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Responsibility

Energy efficiency of aquaculture

1 September 2010

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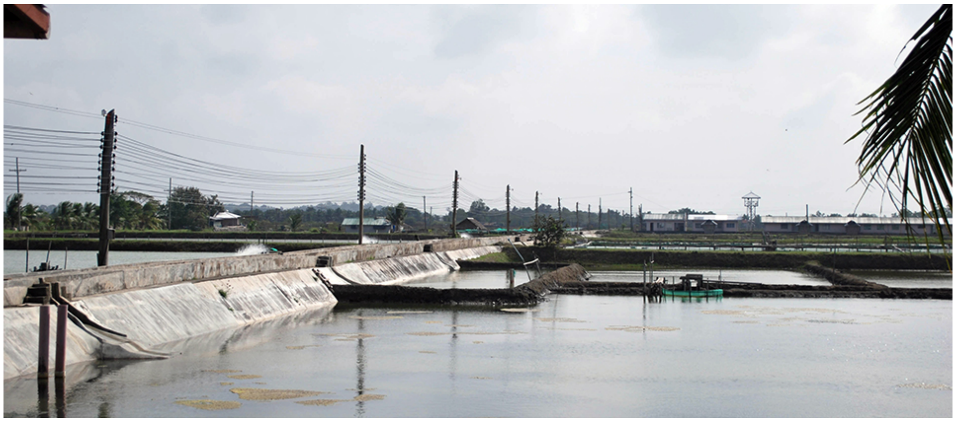
Life cycle assessment useful in evaluating sustainability



Many modern farms use a good amount of energy to run aerators and other farm operations.

Inexpensive energy is often seen as fundamental for economic growth. It has also enabled rapid improvements in living standards over the last century, thanks to constant withdrawals from the global fossil fuel account.

Food production, in common with other industries, has become addicted to cheap energy. Production, distribution and consumption of food accounts for 20 to 25 percent of the energy consumption in developed countries. The largest energy investments are made in the production of protein-rich produce, such as meat and fish (Table 1).

Henriksson, Energy use in food production systems, Table 1

Edible Produce	MJ kg^{-1}
Beef	43-64
Farmed salmon	26-48
Pangasius	12-56
Global fisheries	24
Tilapia, intensive	18-27
Broiler chickens, U.S.	15
Milkfish	7-16
Wheat	4
Soybeans	2-3
Oysters	< 1

Table 1. Energy use in food production systems to farm gate.

Aquaculture energy consumption

Feed production is commonly the major energy-consuming process in finfish and crustacean production systems. Processing accounts for roughly an additional 10 percent of the energy use for most seafood products, while consumption contributes about 20 to 30 percent. For filter feeders, the common energy-intensive stages are transportation and holding of live animals, infrastructure and processing, depending upon final product form and if there is a purification stage.

Transportation accounts for only a few percent of the energy used in the life cycle of farmed salmon, while feed production accounts for over 90 percent. When fresh seafood is transported by air, the emissions from transport become significant.

Energy intensity is not only a good indicator of environmentally unsound systems, but also of systems vulnerable to fluctuations in energy prices. Future increases in energy prices can be expected, as oil will likely become a limited resource over the coming century, and climate change policies are implemented.

A recent report by the United States Joint Forces Command stated: “By 2012, surplus oil production capacity could entirely disappear, and as early as 2015, the shortfall in output could reach nearly 10 million barrels per day.” The food sector will therefore be faced with challenges to keep up supply, especially since the global population is demanding more animal proteins as a result of rapid economic growth in emerging economies.

Life cycle assessment

Aquaculture presents itself as a promising alternative to currently inadequate capture fisheries and inefficient livestock production. This status, however, is highly dependent upon which path the industry takes, as it is still under rapid development.

To guide the industry toward best practices, a thorough evaluation of the sustainability of different aquaculture practices, entailing the whole production chain from extraction of resources to landfill, needs to be carried out. In this process, life cycle assessment can be a highly useful tool.

Life cycle assessment allows evaluations of several environmental impacts to be managed within the same framework, including global warming, water use, land use, depletion of fossil energy, etc. The tool has previously been used to show that closed systems motivated by environmental concerns such as eutrophication, escapes and spread of disease/parasites, can result in other concerns, such as larger energy dependency and greenhouse gas emissions. These trends have also been found for *Pangasius* farms in Southeast Asia, where increased pumping of water, instead of tidal exchange, has resulted in significantly higher fossil fuel consumption.

