetition and concentration of organisms
- brand names of drugs used and active ingredients

7.34.7 In case of irregular behaviour by the organisms, the water quality shall be analysed and adjusted as necessary according to the needs of the organisms.

7.34.8 Aquatic animals shall not be subject to any kind of mutilation.

7.34.9 The use of chemical allopathic veterinary drugs and antibiotics is prohibited for invertebrates.

7.34.10 Operators shall routinely monitor all facets of the operation to maintain water quality, health and natural behaviour of each cohort (school).

7. Naturland Standard (2016) (Germany)

5. Health and Hygiene

5.1 The health of the organisms is, primarily, to be ensured by adopting preventive measures (e.g. optimised husbandry, rearing, feeding). Natural curative methods (ref. also 5.2.) shall be preferred in case of a disease.

Use of conventional medicine is only permitted in vertebrates and after detailed diagnosis and remedial prescription by a veterinarian. In this case, at least twice the legally prescribed waiting period must be observed. Use of conventional medicine is not permitted in invertebrate organisms (e.g. molluscs, crustaceans).

Routine and prophylactic treatment with chemo-synthetic drugs as well as hormones is not permitted. All regulatory and statutory regulations shall be fulfilled. After the application of conventional substances, proof must be given of freedom from residue in the form of appropriate analysis before marketing the goods. If more than three treatments in the total life cycle or two treatments per year are applied with conventional medication or antiparasitic agents, the affected animals may not be sold

with reference to Naturland. In Part B II. – VII further limitations are prescribed as necessary.
The stock shall be regularly inspected with respect to its status of health. Dead organisms shall be removed from the holding system immediately.
5.2 Permitted treatments, also as prophylactics or routine (within the framework of statutory regulations):

- use of natural physical methods (in particular drying out, freezing out)
- use of not residue-building, inorganic compounds as per Appendix 3 of these standards
- use of naturally occurring, not residue-building organic compounds as per Appendix 3 of these standards
- use of naturally occurring vegetable substances (in particular Labiatae and Allium species); further preparations of Azadirachta indica (neem), oil emulsions (free of synthetic chemical insecticides) on the basis of paraffin oils, mineral oils and vegetable oils, preparations of viruses, fungi and bacteria (e. g. Bacillus thuringensis), pyrethrum extracts from Chrysanthemum cinerariaefolium (synthetic pyrethroids and synergists are prohibited) and quassia from Quassia amara.
- use of homeopathic products
- use of stone powder

The use of any substance must be approved of by Naturland, especially for the purpose of eliminating conflicts with the principles of nature conservation and animal welfare which could occur by their use.
6. Oxygen Supply
The basis for aquaculture operation shall form the natural, physical conditions of the water body (affluent volume, current profile, temperature, water chemistry). Measures of aeration must not be used to raise the density above the permitted level.
9. Transport, slaughtering and processing
Transport and slaughtering must be done as quickly and humanely as possible in order to spare the animals unnecessary suffering. The method of proceeding and the materials used have in any case to be oriented towards the needs of the respective species (e.g. sensitivity to higher temperature or to stress).
9.1 Live fish must be supplied with enough oxygen during transport. A transport density of 1 kg of fish per 8 litres of water may not be exceeded. The transport duration is maximum 10 hrs.
9.2 Slaughtering of fishes shall be carried out by means of incision of gills or immediate evisceration. Prior to this, fishes shall be anaesthetised (by means of concussion, electrocution and, if need be, by natural plant anaesthetics, tropical and subtropical fish and invertebrates also by using ice).
9.3 Maintenance of the cold chain from the point of slaughtering up to the sales point must be strictly observed, in order to prevent any deterioration in the product quality.
In the case of processed products, only products and additives in accordance with Naturland standards shall be used. General Processing Standards of Naturland shall be complied with.
9.4 The cleaning of factory rooms, devices and machines must ensure a perfect hygiene along with an as high as possible ecofriendliness. Mechano-physical processes shall be preferred to chemical processes. Regarding the cleaning and disinfection agents used, a separate book of records shall be kept. The wastewater from the slaughtering and processing plants must be subjected to appropriate purification process.

8. Organic Crop Improvement Association - OCIA (2013) (USA & Canada)

The guidelines in this section of the OCIA International Certification Standards, are the "Aquatic Production Standards" from the IFOAM Norms for Organic Production and Processing

9. OFDC Organic Certification Standards (2016) (China)

12.6 Aquatic animal health and welfare
12.6.1 Organic management practices should promote and maintain the health and well-being of animals through balanced organic nutrition, stress-free living conditions appropriate to the species and breed selection for resistance to diseases, parasites and infections.

12.6.2 The cause of outbreaks of disease or infection should be identified. Management practices, including criteria for choosing a site that can diminish causative events and future outbreaks of disease should be implemented.
12.6.3 Natural methods and medicines should be used as the first choice, when treatment is necessary.
12.6.4 Relevant requirements of section 8.6 of this standard shall be complied.
12.6.5 Prophylactic use of veterinary drugs is prohibited.
12.6.6 Use of chemical allopathic veterinary drugs and antibiotics is prohibited for invertebrates.
12.6.7 Synthetic hormones and growth regulators are prohibited for use to stimulate or suppress natural growth or reproduction of animals.
12.6.8 Stocking densities should not compromise animal welfare.
12.6.9 Water quality, stocking densities, health, and behavior of each cohort (school) and shall be routinely monitored. The operation should be well managed so as to maintain water quality, animal health, and natural behavior.
12.7 Aquatic animal transport and slaughter
12.7.1 Organic animals are subjected to minimum stress during transport and slaughter. A person specifically responsible for the well-being of the animals should be present during transport. To avoid unnecessary suffering, organisms should be in a state of unconsciousness before slaughter.
12.7.2 Relevant requirements of section 8.9.of this standard should be complied with.
12.7.3 The live organisms should be handled in ways that are compatible with their physiological requirements.
12.7.4 Defined measures shall be implemented to ensure that organic aquatic animals are provided with conditions during transportation and slaughter that meet animal specific needs and minimize the adverse effects of:

a. diminishing water quality;
b. time spent in transport;
c. stocking density;
d. toxic substances;
e. escape.

12.7.5 Aquatic vertebrates shall be stunned before killing. Equipment used to stun animals shall be ensured to be sufficient to remove sensate ability and/or kill the organism and is maintained and monitored.
12.7.6 Animals shall be handled, transported and slaughtered in a way that minimizes stress and suffering, and respects species-specific needs.

10. Ministry of Agro-Industry of Argentina, Resolution SENASA 374/2016

ARTÍCULO 85.- Manejo de los animales. Para el manejo de los animales se debe:
Inciso a) Tener en cuenta los manuales de buenas prácticas oficiales.
Inciso b) Reducir al mínimo el manipuleo de los animales, con el fin de evitar el estrés y los daños físicos derivados de los procedimientos de manejo. Las operaciones de calibrado deben ser reducidas al mínimo.
Inciso c) Manejar a los reproductores con especial cuidado atendiendo a sus necesidades de bienestar animal y cuando proceda, se puede hacer uso de anestesia para la extracción de esperma u ovas.
Inciso d) Garantizar el bienestar de los animales en el ambiente acuático productivo. Se deberá considerar las densidades de población por especie o grupo de especies establecidas en el Anexo VII de la presente resolución. Deben prevenirse los daños en aletas u otras lesiones, considerarse el ritmo de crecimiento, el comportamiento, la salud de los animales y la calidad del agua.
Inciso e) Utilizar la luz artificial cumpliendo los siguientes requisitos:
Apartado I) La prolongación de la luz natural del día debe respetar las necesidades etológicas de los animales y la salud de los mismos. La sumatoria de la luz natural y artificial no debe superar las DIECISÉIS (1 6) horas diarias.

Apartado II) Se deben evitar los cambios bruscos de intensidad de luz a la hora de transición mediante el empleo de luces con intensidad regulable o luces de fondo.

Inciso f) Permitir la aireación para garantizar el bienestar y la salud de los animales. Se prefiere el uso de aireadores mecánicos que funcionen con energía de fuentes renovables. Dicha utilización debe consignarse en los registros acuícolas.

Inciso g) Usar oxígeno en la terapéutica animal o para atender períodos críticos de transporte y producción únicamente, bajo las siguientes circunstancias:

Apartado I) En casos excepcionales de aumento de la temperatura o descenso de la presión atmosférica o contaminación accidental.

Apartado 11) En oportunidad del muestreo y clasificación de los lotes. Apartado III) Para garantizar la supervivencia de los lotes de la explotación.

Inciso h) Verificar/asegurar que las condiciones ambientales del área de producción y el sistema de manejo garanticen que no haya sedimentación ni acumulación significativa de desechos.

Inciso i) Contar con un mecanismo de remoción, tratamiento y manejo de los organismos muertos para no contaminar el ambiente.

Inciso j) Tomar medidas adecuadas para evitar que ocurran escapes de los animales de la acuicultura a fin de minimizar el impacto en el ecosistema local incluyendo su recuperación, cuando corresponda. Se debe llevar registro de tal situación.

Inciso k) Identificar a los animales acuáticos cultivados por lotes y deben poder ser rastreados desde su nacimiento hasta su sacrificio y comercialización.

Inciso l) Llevar registros de las condiciones precedentes.

ARTÍCULO 88.- Sanidad: La sanidad en los sistemas productivos se basa en la prevención. En caso que ésta no resulte eficaz se deben aplicar tratamientos sanitarios.

Inciso a) La prevención de enfermedades se basa en:

Apartado I) El mantenimiento del medio acuático en condiciones óptimas.

Apartado II) La aplicación de buenas prácticas de manejo acuícola.

Apartado III) Los exámenes rutinarios de los ejemplares.

Apartado IV) La limpieza y desinfección periódica de las instalaciones, equipos y utensilios.

Apartado V) El suministro de piensos de alta calidad en cantidad suficiente de acuerdo a sus requerimientos.

Apartado VI) La densidad adecuada de organismos acuáticos.

Apartado VII) La cría de razas y estirpes adaptadas al ambiente.

Inciso b) Tratamientos sanitarios:

Apartado I) Los animales enfermos deben ser tratados inmediatamente para evitar su sufrimiento respetando las pautas establecidas en los Artículos 38 a 42 del presente anexo.

Apartado II) Está permitido el uso de tratamientos veterinarios inmunológicos.

Apartado III) Es deseable que los animales tratados sean aislados en piletones especiales de cuarentena.

ARTÍCULO 89.- Pautas para la prevención de enfermedades: Se deben tener en cuenta las siguientes pautas:

Inciso a) Se debe asegurar el estado sanitario de los animales y ovas al ingreso al sistema productivo y tomar medidas de bioseguridad para evitar la introducción y dispersión de enfermedades en los organismos cultivados y su propagación en el ambiente acuático.

Inciso b) Se debe diseñar un Programa Sanitario que detalle las prácticas de bioseguridad. Debe estar firmado por un profesional idóneo en la materia, quien debe visitar el establecimiento como mínimo UNA (1) vez al año.

Inciso c) Los piensos que no se hayan consumido, las heces y los animales muertos, se deben eliminar de manera adecuada y segura, recomendando su compostaje, para evitar todo riesgo de daño ambiental respecto de la calidad del agua, enfermedades y atracción de insectos, aves y roedores. No pueden utilizarse como insumos para el compostaje, animales cuya muerte se presuma provocada por agentes patógenos de denuncia obligato- ria en la normativa nacional.

Inciso d) El operador puede proponer la aplicación y duración del barbecho, y la entidad certificadora debe evaluar su pertinencia.

Inciso e) El agua puede ser tratada con luz ultravioleta, y el ozono se usará únicamente en criaderos, viveros y en sistemas de recirculación de agua.

Inciso f) Para el control biológico de los ectoparásitos, se da preferencia al empleo de peces limpiadores.

Inciso g) Se deben llevar registros de las actividades realizadas durante cada ciclo.

ARTÍCULO 90.- Tratamientos veterinarios: En caso de que las medidas preventivas no resulten suficientes, ante un problema sanitario se pueden utilizar tratamientos veterinarios, de acuerdo a las siguientes pautas:

Inciso a) Los tratamientos veterinarios deben conservar el siguiente orden de preferencia:

1.1. Sustancias de plantas, animales o minerales en una dilución homeopática.
1.2. Plantas y sus extractos que no tengan efectos anestésicos.
1.3. Oligoelementos, minerales, inmunoestimulantes naturales o probióticos autorizados.
1.4. Tratamientos con productos de medicina veterinaria de síntesis química.

Inciso b) Todos los tratamientos veterinarios deben ser prescriptos por profesional idóneo ante un diagnóstico realizado y deben estar documentados en los registros que lleven los operadores.

Inciso c) La cantidad máxima de tratamientos con productos de medicina veterinaria de síntesis química que se apliquen, con excepción de las vacunas y los programas de erradicación obligatorios, depende de la duración del ciclo de producción de la especie y debe ser de:

Apartado I) Para ciclos de producción inferior a UN (1) año, UN (1) tratamiento.

Apartado II) Para ciclos de producción superiores a UN (1) año, hasta DOS (2) tratamientos por año.

Apartado III) En caso que se superen dichos máximos, los animales de la acuicultura afectados no pueden venderse como productos orgánicos.

Inciso d) El empleo de tratamientos antiparasitarios, excluidos los programas de control obligatorios, queda limitado a UNO (1) cuando el ciclo de producción sea menor a DIECI- OCHO (18) meses y, si el ciclo fuera mayor, los tratamientos no pueden exceder de DOS (2) por año.

Inciso e) El tiempo de carencia luego de aplicar los productos de medicina veterinaria de síntesis química y los antiparasitarios mencionados en los párrafos anteriores, incluidos los tratamientos aplicados en virtud de programas de control y erradicación obligatorios, es el doble del tiempo de espera legal, o en caso de que este período no esté especificado, será de CUARENTA Y OCHO (48) horas.

Inciso f) Toda utilización de medicamentos veterinarios debe ser notificado a la entidad certificadora con anterioridad a la comercialización de los animales de la acuicultura. Las poblaciones tratadas deben ser claramente identificables.

ARTÍCULO 91.- Transporte de animales acuáticos vivos: El transporte de animales acuáticos vivos debe realizarse de acuerdo a las siguientes pautas:

Inciso a) Los peces vivos se deben transportar en depósitos adecuados con agua cuya calidad permita satisfacer sus necesidades fisiológicas en cuanto a temperatura, oxígeno disuelto, pH, salinidad, nitratos y nitritos.

Inciso b) El transporte debe mantener los resguardos necesarios para no producir contaminaciones en el traslado ni en el destino, asegurando la trazabilidad y manteniendo sus registros.

Inciso c) Se deben tomar precauciones para reducir el estrés de los animales transportados. Durante el transporte, la densidad de los organismos vivos no debe alcanzar niveles perjudiciales para la especie ni se deben suministrar tranquilizantes o estimulantes sintéticos.

Inciso d) Antes del transporte de los animales, los depósitos deben estar limpios, desinfectados y lavados.

ARTÍCULO 92.- Faena: Además de lo dispuesto en la normativa vigente en la materia, la faena orgánica está sujeta a las siguientes pautas:

Inciso a) La faena y procesamiento de los animales debe seguir lo establecido en la norma orgánica vigente.

Inciso b) Las técnicas previas al sacrificio deben conseguir que los animales queden rápidamente inconscientes e insensibles al dolor.

Inciso c) Las diferencias entre los tamaños de la recolección, las especies y la distancia de los emplazamientos de producción hacia los lugares de faena se deben tener en cuenta al considerar las condiciones óptimas de sacrificio.

Inciso d) El agua de desperdicio del sacrificio y de las plantas procesadoras deben someterse a unproceso de tratamiento de efluentes.

11. Soil Association Standard (2016) (UK)

The area of the organic aquaculture standard comply completely with the EU regulation for organic production.

12. ACT Organic Standards (2016) (Thailand)

Health and Welfare

Principles

- Aquatic organisms are cultivated with health-promoting methods which keep them healthy and resistant to diseases and infection.
- Natural curative methods and naturally occurring substances shall be preferred in treating diseases and injuries.

Standards

8.5.1 The producer shall use preventive measures to keep the stocks healthy, e.g. appropriate stocking density, use of disease-resistant young stock, regularly maintaining water quality suitable to the stocks' needs. Animal heath shall be monitored regularly.

8.5.2 The producer shall clean the holding facilities and disinfect the equipment used in the farm properly. Any sources of disease, e.g. dead animals, shall be promptly removed from the farm to prevent diseases and infection in the stock.

8.5.3 The use of products from health- promoting microorganisms is permitted they are not from genetic engineering.

8.5.4 Biological control of ectoparasites is allowed, e.g. use of cleaner fish.

8.5.5 The use of medicinal plants or their extracts are allowed provided that they do not have anaesthetic effects.

8.5.6 The use of chemical, synthetic drugs for prevention and treatment of diseases in the stock is prohibited.

8.5.7 Only methods and products listed in Part 1 of Appendix 3 are allowed for prevention and treatment of diseases.

8.5.8 If aquatic animals are infected by diseases, they shall be treated immediately to avoid unnecessary suffering. If the methods and products mentioned above are unable to cure the diseases, ACT may allow the producer to treat only vertebrates with chemical, synthetic drugs prescribed by fishery experts specialized in diseases in fish farming. In this case, the producer is not allowed to sell the stocks as organic until at least twice withdrawal periods recommended for the drugs or by the fishery experts expire. Additionally, tests shall be carried out to ensure that the stocks are free of the drug's chemical residues and declared to ACT before they can be marketed as organic.

8.5.9 For chemical veterinary treatment according to 8.5.8, a maximum of 2 treatments per year is allowed for animals with production cycle of more than one year, and a maximum of one treatment for those with production cycle of less than one year. A maximum of one parasite treatment is permitted for animals with production cycle of less than 18 months. If the animals' exposure to chemical treatment exceeds the above limits, they cannot be sold as organic.

8.5.10 Treatment of diseases in the stocks shall be documented and updated regularly. The records shall indicate the names of diseases, their possible causes, treatment procedures, e.g. administering dates, dosage, methods and frequency of application per number of infected stocks. The producer shall clearly record the numbers of treated ponds or lot numbers of treated stock for traceability.

8.5.11 The use of synthetic hormones and growth-enhancing substances in the cultivation and breeding of stock is prohibited.

8.5.12 In case of operator applying for EU certification, the operator shall have, in its animal health management plan, written agreement with qualified aquaculture animal health service provider to provide health counselling at least once per year or once every two years in case of bivalve shellfish.

Harvesting, Slaughter and Transportation

Principles

- Harvesting, grading and transportation should not cause stress or injury to aquatic organisms.
- Stress and suffering of aquatic organisms should be minimized during the slaughter process.

Standards

8.8.1 The producer shall use appropriate harvesting and sorting equipment which does not harm or cause stress to the animals and minimizes the impact on the environment.

8.8.2 All synthetic substances are not permitted for use in harvesting, grading and transportation.

8.8.3 If sorting or grading of live animals on farm is needed, it shall be done at a minimum and as quickly as possible in order to avoid unnecessary suffering to the animals.

8.8.4 The producer shall have measures for transporting the animals with efficiency and good hygiene while not causing stress or injury to them.

8.8.5 Equipment, materials and containers used during the harvesting, grading and transporting shall not have chemicals which may be toxic to the animals and shall be able to prevent contamination from outside. Tanks and containers used for transporting aquatic animals shall be thoroughly cleaned and disinfected before use.

8.8.6 During transportation of living aquatic organisms, the producer shall ensure that the following conditions are fulfilled: appropriate water quality for the animals, appropriate density of the organisms in containers, journey distance and time not too long, measures to prevent escapes, having a responsible person to accompany them for the entire journey. Record of transportation shall be kept with sufficient details for verification.

8.8.7 If necessary, use of oxygen during sorting and transportation is allowed.

8.8.8 Slaughtering shall be carried out as quickly as possible to spare the animals unnecessary suffering. In case of vertebrate aquatic species, they shall be stunned before killing. The operator shall ensure that equipment used to stun animals is sufficient to remove their sensate ability and/or kill them. Equipment for slaughtering and cutting up shall be in good working order, clean and regularly checked for its proper functioning.

8.8.9 If the facilities, equipment, containers and machines for harvesting and slaughtering organic aquatic organisms are shared by a conventional operation, the operator shall have measures to clean them before using with the organic stocks. The management and documentation of their utilization shall be clearly separated between the two operations.

8.8.10 The cleanness of ice used for harvesting and transportation shall meet drinking water standards.

13. Organic Aquaculture Standards (2012) (Canada)

6.5 Health and Welfare

6.5.1 Aquaculture facilities shall be designed, operated and managed in a manner that seeks to maximize the welfare and minimize the stress on aquaculture animals, and minimizes the spread of disease within the facility, and to all adjoining ecosystems and native fish species.

