Sustainable Aquaculture and Environmental Interactions

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Abstract : Aquaculture is the fastest growing sector in all of the world in recent years. It is necessary to support the development of sustainable aquaculture in the world. For this purpose The Commission of the European Communities prepared a communication on the strategy for the sustainable development of european aquaculture. Salmon, trout, sea bass and sea bream farming have been developed in european countires. Differents farming methodes and technics are used in aquaculture. But especially marine fish farming has been criticised for its environmental and ecological impacts. The extensive and semi intensive farming methods have less environmental impacts than intensive aquaculture. In this paper we try to review differents fish culture methods and their impacts on the aquatic environment. It is also discussed the necessary measures to be taken to minimize the effects of fish farms on the environments

Key words: Sustainable aquaculture, environmental impacts, aquaculture methods,

Introduction

Fish is an important dietary source of animal protein. Humans consume most of the world's fish production, and by 2030 the average person is expected to eat as much as 20 kilograms of fish each year.

Aquaculture may be a recent addition to our vocabulary, but the farming of fish and the cultivation of shellfish dates back millennia, from old Chinese civilisations to the Roman Empire. What is new is the level of production now demanded by a growing world population and the challenge this presents to farmers who want to conduct their activity in a sustainable way.

Modern aquaculture represents a major innovation in the production of fish and aquatic food and has been the fastest growing food production sector with an average worldwide growth rate of 6-8% a year. With a global production of nearly 52 million tonnes in 2006, world aquaculture has increased. Aquaculture is an important economic activity in certain coastal and continental areas

Elvevoll (2010) asks how much seafood should we eat, in themselves, omega-3 fatty acids are not enough, we need to eat fish. Seafood is rich in antioxidants, fat-soluble and water-soluble vitamins, easily digestible proteins with special amino acid composition, minerals, trace elements and fat of the healthy, polyunsaturated type. He has carried out a clinical study that shows the uptake of omega-3 is three to four times greater from salmon fillet than from fish oil.

Different values exist in the scientific literature for what is the ideal daily or weekly intake of EPA and DHA for human health. Government advice varies considerably between countries. However, as a general rule, a healthy diet is generally assumed to include 1-2 fish per week, especially fatty fish.

Environmental Interactions

Most of the information given below about environmental interactions is taken from Consensus portal available at Euraquaculture organisation. The CONSENSUS initiative was funded by the European Union as part of its key action "Food Quality and Safety". 21 European Organisations are Consensus partners. With its stakeholder representation of consumers, aquaculture producers, environmental and other nongovernmental organisations, Consensus is building *sustainable aquaculture protocols* based on low environmental impact, high competitiveness and ethical responsibility with regard to biodiversity and animal welfare.

The development of aquaculture has raised some associated environmental concerns. Like any farming operation on land, fish farm cages produce waste materials. These fall into three categories - uneaten feed, fish faeces and dead fish. Most of the environmental impacts of coastal aquaculture can be managed and minimised

through understanding of the processes involved, responsible management and the effective siting of farms (FAO 1966).

- *Uneaten Feed*

    - *If uneaten feed reach the bottom of a cage, processes that break it down can reduce the amount of oxygen in the sediment. In severe cases, oxygen levels in the water above may also decrease, creating "anoxic" conditions in which only a few animal species can survive. Should the feed contain antibiotics used to treat the farmed fish above, bacteria in the sediment and the natural breakdown of waste material might be affected.*
    - *In practice, fish farmers do everything they can to prevent such a situation, since the cost of fish feed amounts up to 40 percent of the total production cost. Feed reaching the sediment is lost, and it is in the farmer's interest to minimise such waste. On well-managed farms, feeding is carefully regulated to ensure that the maximum amount of food is taken up directly by the fish and farmers aim to ensure that less than 5 percent of the feed is wasted. To improve uptake by fish, feed pellets are manufactured to either float or to sink slowly through the water.*

- *Fish Faeces*

Unlike land animals, fish do not generally produce compact solid faecal material and more often excrete a loose cloud of faecal material that is easily dispersed by water currents. In still conditions, however, faecal material can build up beneath fish cages. It is, however, not in the farmer's interest to let this happen, since the buildup of faecal material can lead to anoxic conditions which affect the fish above. Fish farmers wanting to ensure the health of their fish will frequently check the bottom below their fish cages to ensure that faecal material is not building up. In addition, in many EU Member States, the government employs diving teams to carry out inspections. If faecal build-up is observed, farmers will be advised to move their cages, allowing the bottom to recuperate for a short period, however full recovery typically takes between three to ten years. In recent years, improved feed formulations have also been introduced that fish digest more efficiently, producing less waste. Fish farmers generally avoid overly sheltered and stagnant sites, preferring areas that contain a healthy flow of water through the cages. Such flows disperse fish faeces so it can enter the natural food chain.

