Fish for the Future: Aquaculture and Food Security

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Key Points

- Aquaculture is the fastest growing food-producing sector in the world, contributing one-third of global food fish production.

- The nutritional benefits of fish consumption have a positive link to increased food security and decreased poverty rates in developing states.

- Wild fish extraction for fish feed has threatened ocean stocks and created conflict with the demand for fish for human consumption.

- Future industry development is limited by restrictive government policies and a lack of access to markets for small-farm holders.

- Australia is experiencing rapid development in aquaculture and has the potential to lead in producing future feed alternatives and systems management.

Summary

Forecasts indicate the global demand for fish production will continue to increase over the next decade, driven predominately by rising populations and urbanisation in developing states. Considered the fastest developing food-producing sector in the world, aquaculture is recognised as a possible sustainable solution for food security and increased dietary nutrition in developing regions. There are a number of limitations which, if not addressed, could impede the successful expansion of aquaculture and global fisheries at large. These
include: environmental degradation and reduced water quality, disease, increased fish feed extraction from the world’s oceans, and a lack of governance and regulation in production. At the same time, if aquaculture does not develop quickly enough global price rises can be expected, reducing access to fish for consumption and leaving less developed countries vulnerable to these changes.

Analysis

**Current State of Global Aquaculture**
Believed to have originated in China over 2000 years ago as a recreational pursuit, aquaculture is expected to have overtaken capture fisheries as the key food-fish producer by 2014. According to the United Nation’s Food and Agriculture Organization (FAO) total aquaculture production in 2011 was over 63 million tonnes. A significant trend in much of developing Asia is the growth in commercial and small farm aquaculture, spurred by increasing demand. The Asian region contributes over 90 per cent of global production, while China remains the world’s largest producer in the sector with 47.5 million tonnes produced in 2004.

**What is Aquaculture?**
Aquaculture can be described as the breeding and harvesting of aquatic organisms, both marine and freshwater. The sector includes over 200 species of fish located within freshwater, brackish and marine water environments. Systems of cultivation include water-based methods, for example cages and pens, land-based methods, including rain-fed ponds, and irrigated systems such as tanks.

Long-term mismanagement of the world’s fisheries has led to the over-exploitation of wild fish resources, reducing available stocks and creating further dependence on aquaculture to meet demand. Over the last two decades, the annual growth rate of aquaculture has reached as much as 8 per cent. With captured fisheries unlikely to meet future demand, it will be a challenge for the sector to maintain current growth rates without significant structural and governance reform.

**Role of Aquaculture for Food Security and Nutrition**

**Nutritional Benefits**
According to the FAO, over one billion people worldwide rely on fish as their primary source of animal protein. Around the world, average annual fish consumption is 16.1 kg per capita. In South-East Asia most major species of fish produced are primarily for local consumption, with Thailand and Vietnam deriving over a third of their fish production from aquaculture. In the last 30 years, animal protein consumption per capita in developing countries has more than doubled, as a direct result of technology advancement in aquaculture.

Those living in poverty and in lower socio-economic households are unable to access sufficient nutritional food to ensure their health and wellbeing. Often the food produced or purchased consists of cereals or low-cost staple ingredients; budgets are unable to stretch to include meat or fruit and vegetables. Fish, particularly produced through aquaculture, is commonly cheaper than other animal meat. It also contains much higher protein levels, as
well as other important minerals and vitamins. As a means of providing greater nutrition for many poorer households, increased availability of fish can mean better health and a more diverse diet.

Indirectly, commercial aquaculture leads to increased food security by providing opportunities for employment and income generation for local communities. More than 500 million people in developing states reportedly depend on fisheries and aquaculture for their livelihood. As a majority of aquaculture production occurs in developing states, a rise in income leads to an increase in food purchasing power and, more importantly, diversification. The consumption of non-staple foods, including fish and vegetables, has a positive correlation with income growth, supporting food security and greater nutritional content in diets.

*Small Farm Aquaculture*

In rural populations, aquaculture, in addition to increasing food production, is often undertaken as a secondary source of income. In developing states the role of fish farming has increased exponentially, with many agricultural farmers discovering that the integration of aquaculture into their production systems leads to increased land and yield productivity. While the benefits of aquaculture are widely discussed, it is important to note quantitative data highlighting this contribution is limited, with few objective evaluations available. Despite arguments to the contrary, it is still too early to determine the exact impact of aquaculture on food security and poverty alleviation. There is, however, great potential for aquaculture to support income security and nutritional diversity, as part of an integrated approach.

As poverty is often worst among rural communities, aquaculture presents an opportunity to diversify income and protect against market fluctuations in the prices of agricultural products. This integrated system of using agricultural land to raise fish, increases potential yield rates per annum. Diversification also increases overall land productivity, by utilising farm by-products as aquaculture feed and the water from aquaculture sites as a means of irrigating crops.