6.5.1.1 When net pen systems are used, producers shall implement measures to minimize transmission of diseases and parasites between cultured and wild aquatic animals. Net pens shall be sited in such a manner as to minimize contamination and disease from conventional fish pens or native fish populations, taking into account factors like currents and seasonal changes.

6.5.2 Management shall be based on the five following domains of welfare:

a. Aquaculture animals shall have ready access to an appropriate diet in sufficient quantities and with a composition that maintains full health and vigour.

b. Aquaculture animals are in close contact with their environment. Water quality is of central importance to their welfare. Water quality parameters shall be appropriate to meet physiological and ethological needs.

c. Disease shall be prevented or rapidly diagnosed and treated.

d. Aquaculture animals shall have sufficient space, proper facilities and, where appropriate, the company of the animal's own kind.

e. Conditions that produce unacceptable levels of stress caused by anxiety, fear, distress, boredom, sickness, pain, hunger and so on shall be minimized.

6.5.3 Holding systems, equipment and utensils shall be properly cleaned according to a defined protocol. Only products listed in section 12 may be used.

6.5.4 If necessary to prevent disease, an appropriate fallowing period shall be applied after each production cycle. During fallowing, the cage or other structure used for aquaculture animal production is emptied, cleaned and left empty before being used again.

6.5.5 Uneaten fish feed, faeces and dead animals shall be managed to support the health and welfare of the animal(s) as described in par. 6.5.2.

6.5.6 Hygienic routines shall be carried out as well as routine examinations to detect nascent diseases and production disturbances. Where possible, the cause of outbreaks of disease or infection shall be identified and management practices implemented to prevent the causative events and future outbreaks.

6.5.7 Vaccinations are permitted. Prophylactic treatment with other synthetic veterinary drugs is prohibited.

6.5.8 Physical alterations are prohibited except when absolutely necessary to improve the health, welfare or hygiene of aquaculture animals, or for identification or safety reasons. Physical alterations shall be undertaken in a manner that minimizes pain, stress and suffering, with consideration to the use of anaesthetics and sedatives.

6.5.9 Where preventive practices and vaccines are inadequate to prevent sickness or injury and where disease and health problems require treatment, the use of biological, cultural, and physical treatments and practices is permitted, in accordance with the Permitted Substances Lists.

6.5.10 Medical treatment for sick or injured aquaculture animals shall not be withheld to preserve their organic status. All appropriate medications shall be used to restore aquaculture animals to health when methods acceptable to organic production fail. Sick and medicated aquaculture animals shall be quarantined from healthy aquaculture animals.

6.5.11 Products from sick aquaculture animals or those undergoing treatment with restricted substances shall not be organic or fed to organic aquaculture animals or livestock.

6.5.12The use of veterinary medicinal substances in organic production systems shall conform to the following:

a. If no alternative treatment or management practice exists, the use of veterinary biologics, including vaccines, the use of parasiticides or the therapeutic use of synthetic medications may be administered provided that such medications are permitted, in accordance with this standard, or are required by law.

b. Phytotherapeutic (i.e. algal, herbal or botanical substances excluding antibiotics), homeopathic or similar products shall be used in preference to chemical allopathic veterinary drugs or antibiotics, provided that their therapeutic effect is effective for the species and the condition for which the treatment is intended.

c. If the use of the products in par. 6.5.12 a. and b. is unlikely to be effective in combating illness or injury, chemical allopathic drugs (not listed on the Permitted Substances Lists) may be administered under veterinary supervision. Some restrictions apply when aquaculture animals are treated (see par. 6.5.13, 6.5.14 d. and 6.5.15). In addition to the treatments allowed for combating illness or injury, anaesthetics may be administered no more than twice a year when handling individual fish (e.g. vaccination, weight counts, parasite counting, fin clipping, tagging, or surgery).

d. When veterinary drugs are used, the withdrawal period indicated on the Permitted Substances Lists shall be observed before the products from treated aquaculture animals can be considered organic.

e. When veterinary drugs are used and the withdrawal period is not indicated on the Permitted Substances Lists or the substance is not listed on the Permitted Substances Lists, a withdrawal period equivalent to double the label or veterinary prescription requirement, or 14 days, whichever is longer, shall be observed before the products from treated aquaculture animals can be considered organic.

f. Broodstock treated with antibiotics may continue to be used within the organic aquaculture system, but shall never be organic for slaughter purposes.

6.5.13 Hormonal treatment shall only be used for therapeutic reasons and under veterinary supervision. The slaughter aquaculture animals so treated cannot be organic unless the treatment is permitted by the Permitted Substances Lists.

6.5.14 The operator of an organic aquaculture animal operation shall not administer

a. synthetic compounds to stimulate or retard growth or production, including hormones for growth promotion;

b. synthetic parasiticides to slaughter aquaculture animals, except as provided in par. 6.5.15;

c. antibiotics to slaughter aquaculture animals;

d. chemical allopathic veterinary drugs (e.g. pharmaceuticals, antibiotics, hormones and steroids) for preventive treatments.

6.5.15 Organic aquaculture operations shall have a comprehensive plan to minimize parasite problems in aquaculture animals.

a. The plan will include preventive measures such as fallowing, lowering density and monitoring, as well as emergency measures in the event of a parasite outbreak.

b. By way of derogation, when preventive measures fail (because of aquatic climatic conditions or other uncontrollable factors), and in the case where the operator uses direct treatment measures such as feeding, topical application or external application in a confined static bath, the use of synthetic parasiticides is permitted, provided that

i. monitoring of the animal, as appropriate for the species, indicates the aquaculture animals are infected with parasites;

ii. the operator has received written instructions from a veterinarian indicating the product and method for parasite control that shall be used;

iii. withdrawal times shall be twice the legal requirement or 14 days whichever is longer;

iv. there shall be only one treatment for slaughter aquaculture animals under a year old and a maximum of two treatments for older slaughter aquaculture animals. Slaughter aquaculture animals that require further treatment will lose organic status;

v. the operator shall provide a written action plan (including timing), describing how they will amend their parasite control plan, to avoid similar emergencies.

6.5.16 Treated stock shall be clearly identifiable.

6.8 Harvesting, Transporting Live Aquaculture Animals and Slaughtering

6.8.1 Techniques used to capture, handle and harvest aquaculture animals shall be selected such that they cause minimal physiological stress or injury, and that natural habitats are preserved. In order to keep stress levels to a minimum, only essential handling shall take place.

6.8.2 Vehicles and boats used shall be adapted to the types of live aquaculture animals being transported. Water quality requirements shall be met (including temperature, oxygen, etc.), and population densities shall meet the aquaculture animal welfare requirements with special

consideration being given to aquaculture animals that are transported live to market and for slaughter.
6.8.3 The use of tranquillizing chemicals, paralyzing toxins and carbon dioxide is prohibited.
6.8.4 Slaughtering shall minimize pre-slaughter and slaughter stress.
6.8.5 Slaughter techniques shall render aquaculture vertebrate animals immediately unconscious and insensible to pain. Differences in harvesting sizes, species, and production sites shall be taken into account when considering optimal slaughtering methods.
6.8.6 Aquaculture vertebrate animals shall not be slaughtered in ponds, cages or tanks where other aquaculture animals are living.
6.8.7 Aquaculture vertebrate animals shall not be slaughtered by suffocation.
6.8.8 Harvesting, transporting, slaughtering and subsequent handling of organic and non-organic aquaculture animals shall be clearly separated in time or space in order to completely avoid commingling.

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EXECUTIVE DOSSIER N°2. BREEDING PRACTICES AND ORIGIN OF ORGANIC AQUACULTURE ANIMALS

2.1. Breeding programs

According to Reg. EC 889/2008 art. 25d, breeding shall aim to give strains which are more adapted to farming conditions, good health and good utilisation of feed resources.

For this purpose, there is nowadays a general acceptance that the implementation of breeding programmes can contribute to improve production efficiency around 7-10% per generation. Indeed, relevant research progress has been attained in the field of aquaculture genetics and genomics, during the last decade, and this can provide an important window of opportunities for the sector. Genetic and genomic tools offer a huge potential for contributing to sustainable growth and to the improvement of the aquaculture competitiveness. These considerations apply to conventional aquaculture, but actually even more for organic aquaculture.

Although the organic aquaculture production volumes are still below the critical mass necessary to economically support specific breeding programmes, some options of conventional breeding programs might be applied also to the organic market.

However, the promotion of specific breeding programs for organic aquaculture would be highly recommendable for the purpose of a more efficient selection of key traits, such as growth, feed conversion and disease resistance, which allow to obtain family lines more adapted to organic aquaculture conditions. This, in turn, would also enhance the actual applicability of the organic principle for which the whole production cycle should be run under organic management.

Huge Single Nucleotide Polymorphism (SNP) resources and cheap genotyping methods are now available for genome screening enabling to understand the genetic basis of productive traits and to apply more efficient selection for key traits difficult to address, such as growth, feed conversion, sexual differentiation and disease resistance. Also, high coverage and well annotated reference genomes are at our disposition for an increasing number of aquaculture species, such as rainbow trout, European sea bass, gilthead sea bream, turbot.

Anyway, improving production performance also needs to take into account economic and market issues, hence, it is necessary to get further insight on how to implement most cost-efficiently genetic and genomics in aquaculture production/companies. It is widely agreed that moving to genomics is a key issue for the aquaculture industry, but the integration of genomic tools in a cost-effective way strongly depends on the Technology Readiness Level (TRL).

The TRL of genomic tools applied to aquaculture should be considered on a case-by-case basis, since the capacity for technology uptake differs significantly between species, and there is a need of scaling up and adopting solutions that allow results to reach higher TRLs, which smaller companies are able to deal with. Therefore, cost-benefit analysis should be addressed at a pilot scale before their industrial application.

In light of the foregoing it is highly recommended that breeding programs, which involve the participation of organic aquaculture farms, are promoted and supported at EU level.

2.2. Juveniles production

Although there are no official data on the number of certified organic hatcheries in Europe, there are informal information on a few hatcheries that have recently converted or are in the process of conversion to organic. According to information provided informally by EU Member States, in the context of discussions at the Committee on Organic Production in 2015, the number of hatcheries producing organic eggs/juveniles resulted as follow:

<u>Atlantic salmon</u>

12 hatcheries selling organic juveniles to farms for on-growing (approx. 12 million ova per year).

3 companies with an integrated system (hatchery + farm), producing their own organic juveniles.

<u>Rainbow trout</u>

9 hatcheries, currently selling more than 12 million eggs each year.

17 farms with an integrated system (hatchery + farm), producing their own organic juveniles.

<u>Common carp</u>

57 hatcheries selling juveniles.

9 farms with integrated systems.

<u>Sea bass</u>

3 hatcheries selling 750.000 eggs/juveniles.

2 farms with integrated systems (hatchery + farm), producing their own organic juveniles.

<u>Seabream</u>

3 hatcheries selling more than 1 million eggs/juveniles.

2 farms with integrated systems (hatchery + farm), producing their own organic juveniles.

Anyway, it is worth noting that these are not official statistics. The information has not been further verified or updated and is likely to be incomplete/incorrect. Furthermore, in 2016 some EU Countries claimed that the present production of organic juveniles is inadequate to supply the growing demand of the organic aquaculture industry. The implementation of a database with the current and planned availability of eggs and/or juveniles, regularly updated by each farm, would facilitate the circulation of information.

Actually, it is not clear why there are so few hatcheries permanently converted to organic production since it does not appear to be any barriers to the acquisition of organic certification. Conversely, the Commission Regulation (EC) No 889/2008 seems to overlook specific organic rules for managing the life cycle stage between the hatching and the weaning of juveniles. This shortage of specific organic regulation concerns fresh water species (e.g. stocking density, husbandry environment) and, even more, marine species (e.g. phytoplankton and zooplankton production, essential nutrients in the trophic chain, stocking density during larval rearing and weaning, husbandry environment). Indeed, according to the Commission Implementing Regulation (EU) N°1358/2014 “*In the larval rearing of organic juveniles, conventional phytoplankton and zooplankton may be used as feed*”.

One possible explanation of the inadequate production of organic juveniles could result from 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”. This Directive established five categories of health status in which countries, zones and compartments have to be classified, and strict rules to be followed for introducing or dispatching animals among areas with different health status classification.

A second barrier to the movements of eggs or juveniles among farms is due to the reluctance of farmers to introduce on their farms animals which could be unsuitable for the local (geographical) environment (e.g. genetic or population traits, resistance to diseases, growth performances, reproductive cycle, behavioural characteristics, etc.). Farmers, rightfully, do not like to have limited or no choice when they have to bring juveniles into their farming facilities.

2.3. Phyto-zoo massive culture

Production rules for the phase of the life stage between hatching and weaning of juveniles would have a strong influence in determining the characteristics of the adult (e.g. skeletal and pigmentation anomalies, immune resistance, etc.). Larval rearing, indeed, is one of the most critical stages for the successful propagation of any species and represents one of the major bottlenecks of the whole aquaculture process. Most fish larvae, particularly the marine ones, are very small at first feeding and thus are sensitive to the rearing environment and to feed quality. Furthermore, these small larvae require live plankton for their first feeding and thus hatcheries include facilities for plankton production (both phytoplankton and zooplankton).

Phytoplankton is of major importance in the hatchery process, having a double role. It is used in the rotifer cultures, both as feed or as enriching media and also as medium for improvement of the rearing environment of the larvae. Its role for larval rearing includes antibacterial properties, but also shading effect that improves larvae predation, or as trigger for feeding behaviour or physiological processes. Commercial nutrient solutions needed for mass-production of phytoplankton contain all necessary macro and micronutrients, silicates and vitamins in easily soluble, mineral form (Lavens & Sorgeloos, 1996). Here there is a potential conflict with the art. 4(b)(iii) of Reg. 834/2007, which limits the use of fertilizers to “low solubility mineral fertilizers”. However, as it has been rightly pointed out in the EGTOP Final Report on Aquaculture (Part B), it is clear that this principle was developed for terrestrial plants, and does not hold for aquatic production, i.e. phytoplankton, where the nutrients are only available in soluble form. Therefore, it may be agreed with EGTOP that it does not seem essential to define organic production rules for phytoplankton.

Two species of zooplankton are mass cultured due to their appropriate size and easiness of mass culture. These are (i) the rotifer *Brachionus sp*. and (ii) the nauplius of the branchiopod crustacean, *Artemia sp.* Rotifers are the initial prey for the majority of marine fish larvae and are later replaced by *Artemia sp.* during the larval rearing process. Appropriate methods have been developed also for the culture of some ciliate species and for some copepods (Lavens & Sorgeloos, 1996). For the feeding of rotifers several products are used (sometimes in combination), such as baker’s yeast, different algal species (locally produced or purchased as algal paste) and formulated feeds. Rotifers and Artemia, however, need to be enriched in highly unsaturated fatty acids (EPA and DHA) and vitamins (C and A) and this can be done with microalgae (local cultures, algal pastes or powders of *Thraustrochytrids* single cell products) as well as oil emulsions. Here too there is a potential conflict with the Reg. 834/2007, because commercial products are made up with synthetic antioxidants and emulsifiers. However, as it has been rightly pointed out in the EGTOP Final Report on Aquaculture (Part B), at the moment there is no information about the availability of organic enrichment diets, neither if such production would be commercially viable, therefore “*In the absence of better alternatives, the use of non-organic zooplankton should be allowed*”.

2.4. Early life stages and weaning

A variety of hatchery techniques are available, all sharing common characteristics, such as the use of phyto and zooplankton during the period of larval first feeding. The main classifications are based on the rearing density (intensive, semi-intensive, extensive) and the use of phytoplankton in the water (clear, green, pseudo-green) (Papandroulakis et al., 2002).

Independently from the method applied, there are three distinct phases during larval rearing: (i) egg hatching and autotrophic phase, when larvae consume their yolk sac reserves, (ii) heterotrophic phase when larvae are fed on zooplankton, and (iii) the weaning to artificial diets. During these phases larvae complete their transformation to juveniles. Juveniles usually remain in the hatchery, for pre-growing, until reaching 2 - 5 g in weight. In cases where on-growing is performed in open sea conditions, the pre-growing period is extended until individuals reach a weight of 10 - 30 g. During this period several procedures are commonly applied, including grading, vaccination and quality control.

In Recirculation Aquaculture Systems (RAS), larvae are reared at high densities under controlled conditions and success is highly depending on the level of knowledge of the larvae’s specific biological needs. Intensive rearing is characterized by high stocking densities, controlled conditions of water quality, light intensity, photo-phase and feeding. The most commonly applied method are (i) the “clear water” technique, with no use of phytoplankton in the rearing medium, (ii) the “green water” technique that is based on the creation of optimum conditions for endogenous phytoplankton bloom of specific organisms in the larval tanks, and (iii) the so-called “pseudo-green water” technology (Papandroulakis et al., 2002), which is based on the frequent addition of phytoplankton and zooplankton in the larval rearing tanks, where phytoplankton is not produced, nor bloom, but its concentration remains constant by daily addition. The pseudo-green method is applied during the most critical segment of the rearing process, at the beginning of larval rearing (until the 20th to 30th day post hatching), when the larvae are still extremely weak, sensitive to alterations in the rearing environment, easily stressed and difficult to feed. After this period, the “clear water” methodology is applied.

In extensive hatcheries, larvae are reared at low densities in large tanks or ponds, under more natural conditions, feeding on endogenous blooms of wild marine zooplankton, but there is no industrial application due to the low productivity.

As an intermediate approach between the intensive and extensive method, semi-intensive techniques, like the so called “mesocosm technology” (Divanach and Kentouri 1999) or “large volume rearing” (Prestinicola et al., 2013), have been developed and are applied for the rearing of several species. The most important characteristic of the infrastructure required is the size of the larval tanks which should range between 20 to 60 m^3. The conditions of rearing are independent from any climatic and/or seasonal changes. There is a partial control of the light conditions (intensity and photo-phase) and a minimal control of the temperature. The initial egg density in the mesocosm ranges from 4 to 7 eggs l^{-1}, depending on species, and should never exceed 20 eggs l^{-1}. Tanks are filled with natural seawater filtered mechanically, and wild plankton is thus introduced in the system offering a capacity for endogenous production. Phytoplankton is added daily to maintain the green medium for a period of 2-4 weeks after hatching. Exogenously produced enriched rotifers and Artemia are added when required. Recent studies (Prestinicola et al., 2013) concluded that large volume rearing leads to a significant improvement of the morphological quality (i.e., lowered incidence of severe skeletal anomalies and meristic count variability) of gilthead sea bream juveniles. Furthermore, there is evidence that the rearing conditions during the early life stages do have an impact on the behavioural response of sea bass during on-growing, and the individuals reared with the mesocosm method are more sensitive to human presence, presenting behaviour closer to wild individuals (Papandroulakis et al., 2012).

The larval rearing fresh water species (e.g. percid) is very similar to that of marine fish larvae due to the size of the individuals at first feeding. Initial stocking density usually ranges between 20 and 50 larvae l^{-1}, but fish density must be reduced after the weaning phase. First feeding is composed of enriched rotifers (either the brackish water species *B. plicatilis* or the freshwater species *B. calyciflorus*). Afterwards, larvae are fed enriched Artemia nauplii. At 25-30 days after hatching the live prey are gradually replaced by dry feed (weaning phase).

As in any aquaculture operation, microbial control in hatcheries is essential and standard disinfection methods are applied for the facility and the equipment used. The aquatic environment is more supportive to pathogenic bacteria, independently of their host, than the terrestrial environment and, consequently, pathogens can reach high densities around the animals, which then ingest them either with the feed or when they are drinking. Several measures and techniques have recently been developed to control disease and closely related bacteria, such as phage therapy, short-chain fatty acids (SCFAs) and polyhydroxyalkanoates, quorum-sensing disruption, probiotics and “green water”. Some of the techniques have only been studied recently and have only been tested in the laboratory (e.g. disruption of cell-to-cell communication), whereas others have a longer history, including farm trials (e.g. the application of probiotics). Each of the techniques has its advantages but also its limitations. In fact, none of them will probably be successful in all cases. Therefore, it is of importance to develop further all of these alternatives to construct a toolbox containing different sustainable measures.

Feed mixes for weaning, when dry feeds are used, are different from those for on-growing. Indeed, there is a clear difference between the nutrient requirements at the different life stages, which are discussed in the Executive Dossier n°4.