Dead Fish

Dead fish are a loss to the farmer and a potential health hazard to the stock as well as a source of pollution. Fish farmers will, at all times, endeavour to minimise the number of dead fish on their farms and to remove such mortalities where they occur. Fish farms are required to report significant fish deaths when they occur and are inspected by state agencies at least twice a year.

Pond Fish Farming

Fish pond systems represent the oldest fish farming activity in Europe, at least dating back to medieval times. Ponds were built in areas where water supply was available and the soil was not suitable for agriculture. The wetlands of Central and Eastern Europe are good examples of this. The total European production from pond farming is approximately 475,000 tonnes. About half of this production is cyprinid fish, such as common carp, silver carp and bighead carp. The main producer countries are the Russian Federation, Poland, Czech Republic, Germany, Ukraine and Hungary.

In order to reach higher yields, farmers today introduce nutrients into the pond such as organic manure. This is accompanied by stocking of fingerlings and by water being flushed through the pond. Fish pond production, however, remains ‘extensive' or ‘semi-intensive' (with supplementary feeding) in most countries, where semi-static freshwater systems play an important role in aquaculture. Chemicals and therapeutics are not usually used in such ponds. Hence the main environmental issue is the use of organic fertilisers, which may cause eutrophication in the surrounding natural waters. The use of organic fertilisers is regulated at national levels.

Extensive fish ponds are usually surrounded by reed belts and natural vegetation, thus providing important habitats for flora and fauna. They play a growing role in rural tourism. Many pond fish farms have been turned into multifunctional fish farms, where various other services are provided for recreation, maintenance of biodiversity and improvement of water management. In areas where water is scarce, some farm systems recirculate, treat and re-use their water.

Such systems are generally self-contained and therefore pose little threat to the environment. Solid waste material produced in such systems is rich in organic compounds and often used as a fertilizer elsewhere. Alternatively, new hydroponic systems have been developed to grow vegetables and other food crops in the nutrient-enriched water. There is much interest in these systems, but their economic viability remains challenging.

Recirculation Aquaculture Systems

Recirculation Aquaculture Systems (RAS) are land-based systems in which water is re-used after mechanical and biological treatment so as to reduce the needs for water and energy and the emission of nutrients to the environment. These systems present several advantages such as: water and energy saving, a rigorous control of water quality, low environmental impacts, high biosecurity levels and an easier control of waste production as compared to other production systems.

The main disadvantages are high capital costs, high operational costs, requirements for very careful management, high land prices and difficulties in treating disease. RAS is still a small fraction of Europe's aquaculture production and has its main relevance in some European countries. The main species produced in RAS are catfish and eel but other species are already being produced using this type of technology such as turbot, sea bass, pikeperch, tilapia and sole.

The Case Of Escaped Fish

It is inevitable that fish farmed in net pens in either fresh or salt water will sometimes escape into the wild. In some cases, there will be a small but steady release of fish. Sometimes, large numbers will escape due to severe damage to the net pen by way of storms, predator attacks or vandalism. Therefore, a limited escape of farmed fish would be unlikely to have a serious effect on wild fish populations. Only if very large numbers of fish escape into a small area, would interbreeding occur and the fitness of the local population potentially be reduced.

In its Aquaculture Europe 2005 conference, the European Aquaculture Society invited the North Atlantic Salmon Conservation Organisation (NASCO) to hold a special workshop on the interactions between wild and farmed salmon. The summary report of this event "Wild and Farmed Salmon - Working Together" drew the following main conclusions: Through the use of single bay management, single generation sites and synchronised fallowing, real progress is being made in relation to minimising impacts of diseases and parasites, which are key issues for wild fish interests.

The development of third-party audited containment management systems may represent a significant step forward. The liaison group should look more at the possibilities of rearing all-female triploid salmon, which could eliminate genetic interaction with the wild stocks, but which need to be balanced by the production cost of these fish, as well as consumer resistance to what could be seen as genetic manipulation.

Sustainable Feed Resources

Fish farming is very efficient in terms of the conversion of protein, which means an important ecological advantage in light of the sustainability of fish feed resources.

