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July 2013

منظمة الأغذية والزراعة للأمم المتحدة | 联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Продовольственная и сельскохозяйственная организация Объединенных Наций | Organización de las Naciones Unidas para la Alimentación y la Agricultura

# COMMITTEE ON FISHERIES

## SUB-COMMITTEE ON AQUACULTURE

## Seventh Session

## St. Petersburg, Russian Federation, 7-11 October 2013

## THE ROLE OF AQUACULTURE IN IMPROVING NUTRITION: OPPORTUNITIES AND CHALLENGES


**Executive Summary**

Fish and other animal products from aquaculture and capture fisheries are gaining more attention amongst consumers due to their nutritional value and health benefits. Fish is a complete package of nutrients, with a unique composition, including fatty acids, amino acids, micronutrients (vitamins, minerals) and also many lesser known nutrients.

Farmed fish is considered by some to be less healthier than its wild-caught relatives, due to the belief that fish is raised in contaminated waters, fed with low quality and low cost diets and that the frequent administration of veterinary drugs is used. However, in the majority of cases it is quite the contrary. Many of the factors that impact the quality and nutritional value of fish can be monitored and controlled during farming.

Farmed fish contain beneficial EPA (Eicosapentaenoic acid) and DHA (Docosahexaenoic acid) long-chain omega-3 fatty acids. These fatty acids originate mainly from what they feed on; in the case of fed-fish, they derive from fish oils in the diet and in the case of filter feeders, from naturally occurring algae which they feed on. Around 75% of global fish oil production is presently consumed by the aquaculture sector and the percentage is continuously growing. Presently, here are no better alternative sources of EPA and DHA for feeding cultured fish at present.

Since EPA and DHA are found in naturally occurring algae and some other sources, and fish oils originating from marine resources may become a limiting constraint for aquafeeds in the coming decades, in the future the production of farmed fish without fish oils but including EPA and DHA from other sources should be encouraged and alternative sources of EPA and DHA should be explored. Similarly, for the mass production of fish as a low cost healthy animal product, particularly when achieving global food and nutrition security, particular attention should be made when producing fish lower down in the food chain, especially the unfed freshwater species which should be critically considered.

Fish is a good source of many essential minerals and vitamins. This is particularly true for small species eaten whole. In some cases small indigenous fish species, where bones and the head are not

consumed, have been replaced by larger farmed species. This has lead to a decrease in the availability of some essential micronutrients in these diets. Polyculture of carp and some small indigenous fish species is an example of how aquaculture could add, rather than replace, essential nutrients to vulnerable diets.

**The Sub-Committee is invited to:**

Guide and advise the Secretariat on how to improve FAO's assistance to Member countries and the civil society to increase the role of aquaculture in order to improve nutrition security at the global level.

## INTRODUCTION

1. People have never consumed so much fish or depended so much on the fisheries and aquaculture sector for their livelihoods as they do today. Employment in the fisheries and aquaculture sector has grown faster than the world's population. About 45 million people are directly engaged in the sector. In addition many people are employed in important secondary sectors such as handling and processing, where women represent half of those involved. Overall, including the dependants of these workers, fisheries and aquaculture support the livelihoods of some 540 million people, or 8 percent of the world's population (FAO, 2011).

2. Fish and fisheries products from both aquaculture and capture fisheries play an important role in food and nutrition security, poverty alleviation and general well-being, and its importance is growing. This is particularly true in the aquaculture sector, where production is rapidly growing and is perceived as having the greatest potential to meet the growing demand for aquaculture and will provide the major part of all fish consumed. Consumption of fish provides energy, protein and a range of essential nutrients. Eating fish is part of the cultural traditions of many, and in some populations, fish and fishery products are a major source of food and essential nutrients. In many cases there are no alternatives or affordable food sources which contain the same essential nutrients.