2.5. References to international standards of organic farming

In this chapter are reported the specific rules applicable to the breeding practices and the origin of organic aquaculture animals as they have been defined in various international standards. For each standard/regulation it is also reported the issue date and the Country of origin.

1. Australian Certified Organic Standard - ACOS (2016)

7.7.11. Preference shall be given to production of endemic species, and strains that are adapted to local conditions, feed resources etc.

7.7.12. For breeding purposes and when organic aquaculture animals are not available, wild caught or non-organic aquaculture animals may be brought in. Such animals shall be kept under organic management for at least three months before they may be used for breeding.

7.7.13. For on-growing, when organic juveniles are not available non-organic juveniles may be brought in. In such cases, at least the latter two thirds of the production cycle shall be under organic management.

7.7.14. The collection of wild juveniles is restricted to the natural influx of fish or crustacean larvae when filling ponds, containment systems and enclosures.

7.7.15. Fish shall be raised under organic principles from fingerling stage, and shall be traceable by batch at least from introduction to harvesting.

2. Instrução Normativa Interministerial n° 28, de 8 de Junho de 2011.

Ministro de Estado da Agricultura, Pecuária e Abastecimento e a Ministra de Estado da Pesca e Aquicultura do Brasil.

Capítulo VI da Aquisição De Organismos Aquáticos

Art. 19. Deverá ser comunicada ao OAC ou a OCS a aquisição de organismos aquáticos para início, reposição ou ampliação da produção aquícola.

Art. 20. Quando for necessário introduzir organismos aquáticos no sistema de produção, estes deverão ser provenientes de sistemas orgânicos.

Parágrafo único. Na indisponibilidade de organismos aquáticos de sistemas orgânicos, poderão ser adquiridos organismos aquáticos de unidades de produção convencionais, preferencialmente em conversão para o sistema orgânico, desde que previamente aprovado pelo OAC ou pela OCS, e respeitado o período de conversão previsto neste Regulamento Técnico.

Art. 26. O plantel de reprodutores deve ser proveniente de empreendimentos orgânicos.

Parágrafo único. Quando comprovada a indisponibilidade de reprodutores orgânicos poderão ser adquiridos organismos aquáticos provenientes de sistema convencional ou de ambiente natural, contanto que sejam mantidos num sistema de produção orgânico durante os três meses que precedem a sua utilização para reprodução.

Art. 27. Reprodutores que não estão sob manejo orgânico não podem ser comercializados como orgânicos, porém, suas crias podem ser orgânicas se as mesmas forem criadas sob esse sistema.

Art. 28. Quando houver a possibilidade do cultivo de espécies nativas e exóticas o aquicultor orgânico dará preferência às primeiras.

Art. 29. Devem ser utilizados métodos naturais de reprodução que interfiram minimamente no comportamento natural da espécie cultivada.

Art. 30. É proibido o uso de hormônios em qualquer etapa da produção de organismos aquáticos.

Parágrafo único. Na impossibilidade do uso de métodos de reprodução natural serão permitidos métodos não-orgânicos cabendo a OAC ou OCS estabelecer prazos para o desenvolvimento da tecnologia para seu atendimento.

Art. 31. Não é permitido o cultivo de:

I - poliplóides;

II - organismos geneticamente modificados (OGM);

III - organismos sexualmente revertidos;

IV - organismos obtidos através de gimnogênese; e

V - populações artificialmente esterilizadas.

Art. 32. As formas jovens, destinadas às etapas de recria e engorda, devem ser provenientes de unidades de produção orgânicas.

3. Hong Kong Organic Production, Aquaculture and Processing Standard (2015)

4.5 Breeds and Breeding

Aquatic animals should begin life on organic units.

4.5.1 Destructive fishing method is prohibited for collecting organisms for culture, and the extent of harvesting should not lead to over depletion of the species.

4.5.2 Brought-in cultured aquatic animals must come from organic sources. Before Dec 31st, 2017, if organic stock is not available, brought-in conventional stock must spend not less than two thirds of their life span in the organic system.

4.5.3 Any brought-in conventional stock must not contain any drug residue.

4.5.4 Cultured species must be well adapted to local conditions.

4.5.5 Aquatic animals produced by natural spawning must be used.

4.5.6 Polyploided stock, artificially sex-reversed stock as well as stock produced by the use of hormones are prohibited.

4.5.7 Transgenic and genetically modified culture stocks are prohibited.

4. The IFOAM NORMS for Organic Production and Processing (2014) (international)

6.4 Breeds and Breeding

General Principle

Organic aquatic animals begin life on organic units.

Requirements:

6.4.1 Aquatic animals shall be raised organically from birth.

Regional or other exception

When organic aquatic animals are not available, brought-in conventional animals shall spend not less than two thirds of their life span in the organic system.

When organic stock is not available, conventional sources may be used. To promote and establish the use of organic stock, the control body shall set time limits for the selected use of non-organic sources.

6.4.2 Operators shall not utilize artificially polyploided organisms or artificially produced monosex stock.

6.4.3 Aquatic animal production systems shall use breeds and breeding techniques suited to the region and the production method.

5. KRAV Standards (2016) (Sweden)

The area of the organic aquaculture standard comply completely with the EU regulation for organic production.

6. NASAA Organic & Biodynamic Standard (2016) (Australia)

7.35 Breeds And Breeding

General Principles

Breeding strategies and practices in organic aquaculture interfere as little as possible with natural behaviour of the animals. Natural breeding methods are used.

Recommendations

Breeds should be chosen that are adapted to local conditions.

Breeding goals should aim at obtaining good food quality and efficient conversion of inputs to animal growth.

Brought-in conventional aquatic organisms should spend at least two thirds of their life in the organic system before being acceptable for certification.

Standards

7.35.1 Where available, brought-in aquatic organisms shall come from organic sources.

7.35.2 Where not available from organic sources, fish from a conventional hatchery may be used for a period until reviewed.

7.35.3 Artificially polyploid organisms and genetically engineered species or breeds, are prohibited.

7. Naturland Standard (2016) (Germany)

2. Species and origin of stock

2.1 As stock, species naturally occurring in the region shall be preferred. In particular, possibility for co-operation with regional breeding/conservation programs should be examined …

2.3 The stock (eggs or hatchlings, fries etc.) has to be reared on the farm itself or purchased from farms that are certified by Naturland or meet certification standards approved as equivalent by Naturland. Insofar as this is not possible (the farm manager has to give notice and proof of non-availability) and, therefore, stock has to be purchased from conventional suppliers, the following conditions shall apply:

- Genetically manipulated (transgenic) organisms or those obtained by means of polyploidization or gynogenesis may not be stocked.
- The organisms must have been kept and fed for at least two thirds of their lives in accordance with the Naturland standards before marketing with reference to Naturland is allowed.

2.4 Feral larvae of fish and crustacean are only allowed for stocking if there is a passive inflow when the ponds or other aquaculture constructions are refilled …

3.3 The objective is the natural reproduction or spawn recovery. The use of hormones, even from the same species, is not allowed.

8. Organic Crop Improvement Association - OCIA (2013) (USA & Canada)

The guidelines in this section of the OCIA International Certification Standards, are the “Aquatic Production Standards” from the IFOAM Norms for Organic Production and Processing

9. OFDC Organic Certification Standards (2016) (China)

12.4 Aquatic animal breeds and breeding

12.4.1 Animals shall be raised organically from birth. If organic animals are not available, brought-in conventional animals shall spend not less than two thirds of their life span in the organic system.

12.4.2 Breeds should be locally adapted and regionally established. For the species that may be reproduced by the farm itself the introduction of non-organic sourced animals must be replaced soonest by the organic ones bred within the farm. For the species that may not be reproduced by the farm itself non-organic animals may only be introduced with no organic animals are available in the same region.

12.4.3 Aquatic animal husbandry should not be dependent on conventional raising systems.

12.4.4 Aquatic animals should be reproduced and bred by natural methods. Artificially polyploided organisms shall not be used.

<u>10. Ministry of Agro-Industry of Argentina, Resolution SENASA 374/2016</u>

ARTÍCULO 81.- Origen del stock y conversión de animales acuáticos convencionales a orgánicos:

Inciso a) Se deben utilizar preferentemente especies autóctonas o adaptadas localmente.

Inciso b) Se prohíbe el uso de especies o variedades provenientes de ingeniería genética, poliploidía o ginogénesis.

Inciso c) Se deben elegir especies que puedan criarse sin causar daños importantes a las poblaciones silvestres en sistemas abiertos o ante posibles escapes.

Inciso d) Se deben seleccionar reproductores teniendo en cuenta sus caracteres fenotípicos, genotípicos, estado sanitario y de adaptación al medio local a fin de prevenir la consanguinidad, evitar daflos genéticos y pérdidas de la variabilidad genética.

Inciso e) El stock puede conformarse a través del ingreso de:

Apartado I) Animales orgánicos.

Apartado II) Animales convencionales o de captura silvestre para mejorar el material genético, o ante sucesos graves imprevistos o por ampliación del stock y de no disponerse de animales orgánicos. Podrán introducirse y comercializar sus productos y subproductos como orgánicos, siempre que el stock sea saludable y se cumplan los siguientes requisitos:

Subapartado 1) Para el ingreso de reproductores: deben manejarse orgánicamente durante al menos TRES (3) meses antes de que sean utilizados como tales.

Subapartado 2) Para el ingreso de ovas: siempre que eclosionen dentro del establecimiento bajo manejo orgánico.

Subapartado 3) Para el ingreso de juveniles: el SENASA debe analizar caso por caso y determinar un período límite de aceptación para dicho ingreso. En el caso de:

3.1. Juveniles convencionales, cuando estén sometidos al manejo orgánico al menos los dos últimos tercios de la duración de su ciclo de producción o al menos el NOVENTA POR CIENTO (90 %) de su biomasa final haya sido bajo manejo orgánico.

3.2. Juveniles de recolección silvestre, de acuerdo a la afluencia natural de larvas o juveniles de peces o crustáceos al momento de llenar los estanques, los sistemas de contención y/o los cercados.

3.3. Juveniles de recolección silvestre, provenientes de captura sostenible.

ARTÍCULO 83.- Reproducción y Desarrollo:

Inciso a) Se recomienda la reproducción natural o el uso de sistemas de incubación que eviten o minimicen la aparición de patógenos, y tratamientos con elementos inocuos para el ambiente y los organismos de cultivo.

Inciso b) La inducción artificial de la reproducción de animales de la acuicultura a través de hormonas y derivados de hormonas es una práctica prohibida en producción orgánica. Para aquellas especies que no son capaces de desovar en forma natural cuando se hallan en cautiverio, será posible inducir el desove mediante hormonas exógenas específicas únicamente si no se dispone de otros métodos. Los reproductores sometidos a tratamiento con hormona liberadora perderán su carácter de orgánicos en el momento del sacrificio, mientras que la descendencia será orgánica si se ha criado de conformidad con la normativa orgánica vigente.

Inciso c) Se prohíbe la inducción poliploide artificial y la clonación

Inciso d) Se permite la crianza de organismos de un solo sexo siempre que la selección se realice en forma mecánica o manual. Se permite como práctica reproductiva la hibridación artificial.

Inciso e) Se debe diseñar un Programa de Manejo Reproductivo que detalle el origen del plantel y la metodología a utilizar para la reproducción. Dicho programa debe estar firmado por un profesional idóneo en la materia.

11. Soil Association Standard (2016) (UK)

The area of the organic aquaculture standard comply completely with the EU regulation for organic production.

12. ACT Organic Standards (2016) (Thailand)

Breeds and Breeding

Principles

- Aquatic organisms of local species shall be preferred.
- Breeding should be done by natural methods with minimum human intervention.
- The stocks shall originate from organic production.

Standards

8.6.1 The stocks should be of species naturally occurring in the region. In case of foreign aquatic organisms, they shall be species which can adapt well to the local environment, and the operator shall implement measures to prevent escapes from the farm.

8.6.2 Eggs and young stock shall originate from organic broodstock. If they are not available, wild caught or conventional broodstock are permitted provided that it is kept under organic management for at least three months before using for breeding in organic hatchery.

8.6.3 Hatcheries shall be managed organically. If young stock from an organic hatchery operation is not available, stock from conventional sources are allowed. In this case, the animals shall be raised in compliance with ACT organic standards for at least two-thirds of their lives before they can be marketed as organic. Exceptions may be granted for some aquatic species due to the constraints of available organic reproduction techniques and hatchery management. In this case, ACT may set appropriate time limits for such exceptions and require the use of organic juveniles when the development of reproduction technology in the region makes it possible to produce organic stock.

8.6.4 Brood stock and young stock from genetic engineering, polyploidization, artificial hybridization, cloning and production of mono sex strain (e.g. sex change through use of hormones) are prohibited.

8.6.5 Natural reproduction shall be ensured throughout the breeding and spawning processes. The use of hormones and physical manipulations, e.g. appendicle cutting, are prohibited.

8.6.6 The use of artificial heating or cooling of water for culture, and ultraviolet and ozone for disinfection is allowed only in hatcheries and nurseries.

8.6.7 The capture of wild stocks for cultivation is not allowed except for natural inflow of aquaculture juveniles (e.g. larvae of fish and crustacean) when ponds or other aquaculture enclosures are refilled.

13. Organic Aquaculture Standards (2012) (Canada)

6.2 Aquaculture Animal Species and Origins

6.2.1 Aquaculture animals intended for organic production shall be taken from indigenous species or adapted to rearing conditions.

6.2.2 Aquaculture animals that are introduced in a production unit shall come from organic sources.

6.2.3 For breeding purposes or for improving genetic stock, and when organic aquaculture animals are not commercially available, wild-caught or non-organic aquaculture animals may be brought into a production unit and shall be kept under organic management. Collection of wild-caught species shall be in compliance with all local regulations, and shall be done in collaboration with government agencies, to ensure that natural populations and the collected individuals are protected, and that biodiversity in the ecosystem is supported.

6.2.4 Broodstock that has not been under continuous organic management shall never be organic for slaughter purposes. However, the offspring may be organic if they have been raised according to this standard.

6.2.5 For finfish, if organic animals are not commercially available, stock from non-organic hatcheries may be used, provided that at least the final 90% of biomass gain occurs while the animals are under continuous organic management.

6.3 Reproduction

6.3.1 Cultivation methods shall allow natural methods of hatching or spawning with the following exceptions:

a. The use of methods involving human intervention to extract gametes and fertilize eggs is permitted.

b. For species that cannot spawn naturally in captivity, spawning may be induced using exogenous releasing hormones only if other methods are not available. Broodstock shall lose organic status when slaughtered.

6.3.2 Aquaculture animals treated with steroids or other hormones shall lose organic status for human consumption. Broodstock obtained by treatment with steroids or other hormones shall lose organic status but may continue to be used within the organic aquaculture system.

6.3.3 Techniques using genetic engineering are prohibited.

2.6. References

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EXECUTIVE DOSSIER N°3. PRODUCTION SYSTEMS

3.1. Land based systems

Fish ponds in some regions of Europe are bound with the rural economy as well as with the natural landscape. In some areas, centuries old fish ponds are even the major feature of the landscape. Currently, the main function of most fishponds is the production of fish based on utilisation of the natural production potential of the pond ecosystem. Carp represents a dominant species of pond aquaculture. It is an omnivorous species that feeds on larger food organisms of zooplankton and zoobenthos, which are the easiest available in the pond's ecosystem. Pond yields are relatively low, ranging from 200 to 1,500 kg/ha^{-1}, depending mainly on the altitude above sea level and climatic conditions. Carp pond polyculture can be integrated with intensive rearing of other fish in facilities connected with a pond. In this case, the flow-through tanks of the intensive system are constructed usually nearby the fish pond. The effluent of the intensive unit is discharged into the pond where the drifted-in fish faeces and other products of metabolism increase the natural fish food production in the same way as manure does. Fertilization of ponds is required, sometime, to supply macro and micro nutrients necessary for development of primary production. At present it is considered a means for adjustment of the proportion of nutrients in ponds in order to support natural production. Liming with limestone or burnt lime is a practice mainly used to adjust the alkalinity of pond water with the aim of maintaining its buffering capacity and stabilize pH values. Pond liming considerably contributes to the function of mineralization of organic matter in the bottom. In order to reduce organic substances from water column, burnt lime is applied on the surface of the water by the end of a growing season with the aim of improving the oxygen regime. Liming is also used as a disinfectant (burnt lime) or a therapeutic (chlorinated lime). The pond bottom is left to dry over a winter or summer period to support the mineralisation processes. Nitrification, oxidization of the organic carbon and transformation of organic phosphorus to phosphate are the main processes that occur during mineralisation. The indispensable importance of wintering and summering also lies in disease prevention. During summering, much more germs are killed than during wintering due to the disinfecting effect of ultraviolet radiation. On the other hand, during wintering, more nutrients are released as the structure of bottom sediments (mud) is more disturbed by freeze and the mineralization thus takes place deeper. In situation of pond siltation, due to soil washes from cultivated agricultural land, the elimination of extremely thick layers of mud can be needed. In such case, the restoration of permanent benthic fauna can take up to several years.

Traditional organic land based farms use flow-through systems in which the water is taken via a damming of the adjacent water course/river, or via borehole, or directly from the sea. The water 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, but some traditional farms have replaced earthen ponds with tanks built of concrete or another waterproof material. Organic farms also include mechanical (micro-sieves, settling ponds) and biological facilities for effluent.

Though less frequent, land based conventional farms can be of extensive flow-through type, with a mechanical effluent treatment and high water consumption.

The land based farms can be also of intensive type, with a highest level of innovation (Blancheton et al., 2007). To reduce water consumption and the environmental impact from the fish production, new cleaner technologies are being implemented in farms, i.e recirculation technologies. This implies a more intensive production, relatively high degree of water re-use, as well as a quite efficient removal of waste (organic matter, nitrogen, phosphorus), and the stocking density may be relatively high. Water treatment takes place partly by internal conversion processes and partly via sludge cones, micro-sieves (or contact filters), plant lagoons, and sludge basins (Jokumsen and Svendsen, 2010).

In addition, intensive farms can be based on a closed recirculation aquaculture system (RAS), in which new water is mainly supplied for filling up and to replace water lost by evaporation. The degree of recirculation can be of about 95% (Jokumsen and Svendsen, 2010). Intensive RAS are used in aquaculture production to minimize water consumption, as well as the environmental impact of the water discharge. RAS can use the same water many times and hence includes a wide range of waste water treatment devices (Martins et al., 2010; Dalsgaard et al., 2012). As a matter of fact, the use of RAS disconnects the production from the external environment. The production water from the fish tanks passes through a mechanical filter (i.e. a micro-sieve with mesh size of about 60 µm). The micro-sieve separates particulate matter, which is flushed as sludge to a sludge storage tank, until it can be used as agricultural fertilizer or for production of biogas. From the micro-sieve the water is pumped to the bio-filters, where the dissolved fractions, especially ammonia (NH_4^+), are converted into nitrate (NO_3^-). In a separate bio-filter with anoxic (no oxygen) conditions (a denitrification filter), the NO_3^- is anaerobically converted into N_2 gas under consumption of easily degradable organic matter (Van Rijn et al., 2006; Suhr et al., 2013). The recirculation water passes through a trickling filter for degassing (N_2, CO_2) and aeration. Then, before entering into the fish tanks, the water passes an UV radiation device to inactivate micro-organisms, especially bacteria. However, a portion of the aerated water from the trickling filter is pumped through an oxygen cone for oxygenation before it enters the fish tanks. In addition, pure oxygen may be added at each tank/section (Chen et al., 2006, Pedersen et al., 2012; Van Rijn, 2013) and the temperature can be adjusted using devices for heating or cooling the water. The amount of new water needed in the RAS corresponds to the amount required to flush the micro-sieves and the bio-filters, to compensate for evaporation, and to keep the temperature at an appropriate level. The water consumption in RAS is more than 100 times less, i.e. less than 500 l kg^{-1} feed fed to the fish, than in traditional flow through systems (Jokumsen and Svendsen, 2010). RAS requires input of external energy for pumping water around, water treatment and aeration. The advanced technologies, management, comprehensive surveillance systems, working processes, and hygienic procedures in a RAS farm requires well-educated and trained personnel with the competence required to achieve optimum productivity. The high degree of recirculation makes it critical to continuously monitor and control the water quality within narrow limits, and the extensive use of alarm systems is necessary for several parameters. In the following table, a comparison has been set up between a traditional flow through system in organic farming and an intensive recirculation aquaculture system (RAS).