One of the most-frequently cited issues with the sustainable development of aquaculture is the capture of other fish as raw material to be used as fish feed in the form of fish meal and fish oil. It is seen as an issue because a food production sector is in part relying on a capture fishery for the supply of raw materials for the production of aquaculture feed.

Typically, these other fish species are small, oil-rich, bony pelagic fish that are not normally used for direct human consumption. Two decades ago, the majority of fish meal and oil was used to make feeds for land animal production. At present, over 50 percent of fishmeal and over 80 percent of fish oil is used for aquaculture.

If aquaculture is to fill the gap in demand for seafood, this raises important sustainability issues as to the availability of sufficient feed supply. This is particularly relevant given the fact that fishmeal and fish oil production has been, and is likely to remain, relatively constant at around 6 million and 0.9 million tonnes per year, respectively.

However, as the demand for fishmeal and fish oil in aquaculture has increased, so the price has risen. This has driven both terrestrial agriculture and aquaculture to seek nutritional alternatives to fishmeal and fish oil.

This is an on-going process and estimates made by the International Fishmeal & Fish oil Organisation show that the growth of aquaculture and the substitution of fishmeal and fish oil can continue together.

Replacement of Marine Protein Sources by Terrestrial Plant Protein

For various reasons, fish meal and fish oil are gradually being replaced by plant proteins in feed that is used in fish farms. Plant proteins can be less costly and they are free of potential contaminants like dioxin, PCB or mercury.

However, fishmeal is an important ingredient in fish feed and can only to a limited extent be replaced by vegetable proteins without reducing feed efficiency and growth. After all, carnivorous or 'piscivorous' fish naturally feed on other fish. The fatty acid composition in the flesh from farmed fish will also reflect the feed composition and inclusion of vegetable oil will reduce the level of omega-3 fatty acids.

Although the introduction of plant protein into the feed can be seen as a way of reducing the sector's dependence on fish meal and fish oil, some have questioned the trend because:

- carnivorous fish do not naturally feed on plants;
- plant proteins may have anti-nutritional effects on fish;
- there is a maximum level of replacement, after which the texture and eating quality of the fish is compromised;
- some plant proteins could be derived from GMOs .

Constraints of Aquaculture in Turkey

Especially marine aquaculture systems are criticised for their environmental and ecological impacts. The extensive and semi intensive farming methods have less environmental impacts than intensive aquaculture. It is necessary to support the development of sustainable aquaculture.

For this reason European Commission designed in 2002 a strategy document for the sustainable development of aquaculture in Europe (CCE 2002). As a candidate country to the European Community, Turkey takes all the measures to respect and to adopt the rules designed by the European Commission. Fisheries and Aquaculture file is one of the 31 files to be discussed with European Commission. The importance of aquaculture has been recognized by the Ministry of Agriculture and Rural Affairs (MARA) and by the private sector in collaboration with the Universities. The development of aquaculture is very important in Turkey because it provides jobs.

The General Directorate for Agriculture Production and Development of MARA is the responsible authority for development and management of aquaculture. The aquaculture sector in Turkey is facing some constraints (Canyurt 2005) such as:

- The complexity of licensing procedures,
- Site selection problems,
- The complexity of project preparation and application,
- Problems with some other sectors, such as tourism, protected areas and navigations,
- High prices of inputs and difficulties in supplying,
- Disease risk with imported eggs and fry,
- Marketing and quality control problems,
- Non organization of the sector,

can be cited as major constraints of aquaculture in Turkey to be solved.

Conclusions and Recommendations

Turkey has rich inland water sources, about 200 natural lakes, about 750 artificial lakes or ponds, about 193 reservoirs, 33 rivers and streams of 177.714 km length and 8.333 km of coastal strips. Some lagoons covering of 70.000 hectares in Aegean and Mediterranean coastal strips are very suitable for aquaculture.

Aquaculture development, especially trout farming in inland waters and sea bass and sea bream in marine waters in Turkey is growing rapidly (Canyurt 1996 &1997, Canyurt&Akhan 2009). Turkey has the third fastest growing aquaculture sector in the world (Deniz 2007, MARA 2006, TSI 2007). Marine and inland water resources provide an important source of protein for human nutrition. In addition to this appreciation, aquaculture has some advantages over capture fisheries in term of marketing the products. One of these advantages is that aquaculture creates jobs. More than 25 000 persons are working in the sector of aquaculture in Turkey (Deniz 2007). Some ecological and socio-economical interactions should be discussed for a sustainable

aquaculture (Canyurt 2005, Deniz 2007), that is why it is necessary to support the development of sustainable aquaculture.

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