3. Fish accounts for about 17 percent of the global population's intake of animal protein. This share, however, can exceed 50 percent in some countries. In West African coastal countries, where fish has been a central element in local economies for many centuries, the proportion of dietary protein that comes from fish is very high, e.g. 47% in Senegal, 62% in Gambia and 63% in Sierra Leone and Ghana. The same picture is seen for some Asian countries and some Small Island States, where the contribution from fish as a source of protein is also significant: 71% in the Maldives, 59% in Cambodia, 57% in Bangladesh, 54% in Indonesia and 53% in Sri Lanka (FAO, 2012).

4. Foods from the aquatic environment have a particular role as a source of the long-chain omega-3 fatty acids (EPA or DHA) important for optimal brain and neurodevelopment in children. Alternative sources of omega-3 fatty acids are found in many vegetable oils, but this is alpha-linolenic acid (ALA) that needs to be converted into, for example, DHA which is a major building stone of our neural system. However, the conversion from ALA into EPA and DHA is not very effective in our bodies, making it difficult to rely on only vegetable oil during the most critical periods of our lives. Experts agree that the consumption of fish, especially oily fish, is essential for an optimal development of the brain and neural system of our children, since omega-3 fatty acids in the form of DHA rather than ALA is needed to secure an optimal brain development. This is particularly important during pregnancy and the first two years of life (the 1000 day window). A recent FAO/WHO expert consultation concluded that fish in the diet lowers the risk of women giving birth to children with suboptimal development of the brain and neural system compared with women who do not consume adequate amounts of fish (FAO/WHO, 2011).

5. Fish consumption is also known to have health benefits among the adult population. Strong evidence underlines how the consumption of fish, and in particular oily fish, lowers the risk of

Coronary Heart Disease (CHD) mortality; it is estimated that fish consumption reduces the risk of dying of coronary heart diseases by 36 percent due to the long-chain omega-3 fatty acids found mainly in fish and fishery products. CHDs are a global health problem affecting more and more populations in developing countries, and aquaculture products are a major source of these long–chain omega-3 fatty acids (Mozaffarian & Rimm, 2006).

6. A daily intake of 250 mg EPA+DHA per adult gives optimal protection against CHD (Mozaffarian & Rimm, 2006). For optimal brain development in children the daily requirement is only 150 mg per day. Evidence on the role DHA has in preventing mental illnesses is also becoming more and more convincing. This is particularly important as brain disorders are dramatically increasing all over the world, and in the developed part of the world the cost related to mental disorders is now greater than the cost related to CHD and cancer combined together.

7. More and more attention is also given to fisheries products as a source of micronutrients such as vitamins and minerals. This is particularly true for small sized species which are eaten whole with the head and bones and can be an excellent source of many essential minerals such as iodine, selenium, zinc, iron, calcium, phosphorus and potassium, but also vitamins such as vitamin A and D, and several vitamins from the B-group. It should be noted that there may be significant variations between species and between different parts of the fish.

8. The unique nutritional composition of fish derives not only from fatty acids, amino acids and micronutrients (vitamins, minerals), but studies on other less known nutrients such as for e.g. taurine and choline which show probable additional health benefits. Fish is an excellent source of protein, but what makes fish a really unique food is all the additional nutrients that can be found in significant amounts (Toppe et al., 2012; Weichselbaum et al., 2013).

9. Although the importance of including fisheries products in a healthy diet is related to its unique nutritional value, more and more evidence underscores that the beneficial role of fish in our diets is also linked to its role in replacing less healthy foods. By replacing a less healthy food with fish, the benefits of eating fish will be linked to a lower consumption of the less healthy food in addition to the beneficial nutrients found in fish. Although fish consumption reduces the risk of diseases related to obesity such as cardiovascular diseases and diabetes, the role fish consumption plays in reducing obesity per se is also suggested, however it needs to be further studied.

**Aquaculture**

10. At present close to 50% of all fish for human consumption is farmed, and aquaculture will be the main source of essential nutrients provided by the fisheries sector. Even though the nutritional composition of farmed and wild fish in most cases is comparable, there might be some differences. From a nutritional point of view, the main difference between farmed fish and their wild counterpart is related to the quality and quantity of fat. The nutrient composition of farmed fish is frequently compared to the composition of their wild counterparts, or to other farmed fish. However, farmed fish should rather be compared to other farmed meats, this is where aquaculture products could have a nutritional advantage by providing high levels of essential nutrients, and some of them are hardly found in non aquatic foods.