Flow-through organic system	**RAS**
Advantages	**Advantages**
1. Production in commune with nature;	1. Low water consumption;
2. Favours biological diversity and animal welfare;	2. Recycling of water;
3. Extensive production;	3. Stabile farming conditions/water quality;
4. Natural temperature and light conditions;	4. Control water temp;
5. “Low” stocking density;	5. No environmental impact;
6. Behavioural needs can be met;	6. Prevent ingress of pathogens;
7. Use of mechanical aerators;	7. Prevent escapes;
8. Waste water nutrients removal using natural-filter beds;	8. Recycling/collection of waste nutrients (fertilizer);
9. Environmental sustainable;	9. Easy to disinfect/clean;

Disadvantages 10. Dependent on external conditions (weather/temperature fluctuations/water quality); 11. Risk of escape; 12. Unstable external conditions may compromise animal welfare/disease prevalence; 13. Risk of up-stream pollution;	**Disadvantages** 10. Energy consuming; 11. Need use of pure oxygen; 12. "High" stocking density; 13. Intensive production; 14. In case of disease, risk of boosting prevalence; 15. Disconnected by the natural environment.

Most of traditional organic farms are open-air flow through systems. However, due to the limitations of water resources, the re-use of water could represent a desirable ecological practice in aquaculture and a responsible use of resources. Closed recirculated systems have several environmental advantages, but require significant input of external energy, high stocking densities (for economic reasons), advanced water treatment devices, use of UV radiation and oxygenation tools, use of artificial light. All the above, together with the disconnection of the aquaculture production from the external natural aquatic environment, makes the closed recirculated systems not in line with the principles of organic production. An alternative strategy is the re-use of water which, to some extent, combines the advantages of both flow through systems and RAS, without compromising organic principles. Re-use of water means a kind of extensive recirculation in out-door systems, with up to 70 % of reuse of the water (Colt, 2006). Instead of being discharged, the water is pumped back to the inlet and re-used in the fishponds, tanks or raceways after passing waste water treatment devices, such as natural-filter beds, settlement ponds, mechanical or biological filters to collect waste nutrients, and/or using seaweeds and/or bivalves and algae, which contribute to improving the quality of the effluent. The type(s) and capacity of waste water treatment device(s) depend(s) on the specific conditions on the specific farm related to production capacity/intensity approved and fulfilment of water quality criteria. To comply with the species-specific physiological requirements of the fish, the proper oxygen saturation in the aquatic environment shall be achieved only by using mechanical aerators. This means that there should be a well-balanced equilibrium between the stocking density, the efficiency of the removal of waste water nutrients and the amount of water re-used for the proper operation of the organic farm.

3.2. Cage systems

By far the largest proportion of European aquaculture biomass production takes place in cage cultures as this is the prevailing production system in the salmon, sea bass and sea bream production. Benefits of cage culture are relatively low investment costs, low energy costs, utilise environmental resources and efficient area use, low carbon footprint compared to other production systems. At the beginning of cage aquaculture, farmers were looking for safe and easily accessible locations for their farms, often resulting in sites with very limited recipient capacity. Shallow localities, with safe weather exposure and low water currents, had led to organic overload of the sediments under the farms, often resulting in anoxic conditions, production of hydrogen sulphide (H_2S) and substantial negative effects on the biodiversity. There is nowadays among farmers a wider awareness of the importance of avoiding a negative environmental impact to the sea bottom. In addition, a number of countries have implemented regulations regarding the environmental interaction of the cage aquaculture.

According to the Norwegian Regulation, each aquaculture site has to undertake a recipient inspection to ensure that the environment close to the site is not negatively affected on long term. Furthermore, the allowed biomass on a site is based on the recipient capacity to handle organic load and the farmers have to document the status of the sea bottom annually. Depending on the inspection report, mitigation actions might be required, such as reduced biomass on the farm, or total fallowing of the location for a given period. In between generations, a period of fallowing is obligatory to let the locality rest for a minimum of three months. The Norwegian Regulation also contains requirements for the physical design of the installation and how the installation shall be operated in order to prevent escape.

Biofouling in cage aquaculture can affect rearing equipment and infrastructure such as the cage nets, support structures and mooring, floats, barges and buoys. It can affect water quality within the rearing system by limiting water flow via occlusion of the net, can act as a vector for transfer of disease and can also lead to cage loading and structural problems. This structural loading can lead to component damage, functionality and material fatigue and may impact upon the security and overall integrity of the farming unit. However, the use of chemical antifouling is not the appropriate procedure, due to the reported toxicity of coatings that contain e.g. copper or zinc. Indeed, to contrast the effects of biofouling, without using toxic chemicals, cage aquaculture has a number of option including i) air exposure of the netting to reduce levels of biofouling; ii) use mechanical or physical net cleaning procedures such as large scale net washers (*ex situ*) or disk or jet based net cleaners (*in situ*); iii) the use of biological control such as cleaner fish or cucumbers. Removal of the nets for *ex situ* cleaning on shore is also a robust method for addressing biofouling problems, but frequent net changing procedures can potentially increase the risk of fish escapes and frequent intensive mechanical washes can reduce the lifespan of the net. With regard to biological control of fouling organisms, there are several geographically specific species that may be suitable for limiting the extent of biofouling in cage culture. Species such as the red sea cucumber *Parastichopus califomicus* have been shown to be an effective anti-fouling species when reared in duo-culture with Atlantic salmon in net pens. Also wrasse (Labridae) can reduce the prevalence of biofouling on nets in salmon farming, which could be a secondary benefit of using cleaner fish for parasite and lice control in salmon farming.

3.3. Integrated Multi-Trophic Aquaculture (IMTA)

Integrated Multi-Trophic Aquaculture (IMTA) offers various benefits when compared with standard “mono-culture”. IMTA integrates cultivation of “extractive” commercial species, from different trophic levels, with commercial finfish, such as salmon or seabream. The extractive macroalgae and/or invertebrates turn farm wastes into value-added products. However, IMTA technology can vary across a range of environmental gradients with the two extremes being the oligotrophic and eutrophic environments.

Though the concept of IMTA is relatively easy to understand, its definition and application is far from simple. A starting point might be to assess how effective the IMTA system is at removing excess nutrients from the environment, especially nitrogen. Depending on the receiving water body, the most important may be the suspended solids that sit on the bottom and may degrade it (quenching of the plants growing on the bottom and creating an anaerobic environment): N and P are immediately converted into µalgae which ‘enrich’ the trophic chain. Therefore, setting the right thresholds for nitrogen removal may be crucial to the success of IMTA applications. However, changes in water quality have a wider variability than could be offset by the extractive species at scales that are liable to be implemented in a European IMTA system. Nevertheless, modelled outputs have shown that both shellfish and algae grow more when co-located with fish, than when they grow without fish, which is suggestive that offsetting take place.

There is a mismatch between the scales of production between finfish and extractive organisms in terms of the space required to make a meaningful reduction in the nitrogen emissions. Work in Canada suggests that to remove 10% of the nitrogen from a 1000 tons salmon farm would require approximately 10 hectares of seaweed. A study from the IDREEM project suggest that benthic IMTA may be far more efficient in terms of space requirements. In this type of IMTA detritivores are grown underneath the finfish cage within the benthic footprint of the cage, feeding on the large particulate waste which falls directly to the bottom.

Temporal overlap in production is also important. Production of some species, especially algal species, relies on removing mature wild to produce sporophytes and, due to temperature limitations, this mainly happen over the latter part of the year, while deployment, generally, is in the early part of the following year for on-growing. This mean that the overlap in production of both fish and algae may be relatively short, thus limiting also the potential offsetting. Timing between fish and shellfish production is, generally, better than with algae. Within this context, and the limitations pointed out, a useful approach for developing commercial IMTA in Europe could be to cultivate multiple fully integrated species at the scale of a water body. With this kind of ecosystem scale approach, species integration issues, spatial scale issues and some of the issues in temporal overlap of production could be more easily managed.

Across Europe the regulatory framework for IMTA is complex, sometimes not available at all and or not harmonized. In some countries, the regulatory framework represents a significant barrier to the development of commercial IMTA. A lack of understanding in what IMTA represents at all social levels, and what the issues are in terms of policy development are an active discouragement to companies, preventing them from developing their own IMTA projects. To address this problem, a closer collaboration between the researchers and policy makers is necessary. There must also be public awareness campaigns to explain the various benefits that IMTA offers compared with standard “mono-culture”. In the meanwhile, research should continue to provide evidence of both the impacts and benefits of IMTA at commercial scale, with all parties working towards the overcoming of these gaps.

3.4. Environmental impact

The escape of fish from sea cage aquaculture is perceived as a threat to natural biodiversity in Europe's marine waters. Escaped fish may cause undesirable genetic effects in native populations through interbreeding, and ecological effects through predation, competition and the transfer of diseases to wild fish. When referring to escapes from cage aquaculture, the definition usually refers to escapes involving juvenile and adult individuals. However, for certain European species such as Atlantic cod *Gadus morhua* L. and gilthead sea bream *Sparus aurata* L. which are known to potentially spawn during the cage holding phase of aquaculture production, escapes of viable gametes via spawning (e.g. Jørstad et al. 2008; Somarakis et al., 2013) has also emerged as an escape risk. However, the majority of the causes of escapes are caused by structural factors. These escapes could be directly related to mooring and structural failures, or abrasion and tearing of nets during severe weather events, possibly in tandem with human error in terms of farm operation or installation. According to the knowledge provided by EU research projects, such as Prevent Escape, and national regulations, such as the Norwegian technical standard (NS 9415), for the design, dimensioning and operation, it is highly recommended the introduction, at EU level, of a technical standard for sea-cage aquaculture equipment, coupled with control procedures to enforce the standard. This recommendation apply to conventional aquaculture, but actually even more to organic aquaculture. The above mentioned technical standard should include calculation and requirements for the physical design of the installation and the associated documentation, as well as operating and maintenance requirements. This mean, for example, requirements for the physical design of all the main components in an installation and the choice of netting materials that have better resistance to tearing or biting (in the case of Atlantic cod and gilthead seabream). Provisions for the periodic training of the staff, in order to limit the frequency and impact of the fish escapes, would be also recommended.

It has been suggested that to better protect wild fish stocks, from the potential detrimental consequences of aquaculture escapes, preventing measures are by far the most effective than operational methods for recapturing escapees. However, a recovery program should be initiated, as soon as an escape has been discovered, to increase the likelihood of potential recapture. The efficacy of recapture methods can vary among species and life stages, but recovery programs that incorporate gill nets (deployed at various depths), rod anglers and also coastal net fisheries appear to be the most effective.

The environmental impact and the interactions between cage aquaculture and sea bottom should be carefully monitored along the farming activity. The choice of the farm location should be based upon the presence of a high current regimes and the absence of sensitive habitats on the sea bottom. In case the organic load from the fish farm aggregate on the sea bottom, mitigation actions should be required (e.g. reduced biomass on the farm, or total fallowing of the location for a time restricted period). In between two production cycles, a period of fallowing is obligatory to let the locality rest for a minimum of three months (Norwegian Directorate for Fisheries). Minimising the organic load from the farms means reducing feed waste and faecal material. The loss may be due to uneaten pellets falling through the cages (Dempster et al., 2009) and fragmentation during feeding (Aas et al., 2006). As the faecal material represents the undigested part of the feed, this proportion depends on digestibility of the feed. To this purpose, it is worth noting that the introduction of plant materials as replacement of marine raw materials in the feed has reduced the digestibility of the diets. The use of fishmeal derived from trimmings, which are higher in phosphorus content compared with high quality fish meal, represent a further potential environmental impact.

The technology for collecting sludge from open sea cages is poorly developed, whereas in land based aquaculture (flow-through and recirculation systems) and potentially in the novel closed sea cages, waste particles larger than a certain particle size can be collected with various filtering methods and potentially recycled (Sharrer et al., 2010; Tal et al., 2009). Aquaculture waste has shown potential as agricultural fertilizer, even sludge from marine water aquaculture, particularly when mixed with other wastes or components (Brod et al., 2012; Brod et al., 2014). This may be the simplest way of recycling aquaculture waste if the logistic challenges (volume, transport distance and sufficient recipient areas) are solved. Fish also excrete nutrients directly to the water which are not captured in the sludge. Nitrogen (N) and other elements/substances are excreted from kidney, gills and skin. Dissolved and dispersed waste can be captured by growing species that extract the dissolved nutrients from the water, such as macro-algae (e.g. kelps), filter feeders (e.g. mussel) and deposit-feeders (e.g. sea cucumber). About such kind of polyculture see the paragraph of integrated multi-trophic aquaculture (IMTA).

3.5. References to international standards of organic farming

In this chapter are reported the main rules applicable to the organic aquaculture production systems as they have been defined in various international standards. For each standard/regulation it is also reported the issue date and the Country of origin.

1. Australian Certified Organic Standard - ACOS (2016)

7.7.1. Sites for organic aquaculture production shall be chosen giving consideration to minimization of potential contamination with non-allowed inputs or other pollutants. In addition, the establishment of an organic aquaculture operation shall not negatively impact upon the surrounding environment or ecosystems. This shall include consideration of the natural ecological function of the water body.

7.7.2. Maps or sites and production areas, and a full description of installations and infrastructure are to be submitted to the CO, and maintained on file by the operator.

7.7.3. If production of organic and non-organic aquatic products is conducted, section 3.6 of the ACOS applies. In the case of Aquaculture, consideration must be given to water distribution systems, tides, and water flows and how these may be managed to prevent contamination of organic products.

7.7.4. A Sustainable Aquaculture Management Plan (SAMP), or equivalent, is required to be prepared as part of the Organic Management Plan (see section 3.4.1.2). The plan shall be specific to the operation in question, and shall include such an environmental assessment, approach for monitoring of environmental effects, minimisation of impact on the environment of the area, maintenance of infrastructure etc.

7.7.5. Where practical, renewable energy sources shall be chosen, and waste minimised and/or recycled.

7.7.6. For conventional (non-organic) operations converting to organic, a conversion period of 12 months, or one full production cycle (whichever is longer) shall apply. During this time, two audits by the certification body must be conducted. Wherever possible, full draining, cleaning, flushing, and disinfecting of ponds, containment units etc. should be conducted prior to converting to organic methods.

7.7.7. Water sources shall be verified to pose minimal risk from contaminants such as heavy metals, pesticides, biocontaminants and hormone disrupting chemicals. Risk is to be assessed on a case by case basis and tests will be required to verify the contaminant status of the aquaculture environment.

7.7.8. For open marine and freshwater environments the prevailing natural ecological balance shall remain significantly undisturbed ensuring that natural populations are not endangered.

7.7.9. Water leaving the operation shall be treated or managed in such a way as to prevent excessive nutrient build up either on or off site.

7.7.16. Certified fish shall not come in contact with uncertified stock during their life cycle. Parallel production of organic and non-organic fish of the same species, where there is no visual differentiation between them, is not permitted.

2. Instrução Normativa Interministerial n° 28, de 8 de Junho de 2011.

Ministro de Estado da Agricultura, Pecuária e Abastecimento e a Ministra de Estado da Pesca e Aquicultura do Brasil.

Art. 15. A conversão parcial ou produção paralela será permitida desde que os organismos aquáticos de mesma espécie tenham finalidades produtivas diferentes, apenas em áreas distintas e demarcadas.

§ 2° A conversão parcial ou produção paralela será permitida, no máximo, por 5 (cinco) anos.

§ 3° A partir do período descrito no § 2o deste artigo, somente será permitido o uso de espécies diferentes em áreas distintas e demarcadas.

Art. 16. Na conversão parcial ou produção paralela, a unidade de produção deverá ser dividida em áreas, com demarcações definidas, sendo vedada a alternância de práticas de manejo orgânico e não-orgânico numa mesma área.

Art. 58. Os sistemas produtivos deverão ser projetados preferencialmente com tanques de decantação, filtros biológicos ou mecânicos para remover os resíduos e melhorar a qualidade dos efluentes.

Art. 60. Todas as instalações deverão garantir boas condições de criação e impedir a fuga os organismos aquáticos para o meio ambiente.

3. Hong Kong Organic Production, Aquaculture and Processing Standard (2015)

4.2.1 Save as is provided in 4.2.2, the buffer zone of pond culture and marine cage culture must not be less than 2 metres and 100 metres, respectively.

4.2.2 If physical barriers such as hedges, barrier plants or drains are available in the buffer zone, the Certification Board may relax the buffer zone requirement in a case by case basis.

4.3.1 Parallel production may be practiced if the following conditions are satisfactorily implemented under an agreement with HKORC-Cert.

4.3.1.2 Mixing of water body between organic and other aquaculture modes is prohibited.

4.3.1.3 A clear and identifiable separation between the areas for organic production and other production modes must be maintained. Feed, fish products harvested and other inputs for organic production must be stored separately.

4.3.1.4 Organic and non-organic aquatic animals must be visually distinguishable. Exceptions can only be granted by HKORC-Cert on a case-by-case basis.

4.4.2 In order to maintain the aquatic environment and surrounding aquatic and terrestrial ecosystems, the following production practices should be adopted comprehensively.

4.4.2.1 Encouraging and enhancing biological cycles.

4.4.2.3 Conserving biodiversity through polyculture

4.4.3 Producers must take appropriate measures to prevent excessive exploitation and use of water resources. They must where possible reuse water, recycle rainwater and monitor water extraction.

4.4.8 Operators must take appropriate measures to prevent escapes of introduced or cultivated species, and documenting any that are known to occur.

4. The IFOAM NORMS for Organic Production and Processing (2014) (international)

6.2 Aquatic Ecosystems

General Principle

Organic aquaculture management maintains the biodiversity of natural aquatic ecosystems, the health of the aquatic environment, and the quality of surrounding aquatic and terrestrial ecosystem.

Requirements:

6.2.2 Operators shall take adequate measures to prevent escapes of introduced or cultivated species and document any that are known to occur.

6.2.3 Operators shall take verifiable and effective measures to minimize the release of nutrients and waste into the aquatic ecosystem.

5. KRAV Standards (2016) (Sweden)

The area of the organic aquaculture standard comply completely with the EU regulation for organic production.

6. NASAA Organic & Biodynamic Standard (2016) (Australia)

7.29.4 Where the entire production is not converted the following is required:

Physical separation between conventional and organic production units. For sedentary or sessile organisms not living in enclosures, the area shall be at an appropriate distance from pollution or harmful influence from conventional aquaculture/agriculture or industry.

7.30.6 Adequate measures shall be taken to prevent escapes of farmed species from enclosures and any known or suspected escapes must be documented.

7.31.1 Distances between organic and conventional production systems shall be a minimum of 5 metres between ponds and 100 metres in open waters where feeding is carried out.

7. Naturland Standard (2016) (Germany)

1.1 By selection of site and the method of management of the farm, the surrounding ecosystems shall not be adversely affected. In particular, negative impact caused by effluents as well as by escape of animals shall be prevented by adopting suitable preventive measures …

1.5 Preference is to be given to the use of renewable energy resources and re-cycle materials. Waste is to be kept to a minimum. Developments in these areas have to be recorded each year.

2.2 Where suitable, polyculture shall be preferred. Polyculture either shall lead to direct benefit for the species cultivated (e.g. wrasse for elimination of ectoparasites in salmon cages) or to more effective utilisation of the available resources (e.g. by building up food chains in the water courses).

8. Organic Crop Improvement Association - OCIA (2013) (USA & Canada)

The guidelines in this section of the OCIA International Certification Standards, are the “Aquatic Production Standards” from the IFOAM Norms for Organic Production and Processing

9. OFDC Organic Certification Standards (2016) (China)

12.2.1 Organic aquaculture management should maintains the biodiversity of natural aquatic ecosystems, the health of the aquatic environment, and the quality of surrounding aquatic and terrestrial ecosystem.

12.2.2 Organic aquatic production should maintain the aquatic environment and surrounding aquatic and terrestrial ecosystem, by using a combination of production practices that:

a. encourage and enhance biological cycles;

c. provides for biodiversity through polyculture and maintenance of riparian buffers with adequate plant cover.

12.2.4 Operators shall take adequate measures to prevent escapes of introduced, or cultivated species and document any that are known to occur.

10. Ministry of Agro-Industry of Argentina, Resolution SENASA 374/2016

ARTÍCULO 74.- Principios Generales. La acuicultura orgánica se debe basar en:

Inciso c) El manejo adecuado de los procesos biológicos y los sistemas ecológicos, utilizando los recursos naturales de manera sostenible.

Inciso d) La preservación del ambiente acuático, la calidad del agua circundante y la biodiversidad.

Inciso e) La realización de evaluaciones de riesgo, y el uso de medidas preventivas.

Inciso f) La tendencia hacia sistemas de producción multitróficos integrados y al policultivo, a fin de utilizar el ambiente acuático de una manera integral y efectiva y minimizar efectos indeseables en el ambiente.