There are considerable constraints on aquaculture, particularly when intensive production is the key income generator for a farmer. Poorly developed infrastructure and limited access to transportation or urban centers, can challenge its effectiveness. Where transportation is difficult, communication services are basic and access to markets is limited, it is challenging for a farmer to generate an income through aquaculture.

Access to financial and social assistance is also a driving factor in successful aquaculture production. Because they are vulnerable to price volatilities, small-farm holders rely on access to capital for farm development and financial and social assistance to provide a safety net. Intensive aquaculture is a particularly high risk enterprise, as a failed harvest leaves no alternative income stream. Small loans and credits to purchase fish feed, chemicals and seeds are often required to begin a production cycle. In Vietnam, collectors and traders are of particular importance, as they often provide loans in advance and take payment at harvest time.
Another limitation is access to markets, particularly in urban centers. Prices for fish are highest in urban centers and the ability of farmers to access and sell fish in these markets can greatly influence potential income generation. Many farmers rely on local markets to sell produce; however, with fish production increasing, an over-supply of fish can lower market value and decrease potential income benefits. Middlemen and traders are often engaged to sell fish further afield, where prices for fish are higher. Farmers without access to urban markets are limited to selling fish at a set price to these middlemen, who then sell them at a higher price to urban buyers. Governing bodies need to prioritise access to markets for local farmers, to increase profit margins.

**Commercial Aquaculture**

According to the FAO, commercial aquaculture refers to “fish farming operations whose goal is to maximise profits, where profits are defined as revenues minus costs”. The global fish trade is currently estimated at US$56 billion, surpassing most traditional agricultural exports. Economists at the WorldFish Research Centre and the International Food Policy Research Institute (IFPRI), estimate that the total world production of food-fish will increase by over 40 per cent by 2020. Internationally, approximately 40 per cent of the world’s fish supply is traded, as compared with 10 per cent of the meat supply.

The economic impact of commercial aquaculture is significant, with large commercial aquaculture farms providing business profits, employment, taxes and generating further investment in the industry. Commercial aquaculture has the potential to stimulate economic growth and create jobs, assisting in poverty alleviation as it does so. As many as thirty-five million people are directly employed in the fisheries sector worldwide, 20 per cent of them in the aquaculture industry; indirectly the industry supports several times this number.

It is suggested that commercial aquaculture can contribute significantly to food security, providing employment and income generation to those in developing countries. Furthermore it provides a reliable supply of affordable aquatic food products with greater access to markets across the developing and developed world. The linkage of the commercial aquaculture sector to local economies is twofold; both directly and indirectly it supports other sectors through the purchase and sale of goods and services. It can also link through investment in infrastructure development, human resources and foreign exchange, all of which support economic growth.

**Threats and Weaknesses in Food-Fish Production**

**Fish-Feed Extraction**

The production of high-value, high trophic food fish continues to receive the greatest support politically and economically. Rising demand and increasing incomes are creating an incentive for farmers to move away from low-value food fish for domestic consumption, to high-value fish for export. The extraction of small or low-value fish species in the wild, also known as ‘trash’ fish, is a significant component of aquaculture as many high-value food fish are carnivorous.

The extraction of wild fish for non-human consumption (i.e. fishmeal, fish oil and feed for farmed fish) is increasingly being questioned for its lack of sustainability and use of
resources. The capture of small fish for the production of feed is problematic in maintaining balanced marine ecosystems and food webs for larger predators. With 70 per cent of ocean fisheries in need of urgent management and 50 per cent of these already fully exploited, the use of captured fish species for fish farming has the potential to cause future conflict.

The production of fishmeal and fish oil requires approximately 30 million tonnes of captured fish each year. Feed is produced predominantly from small pelagic marine fish, including sardines, anchovies, sand eels, herring and mackerels. Future competition is likely between human consumption needs and animal feed requirements at current rates of production. The proportion of fish for human consumption has grown significantly since the 1990s, but the use of fish feed in aquaculture has also experienced considerable growth over the last two decades. The methods used for capture and storage of these smaller fish makes them unsuitable for human consumption, but the continued growth of aquaculture production means it is unsustainable to continue drawing trash fish from the oceans. Finding an alternative source of feed is an international research priority.

Commercial aquaculture has surpassed poultry and livestock production as the key consumer of fish-based animal feeds. With a focus on high-value fish species, many producers rely on carnivorous species with high-trophic levels. As this industry relies on the export market, there is a need to reduce dependence on capture fisheries for sourcing the raw materials for feed. Conversely, small-scale farming is constrained by the availability and cost of feed, limiting small-hold farmers to low-trophic species, which are more popular in domestic markets.