***Consumer benefits***

11. Wild fish usually have a higher proportion of EPA and DHA in the lipids compared to farmed fish, but since the total fat content in farmed fish is often higher, the total amount of these fatty acids could be higher in the farmed counterpart (Hossain, 2011).

12. The main farmed fish species, carps and tilapias, have a much lower level of the long-chain omega-3 fatty acids compared to, for example, salmon, but could still be considered good sources of these fatty acids. Compared to levels in beef or chicken, the levels in carp and tilapia are much higher (USDA, 2013). A single meal of carp can cover up to several days requirement of this essential nutrient. The role consumption of farmed carp plays for food and nutrition security is particularly evident in many Asian countries were the major part of this fish is consumed. Carps alone can cover

the yearly need for long-chain omega 3 fats of more than one billion people, significantly more than the contribution from all salmon species combined.

13. Wild and farmed fish are healthy and better alternative to almost any other meats. Farmed fish have a more constant nutrient composition compared to their wild counterpart, whose environment, food and access to food varies during the year. The environment of farmed fish can be monitored and managed to secure an optimal product. By controlling the composition of aquaculture feeds and other inputs, fish with good health and healthy fish products with optimal nutritional composition can be produced.

***Food safety risks***

14. The increasing focus on the benefits of fish consumption has had an increasing concern on fishery products as a source of contaminants. The consumption of fish, as for any other type of food, may lead to the ingestion of harmful substances such as heavy metals, dioxins, pesticides and residues of veterinary medicines. However, sustainably produced aquaculture products are not major sources of these contaminants.

15. Some claim that farmed fish is less healthy compared to the wild-caught alternative, that intensive fish farming has lead to outbreaks of diseases that have been difficult to control without using veterinary drugs and that fish might also have been raised in contaminated waters and fed with low cost feeds of inferior quality. As a result some environmental and consumer protection groups are advising that aquaculture products should be avoided in a healthy diet because of the low nutritional value, elevated levels of contaminants and veterinary medicine residues. Negative media coverage frequently reports on complex food safety issues without any transparent evidence-based assessment, and in most cases these claims are unfounded (Little et al., 2012).

***Balancing risks and benefits***

16. The increasing demand to control both feed and fish quality is significantly reducing the risk of placing unhealthy farmed products on the market. This is particularly true in the export market where stringent quality and safety control mechanisms ensure that only high quality and safe products reach the market. There is also a current trend towards the prevention rather than treatment of diseases in the aquaculture industry, leading to cleaner and more efficient production.

17. For capture fisheries, most contaminants are difficult to control, whereas for aquaculture there is a greater possibility to manage and control the aquatic environment and inputs such as feed and veterinary medicines. Control mechanisms for domestic and local markets are sometimes less rigid and should in many cases be strengthened.

18. Occasionally aquaculture products are rejected due to their potential threat to human health, but these products are in most cases stopped before entering the market which outlines that the control mechanisms are working by ensuring that only safe products reach the consumers. As a result, farmed fish is not considered to pose a higher health risk to humans compared to other farmed meat products or even wild fish, but is rather an excellent alternative in a healthy diet. Given the state of some wild fisheries stocks, aquaculture products are likely to grab an even larger share of the market in the future.

19. In 2010, FAO and the World Health Organization (WHO) held an expert consultation on the health risks and benefits of fish consumption. The conclusion from the expert consultation clearly indicated that the benefits of eating fish outweigh the risks of eating fish. It was concluded that the consumption of any amount of fish has a positive impact on health. In particular pregnant women and nursing mothers should ensure they eat sufficient fish. No distinction between farmed or wild caught fish was made. Fish farmed under controlled conditions should be considered a very good and healthy alternative to our diets (FAO/WHO, 2011).