ARTÍCULO 77.- Sistemas de contención acuáticos: El diseño y construcción de los sistemas de contención acuáticos debe asegurar que se reduzca al mínimo el riesgo de incidentes de escape.

ARTÍCULO 78.- ... Las instalaciones para la cría de los animales de la acuicultura deben cumplir con los siguientes requisitos:

Apartado IV) Fondo del medio de cultivo lo más similar posible a las condiciones naturales.

Inciso d) Los sistemas de recirculación cerrados están permitidos en cualquier etapa de los ciclos productivos cuando su uso sea consistente con los principios generales de la acuicultura orgánica. Dichos sistemas se abastecerán preferentemente con energías renovables procedentes de fuentes naturales. Las aguas de desecho deberán ser tratadas y se realizará mantenimiento de los equipos, registrando y asegurando que el impacto sobre el ambiente sea mínimo.

ARTÍCULO 79.- Requisitos específicos de las instalaciones según sistema de producción:

Inciso a) Para los sistemas de producción en tierra se debe:

Apartado 11) Disponer de estructuras (estanques, tanques, canales o race-ways) equipadas con sistemas de decantación, de filtrado para recoger las excretas y nutrientes residuales, o utilizar algas, plantas acuáticas u otros organismos acuáticos que contribuyan a mejorar la calidad del agua efluente.

Apartado V) Tratar la fracción disuelta remanente (sustancias químicas inorgánicas y orgánicas, productos del metabolismo de los organismos y del alimento no consumido) tratando de evitar la eutrofización de los ambientes. Para esto se recomienda la adopción de sistemas integrados de producción.

Inciso b) Para los sistemas de producción flotantes se debe:

Apartado I) Elegir la ubicación donde haya movimiento de masas de agua y donde la profundidad y las tasas de intercambio sean suficientes para minimizar el impacto en el ambiente circundante.

Apartado 11) Disponer de jaulas, construcciones y equipos con el mantenimiento adecuado para garantizar su funcionalidad y evitar el escape de especies de cultivo ante fallas estructurales y que pueda producirse impacto negativo sobre el sistema productivo y el ambiente circundante. Para ello los equipos y estructuras de cultivo deben ser regularmente monitoreados.

ARTÍCULO 84.- Producción acuícola orgánica y convencional simultáneas. Se procura que toda la explotación sea manejada bajo el sistema orgánico. Como excepción, el SENASA puede permitir la presencia de unidades de producción orgánica y convencional en una misma explotación, siempre que haya una clara separación física entre las unidades para evitar escapes o posible confusión o fraude.

Inciso a) Solamente pueden coexistir animales orgánicos y convencionales de diferentes especies.

ARTÍCULO 85.- Manejo de los animales. Para el manejo de los animales se debe:

Inciso g) Usar oxígeno en la terapéutica animal o para atender períodos críticos de transporte y producción únicamente, bajo las siguientes circunstancias:

Apartado I) En casos excepcionales de aumento de la temperatura o descenso de la presión atmosférica o contaminación accidental.

Apartado II) En oportunidad del muestreo y clasificación de los lotes.

Apartado III) Para garantizar la supervivencia de los lotes de la explotación.

11. Soil Association Standard (2016) (UK)

The area of the organic aquaculture standard comply completely with the EU regulation for organic production.

12. ACT Organic Standards (2016) (Thailand)

8.2.1 If unable to convert all holding facilities to organic production yet, the producer shall ensure that organic and non- organic units are physically and hydrologically separated to prevent contamination of the organic operation and run with separate management, documentation and financial accounting. All production units in the holding of the producer shall be inspected by ACT.

8.2.2 Aquatic organisms reared in the producer's non-organic production unit shall be species which are different and can be easily distinguished from those cultivated in the organic system.

8.2.3 ACT may allow parallel production of the same species of aquatic life, but the producer shall ensure that production periods in organic and non-organic operations can be clearly distinguished by timing the release of young stocks far apart enough to prevent harvesting times from overlapping. In this case, ACT may impose additional requirements for the producer and require extra inspection. ACT reserves the right to certify produce from the parallel production on a case by case basis.

8.2.4 The producer shall have a conversion plan to convert the entire operation to organic production within 5 years.

8.3.3 Organic aquaculture production systems shall not cause negative environmental and social impact on the surrounding areas and water bodies. If the aquaculture farm applying for certification is large-scale production or located in areas where its operation might have impact on local communities, it shall be subject to an environmental assessment by a relevant competent authority or a licensed organization and submit the report to ACT for evaluation before certification. If an equivalent assessment has already been done on the farm, its report can be used for the purpose.

8.4.3 The producer shall develop polyculture of production, preferably by mixing or rotating other organisms, animal or plant, with the certified species in ways which they mutually benefit one another or create a food chain in production ponds.

8.4.7 The producer shall have measures to prevent escapes of cultivated stock. If escapes are discovered, the producer shall take measures to reduce the impact on the local ecosystem, e.g. by recapture.

8.4.12 Closed recirculation aquaculture production is not allowed if such system depends only on external inputs and high energy consumption, e.g. production in enclosed ponds or tanks, except in hatchery and nursery.

13. Organic Aquaculture Standards (2012) (Canada)

6.1.2 The operator shall detail the environmental effects of the operation and the environmental monitoring to be undertaken, and list measures to be taken to minimize negative impacts on the surrounding aquatic and terrestrial environments, including limiting waste accumulation and minimizing impact to the migratory and reproductive patterns of local wild fish populations, other local species like predators, birds and any other fauna and flora.

6.1.3 Open water units shall be sited and managed in such a way that sediment build-up underneath the unit does not exceed the assimilation capacity of the local environment. The operator shall develop a dissolved and particulate nutrient management plan clearly illustrating how assimilation capacity will be evaluated and how assimilation capacity will be maintained.

6.1.4 Nutrient cycling through practices such as Integrated Multi-Trophic Aquaculture is encouraged.

6.6.2 Cultivation shall occur within a secure and well-managed production system where controls are in place to prevent breaches of containment. A contingency plan for all units shall describe how escapes can be avoided and how escapees may be recaptured. Recaptured animals will lose their organic status. …

6.6.3 Recirculation systems are permitted if the system supports the health, growth, and well-being of the species.

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EXECUTIVE DOSSIER N°4. FEED FOR FISH AND CRUSTACEANS

4.1. Fish meal and fish oil replacement

There is an increasing concern about the consumption of fishmeal and fish oil for aquaculture feed, due to the increasing demand from the expanding aquaculture industry and concerns about decreasing wild stocks. This concern can be addressed by supporting the use of trimmings from sustainable fishery and/or the use of alternative protein sources. However, fishmeal of high quality provides a balanced amount of all essential amino acids, minerals, phospholipids and fatty acids reflected in the normal diet of fish (Lund et al., 2012), and secure high utilization by the fish and minimum discharge of nutrients to the environment. Hence, fishmeal and fish oil are strategic ingredients to be used at critical stages of the life-cycle when optimum performance is required.

Fishmeal from trimmings is lower in protein and higher in phosphorus content, compared with high quality fish meal, which imply a potential conflict with national environmental legislations (e.g. Danish legislation only allows max. 0.9% of phosphorus content in fish feed), as well as nutritional concern. Therefore, in order to comply with the general rules on feed [see Reg. (EC) n° 834/2007, art. 15(d)(i)] the diet for carnivorous fish should include fishmeal derived not only from trimmings, but also from whole fish caught in fisheries certified as sustainable … [see Reg. (EC) n°889/2008, art. 25k(e)].

Replacing fish meal in diets for salmonids and marine species is not straightforward due to its high nutrient digestibility, high palatability, adequate amounts of micronutrients, and general lack of anti-nutrients (Kaushik and Seiliez, 2010; Lund et al., 2012). Indeed, complete replacement by plant proteins is usually not successful due to problems related to the anti-nutrient factors, altered patterns of amino acid uptake and impairment of immune competence (Bendiksen et al., 2011; Borquez et al., 2011; Larsen et al., 2012; Lund et al., 2011). High replacement ratios would require that anti-nutrients factors are efficiently removed from alternative plant protein ingredients and that the dietary amino acid profile is optimised, for example by adding free amino acids, and/or by combining several plant protein sources with different amino acid composition (Kaushik and Seiliez, 2010). Indeed, a carefully balanced amino acid profile is important for the growth of the fish, as well as the minimization of nitrogen discharge. Anyhow, procedures for removing anti-nutrients have to follow organic rules and, furthermore, there is less availability of relevant organic plant sources to optimize the amino acid profile, in comparison to conventional plant sources (Lund et al., 2011). Additionally, supplementation with synthetic amino acids is not allowed by the Council Regulation (EC) No 834/2007 art. 15 1d. (IV). Although, it is worth noting that an exception to this prohibition was introduced by the Reg. (EU) n° 1358/2014 only for the histidine, provided that it is produced by fermentation methods.

There are several other potential feed ingredients, such as microbial organisms (bacteria, fungi, microalgae), terrestrial animal by-products (PAP, blood meal), wild-harvested and/or cultured annelid worms, insect larvae/pupae, gastropods (e.g. golden apple snail), in addition to the plant proteins, which may also be candidates to replace fish meal in aquaculture feed in the future (Sørensen et al., 2011). A special aspect of some of these products is that they can be produced with different kinds of waste as raw material, and thus contribute to recycling of valuable nutrients.

Microalgae as raw matter or a feed ingredient for fish have gained interest, as they are the natural start of the food chain in the oceans. Modern processes of algae cultivation in photo-bioreactors or fermentation systems can provide algae under a flour form, which can be used as meal for the production of formulated pellets. The chemical composition of micro-algae varies depending on species, cultivation parameters and the potential as a feed ingredient varies accordingly (Skrede et al., 2011). The microalga T-Iso (*Isochrysis* spp.), in partial substitution of fish meal in gilthead Sea bream, resulted highly digestible, and supported the best performances of fish fed on a diet based on 70% of microalgae, probably due to its high protein efficiency (Palmegiano et al., 2009). The results obtained using a biomass of photosynthetic micro-organisms composed by a mixture of *Scenedesmus* sp. and *Chlamydomonas* (29.6% of crude protein) showed that a maximum of 12.5% of algal biomass could be incorporated in the feed for rainbow trout fry without negative consequences on growth and body content in lipids and energy of fish (Dallaire et al., 2007). Other algae species such as *Tetraselmis suecica* was able to replace up to 20% of European sea bass protein without hampering growth performance and major quality traits of the fish (Tulli et al., 2012).

Processed Animal Protein (PAP) might be an important ingredient in feeds because of the high nutritional value, although the quality is influenced by the ingredients composition, the freshness of raw materials and the processing conditions. Moreover, PAP contains 10% phosphorus, which is low in relation to the content of amino acids. However, there may be consumer and producer concerns about the feeding of PAP to fish, due to the potential transmission of prions, notwithstanding the scientific opinion of negligible risk to human health published by the European Food Safety Authority (EFSA) in 2011.

Over the last decade, a number of studies on the replacement of fishmeal with insects in the diet of fish have emerged and the results were encouraging. Insects are part of the natural diet of both freshwater and marine fish. Furthermore, they are rich in amino acids, lipids, vitamins, minerals and leave a small ecological footprint. This is why they have been considered as potential alternatives to fish meal (M. Henry et al., 2015). Several experiments have been carried out so far using insects, such as Common housefly larvae, Domesticated silkworm, Yellow mealworm larvae, in the fish diets for feeding catfish, sea bream, sea bass, and rainbow trout. The results of these studies have highlighted the good potential of using insect meal as a replacement of fishmeal in finfish diets, thanks to the high protein content and adequate essential amino acid profiles. Moreover, the use of a mixture of different protein sources (different insects or insects with prebiotics, with plants or with other animal proteins) or dietary amino acid supplementation could reduce the potential nutrient deficiencies, and better balance the amino acid profiles of feeds incorporating insect meal (M. Henry et al., 2015).

Fish oil is a major natural source of the long chain omega-3 HUFAs eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in the diet of fish. Omega-3 fatty acids have crucial biological functions (Montero et al., 2010; Torstensen et al., 2008) because they serve as the building blocks of cell membranes, regulate gene expression, and are precursors of a range of bioactive substances that regulate inflammation, physiology and satiation. By optimizing dietary fatty acid composition, the retention of EPA+DHA can be optimized and thereby improving fish health, as well as securing the farmed fish as a good source of EPA+DHA for human consumption. Freshwater species are capable of converting plant-based omega-3 ALA to EPA and DHA, but the conversion is not very efficient. Furthermore, the conversion is higher in Atlantic salmon prior to smoltification, than at later post smolt life stages in seawater, and rainbow trout has better ability than Atlantic salmon to convert the shorter vegetable omega-3 FAs to the important long-chain EPA and DHA. Marine fish species, such as sea bass and sea bream, have lower tolerance to vegetable oil compared to freshwater or anadromous fish species. This lower adaptation of marine fish species to vegetable oil can be linked to their lower efficiency in synthesizing LC-PUFA from omega-3 and omega-6 precursors present in plants (Geay et al., 2011). However, it is also important to keep focus on human health related to consuming (organic) aquaculture products, including high content of long chain omega-3 fatty acids (EPA and DHA), currently sourced from fish oil. Finally, it is important to consider that non-GMO plants are not able to produce omega-3 fatty acids longer than 18C, and cannot supply EPA and DHA.

4.2. Mineral and vitamin supply

Many factors make difficult the assessment of the dietary requirement of minerals and vitamins in fish. Indeed, fish may absorb some of these nutrients from the diet, but also from the water because nutrients may leach from diet to water. Further difficulties arise from the lack of knowledge on bioavailability of the nutrients. Therefore, the current practice is to add nutrients to the diet based on existing knowledge, but with a significant safety margin.

Status on vitamin requirement knowledge is reviewed by NRC (2011). Vitamins have pivotal roles for ensuring good survival rates for fish and shrimps. Except for some carp (*Cyprinus* sp.) and some sturgeon (*Acipenser* sp.) species, most finfish cannot synthesize Ascorbic Acid (AA). Documented pathological effects of vitamin C (AA) deficiency have been reported for sea bream and white shrimp. Among natural antioxidants, vitamin E has been found to offer a protective role against the adverse effects of reactive oxygen and other free radicals. According to Torrissen and Christiansen (1995), dietary carotenoids are required in fish diets, particularly for the female brood stock (cfr. Reg. EC n° 889/2008, article 25k, paragraph 4) having a metabolic role similar to that of vitamin E and A. Astaxanthin is the preferred carotenoid for pigmentation in salmonids, as well as shrimps, and is found naturally in potential feed ingredients like shrimp, krill, capelin oil and some yeasts and algae.

4.3. Feeding in ponds, lakes and lagoons

The main source of feed in the rearing environment/sites such as ponds, lakes and lagoons is provided by the carrying capacity of the natural environment. However, in order to increase the production, for making organic farming profitable, it may be necessary to supplement the feed naturally available in the rearing environment, taking into account / consideration the species-specific nutrient requirements for the grow-out stage.

The most important shrimp species in aquaculture are the white shrimp (*Litopenaeus vannamei*), and the giant tiger shrimp (*Penaeus monodon*). Although they are benthivore species, they have different diets in their natural habitats. The white shrimp is an omnivorous/benthivore that mainly feeds on living preys and detritus, whereas the giant tiger shrimp is a carnivorous/benthivore that mainly feeds on worms, crustaceans and molluscs (FAO 2011). These differences in feeding habits are due to the different types of enzymes in the digestive tract of the different shrimps. Carnivorous shrimps have proteolytic enzymes like trypsin and chymotrypsin, whereas herbivorous species have more glucolytic enzymes, like amylase. This is why carnivorous shrimp have a greater ability to digest protein and herbivorous shrimp have greater ability to digest plant material. According to the available scientific literature, the needs for protein are between 20 and 30% of the dry matter in feed for the white shrimp (Kureshy and Davis, 2000), and between 35 and 50% of the dry matter in feed for the giant tiger shrimp (FAO 2011). Lipids are also essential components of the diet of shrimps. They are mainly used for direct energy production and cell membrane building. Some lipids are more important than others because they cannot be synthesized de novo or not in sufficient amounts. Phospholipids (e.g. lecithin) and cholesterol are the two main categories of essential lipids for shrimps.

Carp ponds can be stocked with many fish species, different in their feeding habit, because the utilization of natural food is much more efficient by a multispecies fish stock. Consequently, unless very low stocking densities are applied, the production of fish in monoculture is much more feed dependent than in polyculture. The bulk of the natural fish food organisms in the water column of fish ponds are the plankton, which contribute directly to the diet of the different species of the polyculture. Next to phytoplankton and zooplankton, the role of the bacterioplankton is also important in fish ponds (Adámek et al, 2014). This group of living organisms participates in the processes of both composition and decomposition. They serve directly as a food source of other planktonic organisms and their colonies are consumed directly by some of the fish. The pond bottom is another important biotope in carp ponds, as different fish food organisms live and develop there. Moreover, the detritus and the bacteria, ciliates, etc., that are present in the sediments also serve as natural food for common carp, breams or tench. Water weeds that grow on the pond bottom serve as natural fish food for grass carp. *Periphyton* is the collective name of organisms which live on the surface of the submerged objects and macro-vegetation in a pond. These are bacteria, algae, moss and animals of different sizes. Though *periphyton* is less frequently mentioned as an important source of natural fish food, it may still provide a considerable quantity of food for some of the fish of pond polyculture and is considered as a very promising food source with respect to the purposes of organic farming (Milstein et al., 2008). In ponds, the detritus, the colonies of bacteria, the aquatic weeds, the plankton and the terrestrial and water insects and their aquatic larvae are all natural food for the different fish species. In pond polyculture, the role of natural fish food is outstanding, since it is the source of protein in the diet of fish which otherwise would only be supplied by expensive pelletized fish feed.

4.4. Sustainable fishery

In order to ensure the sustainability of fisheries, different systems have been introduced at different levels, such as the United Nations Convention on the Law of the Sea, the FAO Code of Conduct for Responsible Fisheries, the United Nations Fish Stocks Agreement. Recently the new Common Fishery Policy - CFP (EU Reg. 1380/2013) has established that the Maximum Sustainable Yield - MSY should be reached, preserving also ecosystem functioning and integrity, within 2020 for all commercially harvested fish stocks. The MSY is the theoretical largest amount of fish that can be harvested from a stock over time without reduction in population size. There is also a number of scientific bodies working on fish stock assessments and giving advice to the institutional policy makers. The Scientific, Technical and Economic Committee for Fisheries (STECF) is the official scientific body of the European Commission that revise annually the assessments performed at level of Geographical Sub Areas (GSAs). Other international organizations carry on fish stock assessments, such as ICES (The International Council for the Exploration of the Sea), GFCM (General Fisheries Commission for the Mediterranean), that is instrumental in coordinating efforts by governments to effectively manage fisheries at regional level, ICCAT (International Commission for the Conservation of Atlantic Tunas), RFMOs (Regional Fisheries Management Organizations). ICES, GFCM and ICCAT are implementing MSY or MSY agreed proxies in their advices. Advises from ICES are the basis for fisheries management in the EU, Iceland and Norway. Advices and recommendations from STECF are the basis for the fisheries management in the Mediterranean EU countries, while GFCM provide advices for EU and non-EU Mediterranean countries.

There are also private standards and certification schemes which are developed to promote the fishery sustainability and control the fleet’s activities. The International Fish meal and Fish oil Organization (IFFO), now named The Marine Ingredients Organisation, which represents the fish meal and fish oil producers, have developed their IFFO-RS standard for Responsible Sourcing of raw materials (IFFO, 2010), and an increasing number of production plants are certified in this system. Marine Stewardship Council (MSC) is an independent, global, non-profit organization with certification and eco-labelling programs for fisheries and sustainable seafood. The MSC set science based standards and the certification process is performed by an accredited third party. Friend of the Sea is a fisheries and aquaculture certification scheme promoted by the Earth Island Institute, an international not-for-profit and environmental organization. Friend of the Sea’s mission is to promote sustainable fisheries and aquaculture practices through the labelling and promoting of sustainable products on the markets.

4.5. References to international standards of organic farming

In this chapter are reported the specific rules applicable to the feeding practices of organic aquaculture animals as they have been defined in various international standards. For each standard/regulation it is also reported the issue date and the Country of origin.

1. Australian Certified Organic Standard - ACOS (2016)

7.7.30. Feed sources shall be based on the natural diet of the species to be certified and shall enable browsing and variety to mimic as much as feasibly possible the natural diet of the organisms being certified. For carnivorous animals, no more than 60% of the diet may comprise of plant products.

7.7.31. Feed of agricultural origin shall be from sources produced and certified in compliance with this Standard. Where such sources are not available, up to 5% of agricultural dry matter intake may be from non-organic sources.