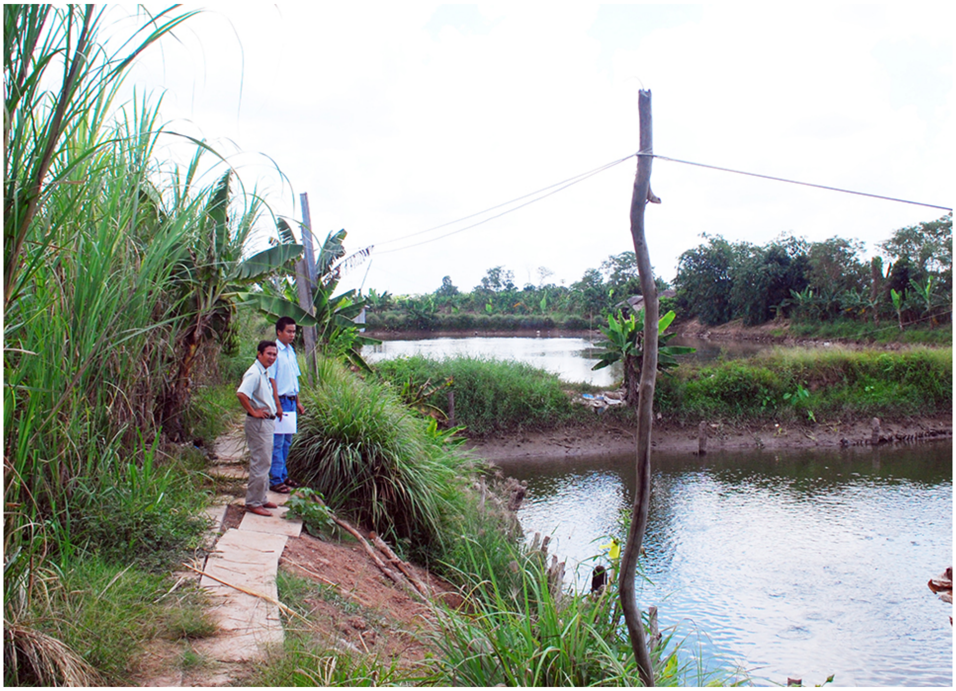
Some environmental consequences may be directly related to feed production, and feed often accounts for over 90 percent of the energy use. Both the feed-conversion ratio and feed composition directly affect the environmental impacts of feed-related production. Plant-based ingredients commonly have less impact, while fishmeal, fish oil and livestock processing coproducts such as offal cause greater effects. Lower feed inputs in extensive farming also allow for more energy-efficient production.

Socioeconomic factors

It is also important not to forget socioeconomic factors when comparing systems. If they are not considered, problems will only be shifted rather than resolved. For example, most aquaculture farms still have a high dependency on fishmeal. Peru is the largest producer of fishmeal, while 25 percent of Peruvian infants are still suffering from malnourishment.

Utilizing crop-derived feed inputs not directly available for human consumption should be encouraged, and direct consumption of forage fish should be promoted. Furthermore, a third of the global food production is currently wasted before it reaches consumers. To reduce this fraction, improvements are needed in the logistics and utilization of food, as well as a change in our perceptions of food.

With an increasing portion of aquatic products entering international markets, there is a need for high scrutiny. Mismanaged capture fisheries in Europe and other parts of the world have resulted in increasing imports of seafood from faraway places, much of which is derived from aquaculture. Some of these imports may, however, contribute to ecosystem degradation and pollution. At times, they may also deprive the local poor of essential sources of proteins.



Even small farms use electricity for various purposes.

Systems approach

Future sustainability evaluation schemes need to use a broad systems approach to cover all areas of concern. Areas of concern are often interlinked, and it is necessary to consider the true consequences of the whole production chain before making decisions. The aim should be to improve human well-being and equity for all relevant stakeholders and developed aquaculture in the context of other sectors, policies and goals.

A good example of such an approach is presented by the Sustaining Ethical Aquaculture Trade project, which intends to incorporate several disciplines and sustainability frameworks to evaluate all three pillars of sustainability – environmental, social and economic – in hopes of guiding consumers toward sustainable seafood.

Ecosystems are fundamental for both social and economic systems, while poverty is often the underlying factor for environmental degradation. There is therefore a complex interaction of bottom-up effects, such as failing renewable resources (fish stocks, for example), as well as top-down effects, such as unsustainable harvesting to maintain livelihood (hunting of bush meat). Failing to acknowledge this can result in a constant chain of false solutions, exemplified by the recent biofuel hype.

Perspectives

Drastic changes will be needed to feed an additional 2.3 billion people with ever-scarcer resources up to the year 2050. The challenge will be to implement these changes in a world that currently allocates its resources toward practices such as tuna fattening and biofuel production from fish processing coproducts. To do so, we need to implement the real costs of resource depletion and environmental degradation into our valuation system or we will push our planet out of its current stability domain.

(Editor's Note: This article was originally published in the September/October 2010 print edition of the Global Aquaculture Advocate.*)*

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