20. Any foods we eat have benefits and risk associated with their consumption, but very few foods provide the benefits to the same levels as fish products. Where there is a need to communicate eventual risks of fish consumption, this should be well planned to ensure consumers are not confused or scared of consuming fish in general.

**Nutrient consumer and provider**

***Feeding fish with fish***

21. With a growing population worldwide, the demand for fish and fish products will increase even if the per capita consumption remains at the present world average level of close to 19 kg/year (FAO, 2012). Capture fisheries has reached its limits. The increasing demand for fish products will force us to improve the utilization of present resources, which could divert more fish into food and less to feed. At the same time the increasing demand for fish will, in practice, mainly be met by an increased production of aquaculture products, concurrently increasing the demand for feed.

22. Fishmeal and fish oil are still major ingredients in most aquaculture feeds. In order to ensure a healthy fish and a final product comparable and as healthy as their wild counterparts, fish need to get EPA and DHA through their diets. In nature, marine micro-algae are the main producers of these valuable fatty acids ending up in our food chain. Freshwater fish seem to be better able to elongate short chained omega-3 fatty acids into EPA and DHA.

23. Expensive fish oil is more and more often being replaced by cheaper vegetable alternatives to reduce production costs. If not carefully monitored, this could produce fish with a less favorable fatty acid profile. Fish oil in feed should be optimized to ensure that most of the long-chain omega-3 fatty acids end up in the final products and are not metabolized by the fish during growth.

24. The amount of fish oil used in fish feed is gradually reducing. This is most likely a direct consequence of better paying markets for fish oil, particularly for nutraceutical purposes. An increasing focus on the benefits of fish oils has increased the demand of fish oil for direct human consumption, with direct consumption growing at a pace of 15-20 percent every year (Packaged Facts, 2011).

25. Fish oil is, and will continue to be, an ingredient of high demand in fish feed. Other marine sources of long chained omega-3 fats are too expensive. In comparison with what is found in traditional fish oil, genetically modified plants can now produce plant seed oils with 16 percent of DHA. Will the aquaculture sector and the consumers be willing to accept the use of oils from genetically modified plants? In many cases, plant based proteins from genetically modified plants are already used as feed ingredients..

26. Most fish feeds contain a minimum level of fishmeal without compromising the optimal content of amino acids and other nutrients that are needed for fish growth and flesh quality. The use of fish derived products in feed formulas could be a dilemma if this fish could be used as direct human food. If less than one kg of fish in feed is needed to produce one kg of farmed fish, it would in most cases be more acceptable. The present trend is that less fishmeal and oil is being used for aquaculture, despite a growing production. More and more fishmeal and oil derives from by-products and waste from fish processing.

27. Around 75 percent of all fish oil produced ends up in aquaculture feed, particularly in feed for carnivorous fish such as salmon and trout. The percentage is decreasing, mainly due to a more rational use of the oil in the feed. The industry claims that 50 percent of fish oil mixed into feed is retained by the fish the day it is slaughtered. This is in line with scientific studies indicating the retention of EPA+DHA in salmon from 30-75 percent depending on the level of fish oil in feed (NIFES, 2013).

28. Fish oil is in practice the only economically viable source of these long chained omega-3 fats for feed purposes, and alternatives such as EPA and DHA production based on microalgae seem to be too costly for feed purposes and not a viable alternative in the near future. As a result of the increasing focus on reducing levels of fish oil and fishmeal in diets for aquaculture, the sector is now a net provider of the valuable and essential fatty acids to our diets.

***Non-fed fish species***

29. Cyprinids and tilapias represent a significant proportion of global aquaculture production. As they are, to a great extent, filter-feeders or non-fed fish low in food chain, production of these fish, at least in theory, does not require formulated feed with fishmeal and fish oil. Although many cyprinid

species are currently produced using supplementary feed, the level of fishmeal and/or fish oil included in the feeds are minimal, just to secure growth performance.

30. In theory, non-fed fish species should have a great potential for expansion since feed inputs are minimal. This also applies to mollusks. Although the demand for carnivorous species such as Atlantic salmon and the North African catfish is still high, non-fed fish species are excellent providers of nutrients, are highly acceptable in many food cultures and do not compete with already limited feed resources. The potential of increasing the production and consumption of these species should be studied and eventually promoted.