7.7.32. The feed manufacturing premises and feed formulations shall be audited and assessed to be in compliance with this Standard.

7.7.33. Where marine food sources are used, a minimum of 50% of the total diet shall be comprised from by-products of wild fish or marine organisms caught for human consumption. A by-product is understood to be a product derived from the target species from processing practices (not harvesting). The balance not derived from such sources shall be derived from wild marine sources independently certified as capable of sustainable harvesting by either ACO or an approved international certifier (e.g. through the Marine Stewardship Council).

7.7.34. There will be no acceptance of specifically harvested juvenile fish or 'trash fish' for aquaculture feeds as this can damage inshore environments and reduce the natural breeding capacity of fish.

7.7.35. There is scope for growing and breeding fish feed stocks within the aquaculture system but the basic organic standards must be adhered to at all times.

2. Instrução Normativa Interministerial n° 28, de 8 de Junho de 2011.

Ministro de Estado da Agricultura, Pecuária e Abastecimento e a Ministra de Estado da Pesca e Aquicultura do Brasil.

Art. 35. Os organismos aquáticos devem receber alimentação orgânica provenientes da própria unidade de produção ou de outra em sistema de produção orgânica.

§ 1o Em casos de escassez ou em condições especiais, de acordo com o plano de manejo orgânico acordado entre produtor e o OAC ou OCS, será permitida a utilização de alimentos não-orgânicos, na proporção da ingestão diária, de até 20% (vinte por cento) com base na matéria seca.

Art. 36. É permitido o uso de:

I - probiótico na dieta desde que composto por microorganismos que não sejam patogênicos ou geneticamente modificados;

II - suplementos minerais e vitamínicos naturais que atendam à legislação específica; e

III - fertilizantes orgânicos para disponibilizar nutrientes naturais no ambiente de cultivo.

Parágrafo único. A relação de substâncias permitidas para a alimentação de organismos aquáticos em sistemas orgânicos de produção está descrita no Anexo IV desta Instrução Normativa Interministerial.

Art. 37. O uso de ração como único componente da dieta será permitido para organismos aquáticos alojados em instalações revestidas de material impermeável, com sistema de circulação de água semifechado nos seguintes casos:

I - para fins de reprodução e produção de formas jovens;

II - criação de formas jovens;

III - quarentena; e

IV - tratamento terapêutico e profilático.

Art. 38. Não é permitido o uso de:

I - aditivo sintético nas etapas de recria e engorda;

II - alimentos provenientes de organismos geneticamente modificados e seus derivados;

III - pigmentos sintéticos;

IV - carcaças, vísceras ou restos de animais terrestres in natura; e

V - dejetos animais na alimentação direta.

3. Hong Kong Organic Production, Aquaculture and Processing Standard (2015)

Organic aquatic animals shall receive their nutritional needs from good quality, organic and other sustainable sources. Feeds for aquatic animals shall be formulated taking into account of the natural feeding habit, using organic ingredients, with appropriate ration size, to satisfy the nutritional requirements of the aquatic animal.

4.6.1 Save as is provided in 4.6.2 and 4.6.3, aquatic animals must be fed with organic feed.

4.6.2 Based on stocking time of fish fry and dry weight of feed, the following percentage of organic feed must be used in one lifespan or annually, whichever is shorter:

4.6.2.1 50% or above before Dec 31st, 2017

4.6.2.2 75% or above after Dec 31st, 2017

4.6.3 When organic feed is of inadequate quantity or quality, other feeds may be used under permission of HKORC-Cert, and comply with the duration and conditions prescribed by HKORC-Cert, and the requirements stipulated from 4.6.4 to 4.6.5.

4.6.4 Non-organic aquatic animal protein and oil sources can only be used if the following conditions are satisfactorily implemented:

4.6.4.1 They are harvested from independently verified sustainable sources; and

4.6.4.2 They are verified to have contaminants below safety limits.

4.6.5 Animals maybe fed with vitamins, trace elements and supplements from natural sources. Synthetic vitamins, minerals and supplements not listed under 4.6.6 maybe used when natural sources are not available in adequate quantity or quality.

4.6.6 Use of the following materials in diet to aquacultural animals is prohibited:

4.6.6.1 The same cultured species or its slaughter products;

4.6.6.2 All types of excrements including droppings, dung or other manure;

4.6.6.3 Feed subjected to solvent extraction;

4.6.6.4 Synthetic amino acids;

4.6.6.5 Urea and other synthetic nitrogen compounds;

4.6.6.6 Synthetic growth promoters or stimulants;

4.6.6.7 Synthetic appetizers;

4.6.6.8 Synthetic preservatives (preservatives based on natural products are allowed);

4.6.6.9 Artificial colouring agents;

4.6.6.10 Genetic modified organisms or their derivatives;

4.6.6.11 Any Antibiotics.

4.6.7 Operators should feed animals according to their natural feeding habit.

4.6.8 Operators should feed animals efficiently, with minimum losses to the environment.

4.6.9 Operators should design systems so that the production area comprises the entire food chain with minimal reliance on outside inputs.

4. The IFOAM NORMS for Organic Production and Processing (2014) (international)

6.5 Aquatic Animal Nutrition

General Principle

Organic aquatic animals receive their nutritional needs from good quality, organic sources.

Requirements:

6.5.1 Aquatic animals shall be fed organic feed.

Regional or other exception

Operators may feed a limited percentage of non-organic feed under specific conditions for a limited time in the following cases:

a. organic feed is of inadequate quantity or quality;

b. areas where organic aquaculture is in early stages of development.

Non-organic aquatic animal protein and oil sources must be from independently verified sustainable sources.

6.5.2 The dietary requirements for aquatic animals shall comply with the requirements of 5.6.4 and 5.6.5.

6.5.3 Use of water containing human excrement is prohibited.

5. KRAV Standards (2016) (Sweden)

The area of the organic aquaculture standard comply completely with the EU regulation for organic production.

6. NASAA Organic & Biodynamic Standard (2016) (Australia)

7.36 NUTRITION

GENERAL PRINCIPLES

Organic aquaculture production provides a good quality diet balanced according to the nutritional needs of the organism. Feed is only offered to the organisms in a way that allows natural feeding behaviour, with minimum loss of feed to the environment. Feed is comprised of organically produced products, in situ nutrient sources, by-products from organic food processing and waste products from the fish industry.

RECOMMENDATIONS

Nutrient management should maintain the biological diversity of the area. Operators should design feed rations to supply most of the nutritional needs of the animal from organic plants appropriate for the digestive system and metabolism of the species. Feed bought into the operation should be comprised of by-products from organic and wild sources not otherwise suitable for human consumption. Operators should maintain the biological diversity of areas that are managed and maintain adequate representation of naturally occurring organisms. Operators should design good quality balanced diets according to the physiological needs of the organism. Operators should feed animals efficiently, according to their natural feeding behaviour and with minimum losses to the environment. Operators should design systems so that the production area comprises the entire food chain with minimal reliance on outside inputs.

STANDARDS

7.36.1 Aquaculture feeds shall contain 100% certified organic components, or waste products only of aquatic origin.

7.36.2 Where certified organic components or waste products are not available feed of conventional origin up to a maximum of 5% (by dry weight) including commercial fishmeal may be used.

7.36.3 Mineral and vitamin supplements are permitted if they are supplied in their natural form.

7.36.4 Feed comprised of by-catch shall not be used.

7.36.5 The following products shall not be included in or added to the feed or in any other way be given to the organisms:

- Synthetic growth promoters and stimulants
- Synthetic appetisers
- Synthetic antioxidants and preservatives, urea and other synthetic nitrogen compounds, feedstuffs subjected to solvent (e.g. hexane) extraction, amino acid isolates
- Material from the same species/genus/family as the one being fed
- Artificial colouring agents
- Genetically engineered organisms or products thereof
- Slaughter products of the same species
- All types of excrement including droppings, dung or other manure
- Preservatives, except when used as a processing aid.

7.36.6 The following feed preservatives may be used:

- bacteria, fungi and enzymes
- by-products from the food industry (e.g. molasses)
- plant based products.

7.36.7 Synthetic chemical feed preservatives are permitted in response to severe weather conditions.

7. Naturland Standard (2016) (Germany)

8. Feeding

8.1 For certain culture systems an upper limit for the application quantity feed/area can be determined (ref. B. Supplementary regulations for specific farming systems and animal species).

8.2 Type, quantity and composition of feed must take into account the natural feeding methods of the concerned animal species. The activity level and the condition of the animals mainly give indications in this respect (e.g. corpulence factor, fat tissue).

8.3 All the feed stuff of vegetable origin must be produced in accordance with Naturland standards. Additionally, feed from animal origin in limited amount and defined quality (s. 8.5.) is permitted. Supplements and additives in animal feed are dealt with in Naturland's processing standards, under the heading "Feed".

8.4 Feed from genetically altered organisms or their products is not permitted.

8.5 If feed ingredients of animal origin (particularly fish meal/oil) have to be used for the culture of carnivorous species with higher protein requirements, the following basic principles shall be respected:

- The animal components in feed shall, where acceptable for nutritional physiological reasons, be replaced by vegetable products. Where feed is used which is not produced in the course of the farm's aquatic food chains, the proportion of animal components in the feed shall be lower than 100%. Provisional maximum values are set in Part B. II. (Supplementary Regulations for specific farming systems and animal species)
- Feed shall not be obtained from conventionally reared terrestrial or aquatic animals.
- In order to work towards a responsible utilisation of wild fish stocks, special standard requirements are set on the origin of fish meal/oil (ref. Appendix 1).

- Fish meal made from a certain species must not be used as feed for the same species.

8.6 Feeding of natural pigments (e.g. in the form of Phaffia yeast or microorganisms) is permitted.

8.7 Synthetic antibiotic and growth-enhancing substances as well as other synthetic feed additives (e.g. synthetic amino acids, chemo-synthetic pigments) are not permitted. Upon approval by Naturland, natural antioxidants (e. g. tocopherol) may be added to the feed.

II. Supplementary regulations for the pond culture of carp (Cyprinus carpio) and its accompanying species (e.g. tench Tinca, pike Esox, the Cyprinidae species) in ponds.

3.3 Fish meal and fish oil is not permitted in the feed.

V. Supplementary regulations for the pond culture of shrimps (e.g. Litopenaeus vannamei, Penaeus monodon, Macrobrachium rosenbergii)

8. Feeding

8.1 Efforts shall be made towards reducing the total doses of external feed, respectively, towards increasing the importance of natural feed production (phyto-zooplankton) in the ponds. Therefore, careful documentation shall be kept by the farm operator, allowing to calculate the feed conversion ratio. Additionally, the fishmeal content as well as the total protein content of compound feed shall be reduced as far as possible. As provisional maximum levels shall be set: 20% for fishmeal/oil content and 30% for total protein.

8.2 Feed intake shall be monitored and documented carefully in order to avoid accumulation of organic sediments by an excess of feed. Feed application by feeding trays (comederos) is recommended

Appendix 1: Requirements regarding fishmeal/-oil used as feed

All feed originating from wild marine fauna has to be harvested in compliance with internationally established sustainability standards (e. g. FAO Code of Conduct30, ICES31). Wherever possible, this should be confirmed by producing proof of independent certification.

The following sources are permitted:

- Products from organic aquaculture
- Fishmeal/-oil from trimmings of wild fish processed for human consumption
- Fishmeal/-oil from by-catches of captures for human consumption in line with corresponding regulations and initiatives.

The use of fishmeal/-oil from other sources may be applied for the solely purposes of safeguarding quality and only up to a limited amount (maximum 30% of total fishmeal/oil, referring to total lifespan of fish). Compliance with these special demands, as well as other requirements which are in general valid for feeds admitted by Naturland, will be confirmed by Naturland by a separate inspection and certification procedure.

8. Organic Crop Improvement Association - OCIA (2013) (USA & Canada)

The guidelines in this section of the OCIA International Certification Standards, are the “Aquatic Production Standards” from the IFOAM Norms for Organic Production and Processing

9. OFDC Organic Certification Standards (2016) (China)

12.5 Aquatic animal nutrition

12.5.1 The biological diversity of areas that are managed and adequate representation of naturally-occurring organisms should be maintained.

12.5.2 Operators should design feed rations to supply most of the nutritional needs of the animal from organic plants and animals appropriate for the digestive system and metabolism of the species.

12.5.3 Animals should be fed efficiently according to their natural feeding behaviour, with minimum losses to the environment.

12.5.4 Systems should be designed so that the production area comprises the entire food chain with minimal reliance on outside inputs.

12.5.5 Animals shall be fed organic feed.

12.5.6 For the calculation of feeding allowances only, feed produced on the farm unit during the first year of organic management may be classed as organic. This refers only to feed for animals that are being produced within the farm unit. Such feed may not be sold or otherwise marketed as organic.

12.5.7 Animals may be fed vitamins, trace elements and supplements from natural sources. Synthetic vitamins, minerals and supplements may be used when natural sources are not available in sufficient quantity and quality.

12.5.8 Use of the following materials in diet is prohibited:

a. slaughter products of the same species;

b. all types of excrements including droppings, dung or other manure;

c. feed subjected to solvent extraction (e.g. hexane) or the addition of other chemical agents;

d. amino-acid isolates;

e. urea and other synthetic nitrogen compounds;

f. synthetic growth promoters or stimulants;

g. synthetic appetizers;

h. preservatives, except when used as a processing aid;

i. artificial colouring agents.

12.5.9 Use of water containing human excrement is prohibited.

<u>10. Ministry of Agro-Industry of Argentina, Resolution SENASA 374/2016</u>

ARTÍCULO 86.- Programa de Alimentación: Debe diseñarse un Programa de Alimentación que cumpla con los siguientes requisitos :

Inciso a) Que cubra las necesidades nutricionales de los animales en las distintas etapas de su desarrollo. El material vegetal utilizado en los piensos de la acuicultura debe obtenerse de cultivos orgánicos.

Inciso b) Que contribuya a la sanidad y bienestar animal; para ello es necesario que:

Apartado I) La calidad del producto y la composición nutricional contribuyan a alcan- zar una alta calidad del producto final comestible.

Apartado II) Minimice el impacto ambiental.

Apartado III) Adopte un enfoque precautorio a fin de evitar la transmisión de enfermedades por medio de los piensos.

Apartado IV) Solamente puede aplicarse un período de ayuno o depuración a los organismos que son manipulados o sacrificados o cuando existan condiciones ambientales extremas que así lo justifiquen.

ARTÍCULO 87.- Requisitos aplicables a los piensos: Los piensos utilizados para la alimentación de los animales en la acuicultura orgánica deben cumplir con los siguientes requisitos:

Inciso a) Requisitos generales:

Apartado I) Para la alimentación de los animales en la acuicultura orgánica pueden utilizarse sólo las materias primas de origen mineral que figuran en el Anexo V de la presente resolución y los aditivos que se detallan en el Anexo VI de la presente resolución, con las restricciones que allí se establecen.

Apartado II) No deben utilizarse factores de crecimiento ni aminoácidos sintéticos.

Inciso b) Requisitos específicos sobre piensos para animales carnívoros de la acuicultura

Apartado I) Los piensos para los animales carnívoros de la acuicultura se suministran preferentemente de acuerdo al siguiente orden:

Subapartado 1) Piensos procedentes de acuicultura orgánica.

Subapartado 2) Harina y aceite de pescado procedentes de subproductos de la acuicultura orgánica.

Subapartado 3) Harina y aceite de pescado e ingredientes procedentes de despojos de peces capturados para el consumo humano en pesquerías sostenibles.

Subapartado 4) Materias primas orgánicas de origen vegetal y/o animal.

Apartado II) Cuando no se disponga de los piensos mencionados en el párrafo anterior, pueden utilizarse harina y aceite de pescado procedentes de subproductos de la acuicultura convencional o de subproductos de pescado capturado para el consumo humano durante un período transitorio que debe determinar el SENASA. Tales materias no podrán exceder del TREINTA POR CIENTO (30 %) de la ración diaria.

Apartado III) La ración de pienso puede comprender hasta un máximo de SESENTA POR CIENTO (60 %) de materiales vegetales orgánicos.

Apartado IV) En las raciones alimentarias del salmón y la trucha se pueden utilizar pigmentos naturales aprobados por el SENASA derivados fundamentalmente de fuentes orgánicas. En caso de no disponer de fuentes orgánicas, pueden utilizarse otros pigmentos naturales.

Apartado V) No deben utilizarse animales muertos provenientes de cualquier sistema de producción acuícola para la alimentación animal, cuando su muerte se deba a enfermedades o causas desconocidas.

Apartado VI) Como medida sanitaria precautoria no se puede utilizar como alimento para animales de la acuicultura piensos que provengan de animales de la misma familia taxonómica.

Inciso c) Requisitos específicos sobre piensos para otros animales de la acuicultura.

Apartado I) Las especies de la acuicultura mencionadas en el Punto A), Secciones AS, A7 y A8 del Anexo VII de la presente resolución, se deben alimentar con piensos disponibles (zoo y fitoplancton) de forma natural en estanques, reservorios de agua y ambientes naturales controlados.

Apartado II) Cuando los piensos disponibles mencionados en el apartado precedente no se encuentren en cantidades suficientes se pueden utilizar piensos orgánicos de origen vegetal, preferentemente producidos en la propia explotación. Los operadores deben conservar la documentación que justifique la necesidad de la utilización de piensos adicionales.

11. Soil Association Standard (2016) (UK)

The area of the organic aquaculture standard comply completely with the EU regulation for organic production.

12. ACT Organic Standards (2016) (Thailand)

Principles

- Aquatic organisms should be provided with balanced dietary feeds to meet their nutritional needs.
- Feed stuffs shall come from materials not suitable for human consumption so that aquaculture production does not compete for human food.
- Feeding shall be performed in a way that respects the natural feeding behaviour of the stocks and mitigates the impact on the environment.

Standards

8.7.1 Production of aquatic species which mainly feed on natural planktons shall be raised in areas where natural feed is sufficient for the needs of the species.

8.7.2 The producer shall prepare the ponds to generate a natural food chain, e.g. phytoplankton and zooplankton, for the stock. Inputs used for pond preparation shall comply with those listed for organic crop production in Part 1 of Appendix 1.

8.7.3 If natural feed is not adequate, the producer shall try to grow organic plants to be used as animal feed on the farm or grow seaweed in grow-out ponds.

8.7.4 Feeds for aquatic animals shall contain certified organic ingredients.

8.7.5 If certified organic ingredients are inadequate due to the early stage of local development of organic agriculture, raw materials of plant origin from conventional production or wild harvest may be used, but in any case no more than 5% of the total dry weight of feeds for the entire year.

8.7.6 Feed for carnivorous aquaculture animals shall be sourced with the following priorities:

1) organic feed products of aquaculture origin;

2) fish meal and fish oil from organic aquaculture trimmings;

3) fish meal and fish oil and ingredients of fish origin derived from trimmings of fish already caught for human consumption in sustainable fisheries;

4) organic feed materials of plant or animal origin.

8.7.7 Use of ingredients from the same species is prohibited.

8.7.8 The producer should use raw materials of plant origin as ingredients in aquaculture feed. But in case of carnivorous species, ingredients of plant origin shall not exceed 60% to prevent nutritional problems in the animals.

8.7.9 Brought-in processed feeds or pellet feed shall be examined or certified b ACT.

8.7.10 Raw materials and products from genetic engineering are not permitted for use as feed ingredients.

8.7.11 The use of chemical, synthetic substances as feed ingredients; e.g. antibiotics, growth hormones, appetite stimulants, hormones, amino acids, pigments, binders, preservatives and antioxidants; or as solvent extracted ingredients; e.g. hexane, is not permitted.

8.7.12 Only minerals, feed additives, and processing aids listed in Part 2 of Appendix 3, are allowed as supplements in animal feed.

8.7.13 Vitamin and mineral supplements of natural origin may be used. If they are inadequate in availability and quality, ACT may allow the use of synthetic vitamin and mineral supplements.

8.7.14 Use of water contaminated with human excrement is prohibited.

8.7.15 Astaxanthin obtained from organic source (such as organic crustacean shells) can be used in feed for salmon and trout as needed. In case organic sources are not available, natural sources (such as Phaffia yeast) can be used.

8.7.16 Histidine produced through fermentation can be used in feed for salmonid fish to prevent the formation of cataracts when the feed sources listed in 8.7.6 do not provide a sufficient amount of histidine to meet the dietary needs for the fish.

13. Organic Aquaculture Standards (2012) (Canada)

6.4 Feed and Feeding

6.4.1 Feeding and feed rations supplied to aquaculture animals shall be compatible with diets occurring in the natural environment and be designed according to the specific nutritional needs of each species.