**Disease**

Disease and chemical contamination of farmed fish is an ongoing management issue for farmers. Disease is most often caused by stress factors, induced by environmental changes. Lowered environmental health, increased levels of waste and pollutants in waterways, high stock density and low quality, all increase stock susceptibility to disease. Closed farming systems where the breeding environment is closely monitored, are considered the safest option for disease prevention and water quality control. Closed systems prevent escape, ensure the availability of optimum levels of feed and water, and eliminate any danger of predators. The movement of live aquatic animals across boundaries is a major cause of the spread of diseases and pathogens within the aquatic environment. Improved technology and management systems are required to better regulate disease, improve water quality and ensure sustainable production can be increased to meet future demands.

**Environmental Degradation**

A key concern with the practice of aquaculture is its environmental impact and water quality degradation from its production processes. Effluent water from ponds causing environmental pollution, nutrient buildup (mostly organic nitrogen and phosphorus) and wastes in ecosystems, land clearing and chemical pollution, are just a few of the negative impacts if systems are not managed correctly.

Of particular concern is the environmental damage to oceans from marine aquaculture. Chemical and effluent pollution can severely deplete oxygen levels in water, create algal blooms and kill corals and other habitats. Antibiotics added to fishmeal, or chemicals added
to pens as a disease preventative, flow directly into the water. Large densities of fish populations in net pens increase pollutant outputs into surrounding waters, putting increased stress on the marine ecosystem. Estimates indicate that a salmon farm of 200,000 fish releases levels of nitrogen, phosphorus and fecal matter equivalent to the untreated sewage from over 20,000 people.

Land degradation and changed river ecology caused by inland farming are also challenges which need to be addressed to ensure production has a minimal effect on natural biodiversity and ecosystems. Commercial aquaculture poses a particular set of problems, with large-scale production and limited management in some instances leading to critical environmental damage and irreversible ecosystem degradation.

**Future Opportunities**

**Governance and access to market**

The culture of exporting high-value fish persists, aided by government incentives; credit, low tariffs on imported supplies and infrastructure, and cheap land leases are prevalent. These benefits tend to favour wealthier producers, with low-income subsistence farmers often left with little support to sustain their aquaculture farms. Future policies and governance should focus on small-scale aquaculture as a means of poverty alleviation and improving food security. This assessment is supported by the positive effects on the production levels of poorer farmers, when they have been given access to technology and market opportunities.

Growth in the sector over the last two decades has been achieved through the adoption of new technologies and the diversification of farming practices. In Vietnam, the adoption of artificial propagation techniques for striped catfish, made it possible to produce fish seeds on a mass scale. In 2007, catfish production accounted for more than 50 per cent of Vietnam’s aquaculture production and has created livelihood opportunities for hundreds of people living in the Mekong Delta.

Past failures in aquaculture development have been linked to mismanagement, unclear land and water rights, and the use of inefficient government hatcheries. The capacity to develop aquaculture continues to suffer limitations due to weak institutions. A critical issue for fish farming, both subsistence and commercial, is the stringent health and safety requirements for exporting to the global market. With the costs and infrastructure required to meet standards, government support will be necessary if farmers, particularly small-hold farmers, are to successfully produce for overseas markets.

Instead of policies focusing on commercial farming and exports, policies and supporting systems need to address the needs of small-hold farmers, to ensure stability and food security for subsistence level households. Improved productivity, the expansion of aquaculture and the introduction of strategies to engage the poor, will enable aquaculture to have a far greater impact on food security. A key challenge regionally will be in developing standardised regulations and practices in line with international regulations.

**Australia’s Role**
Australia is in a unique position to engage with the aquaculture industry in the Indian Ocean region and provide considerable support for its development. Fish trade in the region is strong and Australia, as a key trading partner in the agricultural sector, can monitor and support its stability while providing guidance to partner nations and establishing new trade opportunities.

The ongoing research into feed alternatives is also a key priority for future aquaculture expansion. The potential use of Australian grains and agricultural products for future feed supplies creates a unique opportunity for global marketing. Currently 20-25 thousand tonnes of lupins are used annually in aqua-feed in Norway, Japan and Australia. As the use of wild fish as feed in aquaculture farming is addressed, Australia will increasingly find new trade opportunities in feed development, production and export.

The aquaculture industry in Australia is witnessing rapid growth, with bluefin tuna, one of the most lucrative fish species farmed along the south coast. Atlantic salmon and tiger prawns are two other high-value species farmed in Australia, along with rainbow trout, barramundi and various species of molluscs. With health and safety standards restricting many aquaculture farmers in developing states, Australia could play a vital role in technology transfer and systems management for others in the region.

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