31. In many cultures small indigenous fish species are harvested from, for example, rice fields. The importance of these fish in traditional diets has been increasingly highlighted due to their contribution to micronutrients (Halwart 2013; Thilsted, 2012). However, more intensive agriculture and aquaculture have in many cases reduced the availability of this important source of micronutrients. On the other hand, farming fish such as carp does not necessarily need to replace the production of these small fish species. Studies have shown that the culture of carp and small indigenous fish species can perfectly coexist in a polyculture system. In this case farmed fish will be an additional source of food rather than a replacement of a traditional food item rich in essential nutrients.

**Small-scale aquaculture and nutrition**

32. It is increasingly evident that, in addition to the provision of protein, fish contribute to the nutritional security of poor households in developing countries in various ways. They include: (a) consumption pathway - where the direct consumption of fish (mainly from wild fisheries) leads to increased micronutrient intakes; (b) cash-income pathway – where commercialization of fish (caught or home-farmed) contributes to improved purchasing power and a higher overall food consumption. In addition, small-scale aquaculture also offers important livelihood opportunities for women in developing countries through their direct involvement in production, processing or the sale of fish. As such, these activities reinforce the economic and social empowerment of women. This process contributes to the nutritional security of households through the demonstrated influence that women have on the food security of the members of their households, especially children.

**Fish, nutrition and data**

33. Although there is some evidence of the processes and mechanisms through which different nutrition pathways operate, the contribution of fish to these processes are still poorly documented and should be more systematically and rigorously demonstrated. Data and information on fish and nutrition remains scarce in many developing countries, hence more efforts should be made to rectify this important shortfall. It is also important that we look at the consumers' side and determine how aquaculture can better contribute to the nutritional security of rural and urban poor consumers through improved trading and marketing systems.

34. FAO is coordinating an EU-funded project assessing and evaluating the contribution of aquaculture to food and nutrition security (www.afspan.eu). This project is expected to generate much needed information and data on this important subject area through a comprehensive farm and household survey conducted in twenty countries worldwide.

35. In November 2014 the Second International Conference on Nutrition (ICN-2) will be held in Rome (http://www.fao.org/food/nutritional-policies-strategies/icn2/en/). It will be a high-level ministerial conference which will propose a flexible policy framework to address today's major nutrition challenges and identify priorities for enhanced international cooperation on nutrition. Because fish products play an extremely important role as a very important provider of certain essential nutrients, some of which are hardly found in any other foods, the existing knowledge on the role aquaculture and fisheries could play in combating malnutrition should be highlighted in the Conference more than ever.

**Salient points**

36. Fish is an excellent source of protein, but what makes fish a really unique food is the additional nutrients that can be found in fish. Fish is a complete package of nutrients. This unique

nutritional composition of fish mainly derives from fatty acids and micronutrients (vitamins, minerals).

37. Wild and farmed fish are healthy and a better alternative to almost any other meats. Farmed fish have a more constant nutrient composition compared to their wild counterpart, whose environment, food and access to food varies during the year.

38. Consumption of fish and especially oily fish is essential for an optimal development of the brain and neural system of our children, since omega-3 fatty acids in the form of DHA rather than ALA is needed to secure an optimal brain development. This is particularly important during pregnancy and the first two years of life (the 1000 day window).

39. Alternatives to fish oils as a source for long-chain omega-3 oils should be explored, concurrently more attention for producing fish low in the food chain, especially the non-fed freshwater species should be critically considered.

40. In addition to being a good source of essential nutrients, aquaculture products also play an important role in replacing less healthy diets. However, one should ensure that aquaculture products do not replace important foods such as small indigenous fish species with a long tradition as a source of many essential micronutrients.

41. The role aquaculture and fisheries could play in combating malnutrition is significant. This should be highlighted during the preparations of the Second International Conference on Nutrition (ICN-2) to be held in November 2014.

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