6.4.2 Fish meal and fish oil derived from aquatic animals and other feed sources shall be organic, when commercially available.

6.4.3 When organic fish meal or fish oil is not commercially available, it shall be preferentially sourced from trimming of fish already caught for human consumption in sustainable fisheries.

Note: See Implementation of the 1995 FAO Code of Conduct for Responsible Fisheries.

6.4.4 When non-organic feed sources are used, they shall not exceed 80% of the action levels of the contaminants in feed.

6.4.5 Feed shall only be offered in a way that minimizes loss of feed to the environment.

6.4.6 Feed, feed additives and feed supplements listed in par. 10.2 may be used in organic aquaculture.

6.4.7 Pigments from organic sources may be added to the feed. When organic sources are not commercially available, only non-synthetic pigments may be used.

6.4.8 The following shall not be fed:

a. Urea, antibiotics and hormones used to promote growth and synthetic growth agents

b. Silage preservation products except for products listed in par. 10.2

c. Synthetic appetite-enhancers or synthetic flavour-enhancers

d. Synthetic colouring agents.

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EXECUTIVE DOSSIER N° 5. SPECIFIC RULES FOR MOLLUSC AND ALGAE

5.1. Mussel and oyster culture

Shellfish culture

In Europe, 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 feed availability in the water. In addition, the nearby presence of spats and suitable substrate are important. These conditions are usually found in coastal waters.

Pacific oyster is tolerant for salinity and temperature with good growth with ranges between 25 - 32 ppt (tolerance from 10 to more than 35) and 15 - 25°C (tolerance from –2° to 35°C), respectively. Various cultural practices are used in the production of the Pacific oyster, according to the production areas, such as bottom culture (sown oysters) and off-bottom culture (tables), deep waters growing with sown oysters or suspended ropes (typical of Mediterranean area), and suspended cultures with floating systems. Pacific oyster juveniles are obtained either through wild spat collection or by hatchery production. Concerning the European flat oyster (*Ostrea edulis*), total European production was 2,200 T in 2012, with main production in France and Spain (around 1000 each) and small scale productions in Ireland and UK.

In Spain, bivalve production has focussed on Mediterranean mussel with around 200,000 T produced in 2010; France is the European second producer, with 75,000 T of both Mediterranean mussel and blue mussel, then Italy (60,000 T) and Netherlands (50,000 T). Mussel production can be on-bottom or off-bottom (raft, bouchots, longlines) but traditionally is based on offshore longlines or intertidal bouchots (mussel beds). Mussel seeds are only provided by natural larvae harvesting. After metamorphosis, the larvae turn into spats which require a surface to fix on. During favourable periods (March-April), spats are gathered in the environment and set generally on coconut ropes located offshore or along the intertidal zone. After 2 to 4 months, the catch ropes are moved to rearing structures, offshore longlines or coastal bouchots.

Cultured shellfish and their associated rearing structures (ropes, tables, longlines) may impact the environment in positive and negative ways (Cranford et al., 2006). Four basic areas of concern are the effects of bivalve culture on: (1) suspended particles, particularly in terms of food resources; (2) sediment geochemistry/benthic habitat; (3) nutrient cycling; and (4) benthic and pelagic population dynamics/community structure. Appropriate stocking density for extractive aquaculture should be linked to the carrying capacity of the production area. Carrying capacity is defined by the environmental conditions of the site (trophic capacity, hydrodynamics), the cultivated species (filtration rates, sizes) and the cultural practices (rearing volume, estimated total biomass, stocking densities) of the area. Some models are developed to evaluate the carrying capacity of production areas; those models can predict responses in terms of bivalve growth rate in relation to the different management strategies, taking into account biomasses, species and environmental conditions (Heral 1993). For example, ECASA project (www.ecasatoolbox.org.uk) identified models that can be used to minimize environmental impact from bivalve aquaculture operations.

Benthic community

One of the environmental risks of shellfish culture is the disruption of the benthic community at the site. Borja et al. (2009) showed that the use of benthic indicators such as individual abundance, and the biomass, together with dynamics of the site, water depth, years of farm activity, and total annual production, are important aspects when interpreting the response of benthic communities to organic enrichment from aquaculture. In a similar study, Christensen et al. (2003) found reduced sediments and enhanced benthic mineralization, containing low microphytobenthic biomass and few subsurface macroinvertebrate species below a mussel farm. This was associated with sulfidic sediments and a lower nitrogen removal rate due to impeded benthic photosynthesis and denitrification activity. Hartstein and Rowden, (2004) showed differences in macroinvertebrate assemblage composition inside and outside of mussel farm sites experiencing different hydrodynamic regimes. The study indicates there is a relationship between the hydrodynamic regime of a farm site, organic enrichment of seabed sediments by mussel bio-deposits, and a subsequent modification of the macroinverebrate assemblages. Miron et al. (2005) studied sediments and macroinvertebrate diversity underneath suspended mussel lines in a shallow water system to underline various relationships between benthic parameters and husbandry practices. No strong relationship between husbandry practices and the studied benthic parameters were found and this might be related to the oceanographic characteristics and land-based activities associated with the water system rather than direct and cumulative effects of mussel culture. Mirto et al. (2000) studied the impact of organic loads under a mussel farm and found accumulation of chloroplastic pigments, proteins and lipids, and changes in meiofaunal density. Such changes in the sedimentary conditions reflected the accumulation of faeces and reduced conditions. However, comparative analysis of the mussel bio-deposition and fish farm revealed that mussel farms induced a considerably lower disturbance on benthic community structure compared to fish farms.

In contrast, Danovaro et al. (2004) investigated the impact of a large mussel farm on the benthic environment for one year using biochemical, microbial and meiofauna benthic indicators and concluded that mussel farming in the investigated system is eco-sustainable and does not significantly alter the coastal marine ecosystem.

Byron, (2011) states that ecosystem-based management (EBM) is an important tool to protect coastal ecosystems where bivalve culture potentially pollutes the benthic community. EBM can be improved when it is informed by ecological science and considers the socio-economic needs of the community, and in addition, communication between stakeholders is key.

Carrying capacity and site selection

Jiang and Gibbs, (2005) investigated the carrying capacity of suspended bivalve culture. Introducing the large-scale bivalve culture resulted in a decrease of the mean trophic level of the ecosystem, an increase of the total yield, and the bivalves replaced zooplankton as the major grazers in the modelled system. McKindsey et al. (2006) outlines four hierarchical categories of carrying capacity for bivalve farms: physical, production, ecological, and social carrying capacity. At present, most scientific studies focussed on production carrying capacity, however, further knowledge should include better modelling of feedback mechanisms between bivalve culture and the environment, a consideration of all steps in the culture process (seed collection, on-growing, harvesting, and processing), and culture technique.

In a study to assess the scope for growth of bivalve culture, Gibbs, (2007) presented indicators for interaction between the culture and the water-column. Sea-based suspended bivalve culture development is more often controlled by the ability of the water-column environment to supply particulate food material then by the ability of the sea bottom to absorb waste products. Saxby, (2002) reviewed a range of influences (temperature, salinity, particulate matter, food availability, current speed and water depth) for bivalve growth and condition in a series of areas to build a broad picture of the environmental characteristics of successful bivalve farms. Sedentary bivalve molluscs can tolerate a wide range of water conditions, although fluctuations in environmental conditions influence growth and flesh conditions strongly.

Camacho et al. (1995) showed that site selection, and thus phytoplankton availability, and the choice of seed stock is of major importance in the duration of the cultivation process for mussel culture. In a similar study, Cubillo et al. (2012) studied the effects of stocking density on growth performance on mussels and found that mussels cultured at lower densities showed better growth performance. The effects started to be visible after four months into the culture cycle and implies competition for food and space allocation. The combination of stocking density and seed seize was studied by Lauzon-Guay et al. (2005). A study by Ramón et al. (2007) showed that the using mussel seed from the same area where the cultures are carried out is advantageous for growth and reduced mortality. Rosland et al. (2011) present a model for simulation of flow reduction, seston depletion and individual mussel growth inside a longline farm, to cope with the challenge to configure the farms to optimise production and individual mussel quality under different environmental regimes. The model can be incorporated as a decision support tool in mussel farm management. These studies show that farm management can make a significant difference in successful bivalve culture. A statement that is confirmed by Ferreira *et al*. (2007), who described a model for farm management and regulation.

Larval culture

Larval culture is an important aspect in bivalve culture, where natural seed collection is still relied on in the culture process. Walter and Liebezeit (2003) investigated spat collectors to improve the process of collecting spat from the environment. Hatchery production could potentially contribute to a reliable and economic expansion of the industry and to genetic domestication. Galley *et al.* (2010) studied elements of hatchery production of mussel larvae as an alternative for natural spat collection; density, temperature and microalgal diets. Laxmilatha *et al*. (2011) conducted a similar study where the Asian green mussel was spawned and the larvae were successfully reared, whereas Lazo and Pita, (2012) performed a study with temperature treatments on mussel larvae. Although further studies are needed, these studies highlight that hatchery seed production can produce spat for the industry so that the pressure on the environment decreases.

Polyculture

Some studies also focus on the integration of mussel and oyster culture and cage farming of marine salmon, sea bass and sea bream (Lefebvre *et al*., 2000; Navarrete-Mier *et al*., 2010; Gao *et a*l., 2006). The shellfish can potentially limit the pollution from the fish farms and serve as additional production animals for consumption. In addition, Whitmarsh *et al.* (2006) examined the financial viability of a polyculture system that integrates the farming of salmon and mussels. The results demonstrated the commercial potential under present market conditions, but highlight the critical role played by future price trends.

5.2. Algae harvesting and culture

Seaweeds are marine macroalgae, of ecological importance for oxygen production and as primary function in the food chain. Seaweeds are robust and can take up high levels of nutrients and in some cases heavy metals from the water (Chan et al., 2006). The largest and fastest growing species is *Macrocystis pyrifera* (giant kelp). Not surprisingly therefore, this species has been the subject of research for many years. The most common production is by long line cultivation, where sporelings are produced in a cooled water greenhouse and later planted out in the ocean attached to long lines (ropes). Harvesting occurs after two years, by transporting the ropes to the shore for harvesting the entire organism. An alternative harvesting method is by surface canopy harvesting several times each year. Farming of seaweeds is thus either (semi) controlled at sea, or in land based systems. Seaweeds feed on nutrients dissolved in seawater and can be farmed without supplemental feed, a practice called extractive aquaculture.

Seaweeds are cultured for different purposes, mainly as bio-filter for the effluent water in (intensive) aquaculture systems, as feed for other aquaculture products (e.g. sea urchins, shrimp, abalone, fish), as bio-fuel or as human food product or cosmetics.

Some cultivated seaweeds have very high productivity, can absorb large quantities of nutrients (such as N, P, and CO_2) and can produce large amount of oxygen. Culture of seaweeds can thus limit eutrophication that forms a big problem in many coastal regions in the world. There is little information on the influence of seaweed culture on the environment and possible pollution of seaweed farming (Beveridge et al., 1997). Studies mainly focus on the inhibition of eutrophication and the associated algae blooms in coastal areas (Liu *et al.,* 2009; Lüning and Pang; 2003; Fei, 2004) with a focus on the coast of Chile and South-East Asia. Seaweed farming can be particularly problematic for the environment when a proper planning and management in terms of plant density, harvesting strategies and disease control is lacking (Gutierrez et al., 2006). In addition, Eklöf *et al*. (2006) studied the effects of seaweed farming on a sea grass ecosystem and found a decreased biomass, increased litter and a different and poorer fauna in plots where seaweed was farmed compared to controls. In addition to the seaweed, predation of fish and disturbance of the sediment were factors that influenced the environment.

Some research are conducted for seaweeds to be incorporated in novel (food) products for humans. This requires specific farming conditions, such as site and sporophyte selection, culture density (Gutierrez *et al*., 2006), and farm management aspects, such as sustainability and quality assurance. Many seaweeds with the potential for human use are small in size and occur in low, seasonal densities, forming additional challenges for commercial farming. On the other hand, on-land farming offers the highest level of control (Bolton *et al.*, 2009; Hafting *et al.,* 2012). Harvested products that are not suitable for human usage can for instance be used for abalone feeding. *Ulva* (Chlorophyta) is cultivated for human consumption in some countries (mainly in South-East Asia) and can grow unattached in estuaries in high nitrogen waters, and secure a large biomasses production and thus more nutrient removal.

Robertson-Andersson *et al*. (2008) investigated the use of *Ulva lactuca* in a recirculation system for abalone farming and found no adverse effects on the abalone with respect to health or growth rate or the seaweeds by running the system at 25% recirculation, with both cultured organisms behaving similarly to ones cultivated in a flow-through system. In addition, no negative environmental effects from accumulated and suspended sediment build up were reported. In a similar study, (Neori *et al.,* 1998) established an integrated on-based culture of abalone that aimed to eliminate external feed dependency and to reduce water requirements and nutrient discharge levels. Effluents from two abalone (*Haliotis tuberculata*) culture tanks drained into macroalgae (*Ulva lactuca* or *Gracilaria conferta*) culture and bio filter tanks, where nitrogenous waste products contributed to the nutrition of the algae. The net algal production from each algal tank was harvested and used to provide a mixed diet for the abalone. In a study by Msuya and Neori, (2008), intensive fishpond effluent passed through seaweed tanks at four nutrient loading levels and four tank designs for water exchange, bottom aeration and frequently changing water levels to study optimal conditions for *Ulva lactuca* as bio filter. Neori *et al*. (2003) studied the problem of ammonia kinetics in seaweed based bio filters since seaweed yield and protein content is inversely related to ammonia uptake efficiency, which is in sharp contrast to the desired situation of a high uptake rate in combination with a high uptake efficiency. Sanderson *et al.* (2008) studied the potential of seaweeds in the vicinity of fish farm cages to maximise potential utilization by cultured macroalgae for nutrient removal from the salmon cages. Additional studies are still needed if the objective is to maximise exposure of cultured algae to farm-derived nutrients, but it shows the potential of the use of seaweeds in aquaculture.

The most studies that involve seaweeds are about seaweed based IMTA systems (Integrated Multi-Trophic Aquaculture, where the seaweed serves as bio-filter and exceed seaweed can serve as feed for the primary aquaculture product (e.g. abalone or fish).

Abreu *et al*. (2011) investigated *Gracilaria* as being efficient bio filters and noted that with appropriate upscaling *G. vermiculophylla* can be implemented in fish productions systems with economic and environmental advantages. In a similar study, Hernández *et al.* (2005) studied the culture of *Ulva rotundata* and *Gracilariopsis longissima* in effluents from an intensive marine grow-out culture of gilthead seabream. Since nutrient limitation in an effluent tank from a fish farm is highly unlikely, self-shading is often the factor that determines maximum stocking density of the seaweeds in bio filter tanks. Kang *et al*. (2011) evaluated the potential of *Ulva pertusa, Saccharina japonica* and *Gracilariopsis chorda* as bio filters or effluents from black rockfish (*Sebastes schlegeli*) tanks and showed that the three species can each serve as bio filter. In addition, the study provides information on the behaviour of integrated cultures for upscaling. Mata *et al.* (2010) investigated the use of the tetrasporophyte of *Asparagopsis armata* has as a novel seaweed bio filter for IMTA and states that the growth and bio-filtration rates for this species are much higher than the values described for the most common seaweed bio filter, *Ulva rigida*.

5.3. References to international standards of organic farming

In this chapter are reported the main rules applicable to the mollusc and algae organic production systems as they have been defined in various international standards. For each standard/regulation it is also reported the issue date and the Country of origin.

1. Australian Certified Organic Standard - ACOS (2016)

7.7.27. Bivalve mollusc production areas shall be clearly marked, and stock restrained by nets or similar means. If predator nets are used, risks to non-target species must be minimised.

7.7.28. Collection of seed from wild areas should be from natural settlement on collectors, or where natural surplus occurs. Such seed from non-organic sources may be used where organic sources are not available.

7.7.29. Stocking densities, and cultivation methods shall be such to ensure optimal animal welfare, and environmental outcomes. Bottom cultivation is only allowed where it is verifiable that no significant environmental impact is caused.

7.7.36. An initial estimate of biomass must be provided with the application for certification. Up to date bed maps are to be supplied annually, along with verification of ongoing monitoring and documentation of populations.

7.7.37. In instances of direct harvesting, harvesting of sea vegetables shall be carried out in a manner which assists natural replenishment of vegetative populations.

7.7.38. Harvesting shall not impact negatively on other natural species which utilise the sea vegetables in question.

7.7.39. Distance of contamination sources, whether chemical, biological or radioactive, shall be assessed at time of inspection. Ongoing monitoring and verification shall be the responsibility of the operator to ensure end product does not accumulate excessive environmental contaminants.

2. Instrução Normativa Interministerial n° 28, de 8 de Junho de 2011.

Ministro de Estado da Agricultura, Pecuária e Abastecimento e a Ministra de Estado da Pesca e Aquicultura do Brasil.

The standard contain only generic rules on the subject.

3. Hong Kong Organic Production, Aquaculture and Processing Standard (2015)

The standard does not contain rules on the subject.

4. The IFOAM NORMS for Organic Production and Processing (2014) (international)

6.3 Aquatic Plants

General Principle

Organic aquatic plants are grown and harvested sustainably without adverse impacts on natural areas.

Requirements:

6.3.1 Aquatic plant production shall comply with the relevant requirements of chapters 2 and 4.

6.3.2 Harvest of aquatic plants shall not disrupt the ecosystem or degrade the collection area or the surrounding aquatic and terrestrial environment.

5. KRAV Standards (2016) (Sweden)

The area of the organic aquaculture standard comply completely with the EU regulation for organic production.

6. NASAA Organic & Biodynamic Standard (2016) (Australia)

7.32 AQUATIC PLANTS

GENERAL PRINCIPLES

Organic aquatic plants are grown and harvested sustainably without adverse impacts on natural areas.

RECOMMENDATIONS

The act of collection should not negatively affect any natural areas.

STANDARDS

7.32.2 Harvest of aquatic plants shall not disrupt the ecosystem or degrade the collection area or the surrounding aquatic and terrestrial environment.

7.33 LOCATION OF COLLECTING AREAS

GENERAL PRINCIPLES

Wild sedentary or sessile organisms in open collecting areas may be certified as organic if they are derived from an unpolluted, stable and sustainable environment.

RECOMMENDATIONS

Collecting areas should be at appropriate distances from contamination and conventional aquaculture. Negative environmental impact from aquaculture production or harvesting shall be minimised.

STANDARDS

7.33.1 The harvesting/production area shall be clearly defined and shall be capable of inspection with respect to water quality, feed, medication, input factors and other relevant sections of this Standard.

7.33.2 Collecting areas shall be at appropriate distances from pollution and possible harmful influences from conventional aquaculture. A minimum of 100 metres must separate conventional and organic operations where feeding is carried out.

7.33.3 Any identified sources of pollution must be at least 5km from organic sites unless it can be clearly demonstrated through objective testing that the pollution sources pose no significant risk of contamination to the operation.

7.33.4 The harvesting of aquatic plants shall not disrupt the ecosystem or degrade the collection area or the surrounding aquatic and terrestrial environment.

7. Naturland Standard (2016) (Germany)

IV. Supplementary regulations for the marine culture of mussels (e.g. *Mytilus edulis*) on ropes and frames

1. Site selection, interactions with the surrounding ecosystems

1.1 Mussels have to be regarded as indicator organisms. Therefore, their microbiological and chemical status reflects water quality. Water quality shall be class of class 1A (≤ 3 faec. E.coli counts/g tissue). Water quality shall be determined at least monthly by an in-dependent institution. Results have to be documented continually

1.2 The mussel cultivation must be subjected to maximum possible turnover of water from the open sea. Mussel culture in immediate proximity to shore or close to nutrient-rich inflows is not per-mitted.

1.3 Mussel cultures managed according to these standards form an important habitat for plants, invertebrates and fishes. All management measures esp. during harvest shall be directed to-wards protecting and supporting this special habitat.

2. Type and origin of stock

2.1 If seeds are collected from wild stocks, care should be taken that collecting activities will not cause lasting damage to the ecosystem.

- The collecting area shall be identifiable. Therefore, it has to be clearly identified by maps, site plans etc.
- Collecting activities shall be documented and traceable to the respective collecting area (time of

collection, quantity of seed collected, name of the collector(s) etc.).

- Collection shall not exceed the sustainable quantity in a given area.

2.2 Mussel larvae are allowed for stocking if they have settled on substrate which has been especially introduced for this purpose.

3. Culture systems

3.1 To assure that while lifting the culture units for control purposes or for harvesting no damage is done to the sea bottom settling fauna and flora, the mussels shall be cultured in/on nets or ropes that are anchored firmly on the sea bottom and kept in a vertical position by floats. Therefore, it is not allowed to cultivate mussels loose on the sea bottom and to harvest them by dredging.

3.2 Nets or ropes shall be appropriate for reuse as far as possible. After use they shall be decomposed or recycled.

4. Processing

For treatment of water for depuration/purification purposes only mechanical means (filters) and/or UV light is allowed. Use of chemicals (e.g. chlorine compounds) is prohibited. Waste water from processing plants shall be cleaned by adequate measures.

VIII. Supplementary regulations for the cultivation and collection of marine macroalgae (*Chlorophyceae, Phaeophyceae, Rhodophyceae*)

1. Selection of site, interaction with surrounding ecosystems

1.1 Seaweed beds form an important habitat for invertebrates and fishes. All management measures esp. during harvest shall be directed towards protecting and supporting this special habitat.

1.2 Algae in accordance with these standards shall grow only in locations that are not subject to any radioactive, chemical or bacteriological contamination or to any pollutants that would compromise the organic nature of the products. Potential contamination sources may include nuclear power plants, sewage discharge, waste disposals, important harbours, coastal industry and intensive agriculture in the zone of influence, conventional aquaculture sites, etc.

1.3 Macroalgae can be regarded as indicator organisms. Therefore, their microbiological and chemical status reflects water quality. The growing areas have to be of high ecological quality (class 1 or 2) as defined by the Water Framework Directive (WFD) 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. In regions, where WFD 2000/60 is not implemented, the scope of water quality monitoring has to be equivalent to that laid down in WFD 2000/60. This equivalency has to be approved by Naturland.

1.4 All operations are required to provide a detailed sustainable management plan, based on an environmental assessment. This plan shall in particular identify and evaluate the impacts of the once-off biomass on target and non-target species as well as on local macroalgae biodiversity. The biology and life cycles of the main seaweeds harvested have to be considered. The plan has to list potential environmental effects of the operation and provide a list of measures to be taken to minimise negative impacts on the surrounding aquatic and terrestrial environments. It has to be approved by Naturland.

2. Cultivation

2.1 If plantlets are collected from wild stocks, the regulations under article 3 apply: “Collection of wild seaweed”

2.2 Fertilizing is only allowed in tank based facilities. Fertilizers used have to comply with the requirements in the “Regulations governing organic aquaculture”, part B.I.7. Chemo-synthetic fertilizers are not allowed. Mineral nutrients and trace elements have to be from naturally occur-ring sources with known composition (e.g. stone meal). In tank based facilities where such external nutrient sources are used, the nutrient level in the effluent water shall be at most the same than the inflowing water.

The use of antibiotics and other chemo-synthetic substances is prohibited.

2.3 For the protection of ropes and other equipment used for growing seaweed against growth of algae and colonisation by invertebrates, environment-friendly methods shall be employed. Use of chemical "anti-fouling" agents is prohibited.

2.4 Culture density (growth of biomass for harvest estimation) of the algae culture shall be recorded.

2.5 Nets, ropes, floats, poles (no depletion of forest stands, destruction of mangroves) etc. used for growing seaweed shall be appropriate for reuse as far as possible. After use they shall be de-composed or recycled. In any case, they shall not be left on the beach or in tidal areas after use.

3. Collection of wild seaweed

3.1 Definition

“Wild seaweed” is defined in analogy with “wild grown products” (refer to “Naturland Standards on Production; Part B.X.1.):

"Wild grown products" are defined as products that have grown without or with low influence of the operator gathering the products. The harvest has to be planned and carried out applying a sustainable system that is eco-friendly and socially acceptable.

This means in detail:

- The plants must not be cultivated, i.e. any measures to enhance or protect growth shall not be taken, or kept on a very low level.
- In their location the plants have to be found naturally.

The human interference consists mainly of the harvest (gathering) of these wild grown products or in measures taken to protect their natural growth potential.

Due to their extremely fragile nature resp. long growing conditions or potential habitat damage due to harvesting activities etc. the harvest of certain seaweed species (see Appendix 2) cannot be considered as sustainable according to the current state of knowledge. These species are therefore excluded from certification.

3.2 Requirements

3.2.1 The harvesting areas have to be clearly identified and adequately mapped, indicating each harvesting site.

3.2.2 All legal aspects regarding land ownership, harvesting rights etc. have to be clarified and documented. The individual harvesting rights have to be arranged and defined clearly within the collection area.

3.2.3 Before the start of each collecting season, the maximum amount to be harvested has to be defined annually. For this, the following information has to be available:

- A yearly biomass estimation of the algae before harvesting season.
- Regular monitoring and documentation of changes of algae stocks for size, density, colour, composition and regeneration.

3.2.4 In case of evident reduction of seaweed biomass resp. other impacts on the stock, appropriate counteractions have to be taken (e.g. reduction of harvest biomass; fallowing of harvest area).

3.2.5 If the harvesting area is used by a group of harvesters, the Naturland requirements for an ICS (Internal Control System) apply (see Naturland document “Minimum Requirements of an Internal Control System (ICS) for Smallholder Grower Groups“).

3.2.6 Harvesting methods shall minimize damage to seaweed and substrate. Only selective harvesting methods shall be applied. Manual harvesting methods are to be preferred. Motorized harvesting techniques are only allowed, if they demonstrably do not have a negative impact on the marine ecosystem.

3.2.7 Wild harvested seaweeds shall be harvested in a manner that safeguards continued reproduction of the algae. Collectors shall not remove the entire algae, but have to leave the necessary plant elements required for the plant to regrow on its own.

4. Post-harvest

Seaweed shall be processed as soon as possible after harvest. All processing steps as well as storage etc. shall be aimed at conserving the quality of the algae at its best.

The use of direct flames for drying seaweed is prohibited. Seaweed shall not be situated in the combustion chamber, but have to be dried via a heat exchanging device that prevents direct contact with flames or harmful smoke/gases.

For flushing of the algae, seawater of appropriate quality is to be preferred to save drinking water.

For the algae products, an analytical protocol according to article A.I.6 has to be followed.

8. Organic Crop Improvement Association - OCIA (2013) (USA & Canada)

The guidelines in this section of the OCIA International Certification Standards, are the "Aquatic Production Standards" from the IFOAM Norms for Organic Production and Processing

9. OFDC Organic Certification Standards (2016) (China)

1.2.3. Aquatic plants

1.2.3.1. Organic aquatic plants are grown and harvested sustainably without adverse impacts on natural areas. The act of collection should not negatively affect any natural areas.

1.2.3.2. Aquatic plant production shall comply with the relevant requirements on ecology and cultivation of this standard.

1.2.3.3. Harvest of aquatic plants shall not disrupt the ecosystem or degrade the collection area or the surrounding aquatic and terrestrial environment.

1.2.3.4. To ensure that a wide gene-pool is maintained, the collection of juvenile seaweed in the wild should take place on a regular basis to supplement indoor culture stock.

1.2.3.5. Fertilisers shall not be used except in indoor facilities and only if they are in Annex A of this standard.

10. Ministry of Agro-Industry of Argentina, Resolution SENASA 374/2016

ARTÍCULO 97.- Producción de algas y plantas acuáticas. Ámbito de aplicación. Alcanza la producción de algas y plantas acuáticas para su utilización para consumo humano, como pienso y otros usos.

A los efectos de la presente resolución se entiende por algas tanto a las grandes algas marinas presentes en formas naturales u obtenidas del cultivo como el fitoplancton, las microalgas y las algas verde-azuladas (como la espirulina).

ARTÍCULO 98.- Sistemas de producción de a lgas y plantas acuáticas orgánicas. La producción orgánica de a lgas y plantas acuáticas puede realizarse a través de la recolección sostenible o del cultivo.

ARTÍCULO 99.- Período de conversión. Se establecen los siguientes períodos de conversión de unidades convencionales a orgánicas:

Inciso a) Para sistemas de recolección silvestre: de SEIS (6) meses.

Inciso b) Para sistemas de cultivo: de SEIS (6) meses o un ciclo de producción total, escogiendo el período más largo de ambos.

ARTÍCULO 100.- Recolección sostenible. La recolección de algas y plantas acuáticas silvestres o parte de ellas, en ambientes acuáticos y sus litorales, se considera un sistema de producción orgánico siempre que:

Inciso a) Las zonas de recolección estén sujetas al régimen de control, tengan una alta calidad ecológica y sean adecuadas desde el punto de vista sanitario.

Inciso b) La recolección no afecte a la estabilidad a largo plazo del hábitat natural o al mantenimiento de las especies de la zona.

Inciso c) Se mantengan registros en la unidad o los locales, que permitan al operador identificar que los recolectores han cosechado sólo organismos silvestres producidos de acuerdo con la normativa orgánica vigente.

Inciso d) La recolección se lleve a cabo de manera que las cantidades cosechadas no causen un impacto negativo significativo sobre el estado del ambiente acuático. Deben adoptarse medidas para garantizar que los organismos puedan regenerarse, debiendo volcar las mismas en el Programa de Gestión Sostenible mencionado en el Artículo 75 del presente anexo. Dichas medidas deben tomar en cuenta, entre otras:

Apartado I) Técnicas de cosecha.

Apartado II) Tallas y edades mínimas.

Apartado III) Ciclos reproductivos sostenibles.

Apartado IV) Densidad y tamaño de los organismos restantes luego de la recolección.

Inciso e) En caso que la recolección se realice en área compartida o común se disponga de evidencias que acrediten que la totalidad de la misma cumple con la normativa orgánica.

Inciso f) Los registros aporten evidencias respecto del cumplimiento del manejo sostenible y el bajo impacto negativo a largo plazo en las zonas de recolección.

Las plantas acuáticas y algas de recolección y/o de cultivo deben ser identificadas por lotes.

ARTÍCULO 101.- Cultivo. El cultivo de algas y plantas acuáticas orgánicas debe ajustarse a las siguientes pautas:

Inciso a) El cultivo se debe realizar en zonas cuyas características ambientales y sanitarias cumplan los requisitos señalados para recolección sostenible.

Inciso b) Las técnicas de cultivo deben mantener la sostenibilidad del sistema productivo en todas las fases de la producción tanto de organismos jóvenes como adultos.

Inciso c) Se deben recolectar periódicamente algas jóvenes para complementar las poblaciones cultivadas en una explotación, a fin de garantizar el mantenimiento de un amplio patrimonio genético.

Inciso d) En el cultivo de algas sólo se utilizan los nutrientes presentes en el ambiente o los provenientes de acuicultura orgánica animal de las inmediaciones, como parte de un sistema de cultivo mutitrófico integrado.

Inciso e) Para los sistemas de cultivo en confinamiento y en caso que se requiera utilizar fuentes de nutrientes exteriores, sólo se pueden utilizar los nutrientes que figuran en el Anexo 11. A tal efecto, los operadores deben solicitar a la entidad certificadora la autorización para dicha aplicación con la correspondiente justificación. Los requisitos de composición y condiciones de uso deben ser verificados por la entidad certificadora.

Inciso f) Pueden utilizarse como acondicionadores en los recintos de cultivo de algas y plantas acuáticas las sustancias que se detallan en el Anexo VII, C).

Inciso g) La densidad de cultivo debe ser adecuada para no producir un impacto negativo sobre el medio acuático.

Inciso h) Las cuerdas y otros equipos utilizados para el cultivo de algas deben ser reutilizados o reciclados cuando sea posible.

ARTÍCULO 102.- Acondicionamiento. Cuando el producto final sea algas y plantas acuáticas frescas, luego de cosechadas, deben ser lavadas con agua de aptitud microbiológica para la industria alimentaria. La sal se puede utilizar para eliminar la humedad. Para el secado de las algas se prohíbe el uso de llama directa. Si se utilizan cuerdas u otros equipos en el proceso de secado, deben estar libres de tratamientos antiincrustantes y de productos de limpieza o desinfección. Sólo se pueden utilizar los productos que se detallan en el Punto B) del Anexo VII de la presente resolución.

ARTÍCULO 103.- Requisitos de control. Cuando el sistema de control se implemente por primera vez, la descripción del sitio debe incluir:

Inciso a) Descripción completa de las instalaciones en tierra y en agua.

Inciso b) Un estudio de evaluación de impacto ambiental proporcional a la unidad de producción al inicio de la actividad.

Inciso c) Descripción detallada y un mapa de las zonas de costa y mar donde se haya realizado recolección y las zonas terrestres donde se hayan realizado las actividades de producción.

Inciso d) Programa de Gestión Sostenible para las unidades de recolección, según lo mencionado en el Artículo 75 del presente anexo.

ARTÍCULO 104.- Registros de producción. El operador debe compilar los datos de su producción en un registro que debe estar actualizado y siempre a disposición de la entidad certificadora y del SENASA en las unidades de la producción. Este registro debe incluir, al menos, la siguiente in- formación:

Inciso a) Lista de especies, fecha y cantidad cosechada.

Inciso b) Fecha de aplicación, tipo y cantidad de fertilizante, si se hubiera utilizado.

Inciso c) En lo que respecta a la recolección silvestre, también se debe registrar:

Apartado I) Historial de la actividad de recolección para cada especie en lechos identificados.

Apartado II) Estimación de la cosecha por temporada.

Apartado III) Fuentes de posible contaminación de los lechos de cosecha.

Apartado IV) Rendimiento anual sostenible de cada lecho.

ARTÍCULO 105.- Producción de Moluscos Bivalvos y Otros: Abarca animales que se alimentan de plancton natural y de partículas orgánicas por filtración. La producción de moluscos bivalvos y otros deben cumplir con los principios generales de la producción acuícola orgánica ya enunciados y las pautas siguientes:

Inciso a) Es deseable que la conformación de sistemas de cultivo multitrófico integrado incluya a los moluscos bivalvos filtradores por su efecto beneficioso en la calidad de las aguas costeras debido a la captación y transformación de nutrientes.

Inciso b) Zona de cultivo: La cría de moluscos bivalvos puede ser llevada a cabo en:

Apartado I) Áreas naturales controladas delimitadas por postes flotadores u otros marcadores visibles, retenidos por mallas, jaulas, contenedores o bolsas colocadas en caballetes.

Apartado II) Estanques o tanques en régimen de policultivo.

Inciso c). Las explotaciones de moluscos orgánicos deben reducir al mínimo los riesgos de extinción de las especies con interés de conservación. En caso de utilizar métodos de prevención contra predadores se deben tomar los recaudos necesarios para no perjudicar la fauna natural.

Inciso d) Recolección de material de reproducción: Se puede utilizar material de reproducción silvestre proveniente de fuera de los límites de la unidad de producción cuando no se produzca un daño importante en el ambiente, la legislación local lo permita y siempre que:

Apartado I) Proceda de poblaciones cuya sustentabilidad no se vea afectada por la recolección.

Apartado II) Proceda de asientos naturales o captadores de semillas de bivalvos.

Apartado III) Se lleven registros del origen de semillas silvestres, que permitan asegurar la trazabilidad y la identificación de la zona de recolección.

Inciso e) Manejo. El manejo de la producción debe ajustarse a las siguientes pautas:

Apartado I) La densidad de la población orgánica no debe superar a la densidad de población de moluscos en sistemas de producción convencionales de la zona.

Apartado II) Se debe regular la biomasa ajustando la densidad, seleccionando los individuos para garantizar el bienestar animal y una alta calidad del producto.

Apartado III) Los organismos bioincrustantes se eliminan por medios fisicos. Los moluscos pueden tratarse sólo UNA (1) vez, durante el ciclo de producción, con una solución de cal para controlar los organismos incrustantes com- petidores.

Apartado IV) Se debe diseñar e implementar un Programa de Gestión Sostenible que será evaluado y controlado por la entidad certificadora. El mismo debe detallar: situación del ambiente acuático previo al emprendimiento, origen de la semilla, productividad, manejo, producción a obtener, entre otros.

Inciso f) Normas de cultivo:

Apartado I) El cultivo de moluscos bivalvos puede realizarse en cuerdas y otros siste mas de contención mencionados en la Sección A6 del Anexo VII de la presente resolución.

Apartado II) El cultivo de fondo de moluscos bivalvos sólo se permite en caso que no cause ningún impacto ambiental destacable en los lugares de recolección y cultivo. La evidencia de que ese cultivo tiene un impacto ambiental mínimo debe respaldarse por un estudio y un informe sobre la zona explotada que debe presentar el operador a la entidad certificadora. Dicho informe se debe adicionar al Programa de Gestión Sostenible en forma de capítulo separado.

Apartado III) El cultivo de ostras en bolsas sobre estructuras sobreelevadas está permitido siempre que estén ubicadas de manera de evitar la formación de una barrera total a lo largo de la costa o litoral y en un lugar adecuado en relación con el flujo de las mareas para optimizar la producción.

Apartado IV) Para este tipo de producción se debe realizar una estimación de la biomasa en cultivo al comienzo de las actividades.

Inciso g) Visitas de control: Para moluscos bivalvos deben realizarse antes y durante la producción máxima de biomasa.

Inciso h) Registros de producción: Se deben llevar registros de todas las actividades productivas, que deben estar actualizados y disponibles para la entidad certificadora y para el SENASA, en la unidad de producción, y que deben detallar al menos:

Apartado I) Origen de los animales.

Apartado II) Número de lote.

Apartaao III) Fecha de ingreso.

Apartado IV) Tratamientos.

Apartado V) Fecha y volumen de la biomasa recolectadas.

Apartado VI) Ubicación.

Apartado VII) Traslados.

Apartado VIII) Destino.

11. Soil Association Standard (2016) (UK)

The area of the organic aquaculture standard comply completely with the EU regulation for organic production.

12. ACT Organic Standards (2016) (Thailand)

The standard does not contain rules on the subject.

13. Organic Aquaculture Standards (2012) (Canada)

5. SEAWEEDS AND AQUATIC PLANT AQUACULTURE

5.1. Water Quality and Environment

5.1.1. Operations shall be situated in locations where water is not subject to contamination by products or substances not authorized for organic production, or pollutants that would compromise the organic nature of the products.

5.1.2. The operator shall detail the environmental effects of the operation and the environmental monitoring to be undertaken, and list measures to be taken to minimize negative impacts on the surrounding aquatic and terrestrial environments.

5.1.3. For seaweed harvesting, a once-off biomass estimate shall be undertaken at the outset.

5.2. Sustainable Harvesting of Wildcrafted Seaweeds and Aquatic Plants

5.2.1.Records shall be maintained to demonstrate that harvesters have supplied only wild seaweeds and aquatic plants in accordance with this standard.

5.2.2. Harvesting shall be carried out in such a way that the amounts harvested do not cause significant impact on the state of the aquatic environment. Measures shall be taken to ensure that seaweeds and aquatic plants can regenerate, such as harvest techniques and tools, minimum sizes, ages, reproductive cycles or size of remaining seaweeds and aquatic plants. Evidence of sustainable management and of no long-term impact on the harvesting areas shall be provided.

5.2.3. If seaweeds and aquatic plants are harvested from a shared or common harvest area, records shall be available to demonstrate that the total harvest complies with this standard.

5.3. Seaweed and Aquatic Plant Cultivation

5.3.1.Seaweed and aquatic plant cultivation shall only utilize nutrients naturally occurring in the environment, or from organic aquaculture animal production, preferably located nearby as part of an Integrated Multi-Trophic Aquaculture system.

5.3.2. In enclosed and recirculation systems, the dissolved amounts of nutrients shall not exceed those necessary for healthy growth of the plants, and culture media shall be disposed of in a manner that does not adversely impact the environment. Nutrients from organic aquaculture animal production or nutrients of plant or mineral origin as listed in CAN/CGSB-32.311, Organic Production Systems — Permitted Substances Lists, may be used provided that the origin and use are consistent with the annotation for that substance. Nutrients listed in par. 9.2 may be used.

5.3.3. In enclosed and recirculation systems, crop production aids and materials as listed in CAN/CGSB-32.311, Organic Production Systems — Permitted Substances Lists, may be used provided that the origin and use are consistent with the annotation for that substance. Crop production aids and materials listed in par. 9.3 may be used.

5.3.4. Retired equipment that was used in growing seaweeds and aquatic plants shall be re-used or recycled where possible.

5.4. Antifouling Measures and Cleaning of Production Equipment and Facilities

5.4.1. Bio-fouling organisms shall be removed by mechanical means and disposed of in an appropriate manner, or by using substances permitted for that use in par. 9.3 or section 12.

5.4.2. Cleaning of equipment and facilities shall be carried out by physical or mechanical means. Where this is not satisfactory, only the substances listed in section 12 may be used.

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