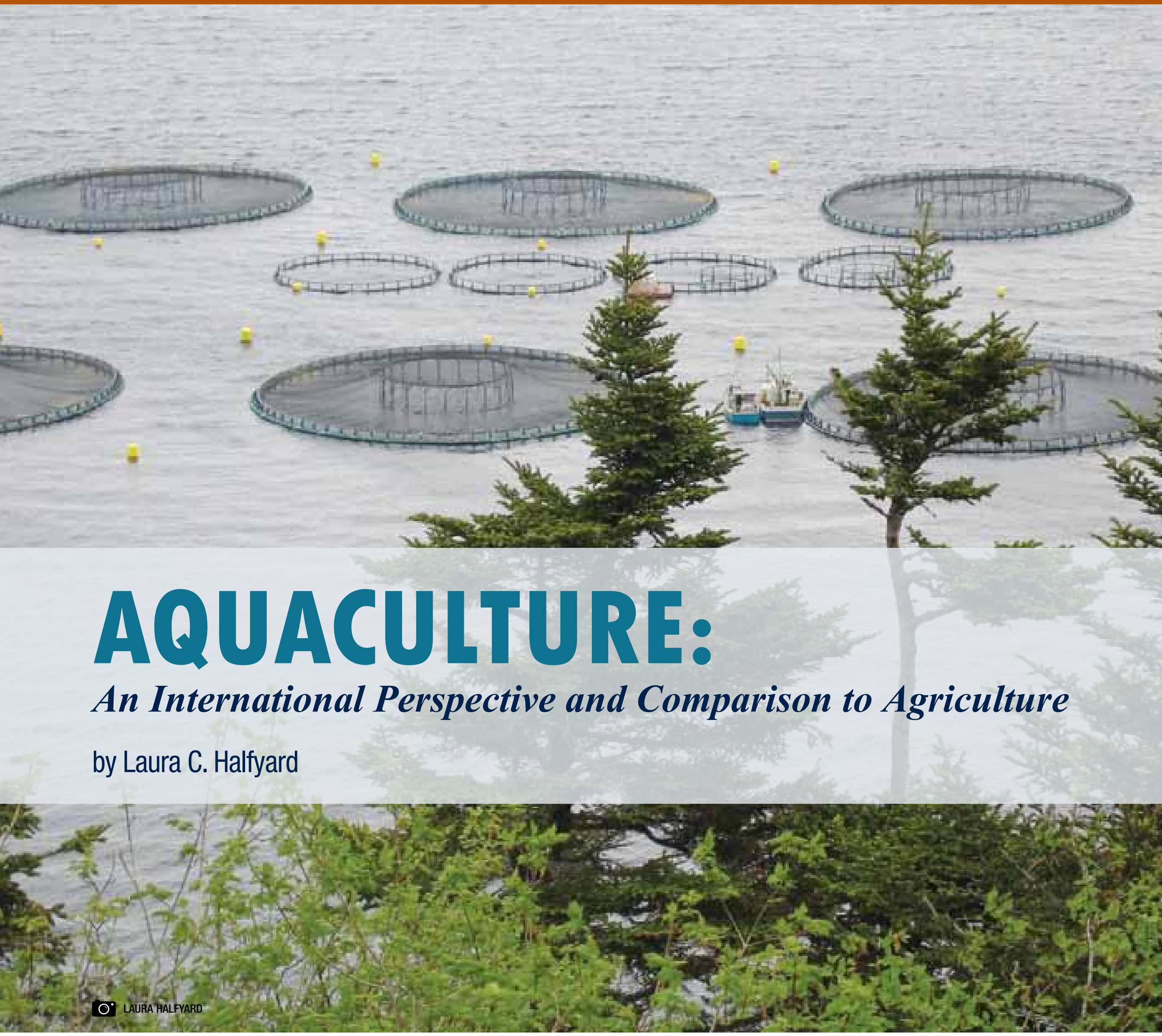

AQUACULTURE:

An International Perspective and Comparison to Agriculture

by Laura C. Halfyard

Figure 1: Salmon cage farm site near Belleoram, Newfoundland, with predator nets to protect the smolts recently transferred from fresh to seawater. Large vessels are used to automatically feed the fish and maintain the farming cage structures.

This essay looks at the issues facing the development of various types of aquaculture around the world. It gives a perspective of scales of intensity of the operations for developed and developing countries, while comparing it to the past and present agriculture sector. This is especially critical as, for much of Asia, aquaculture is closely tied to agriculture for integrated farming practices. Global population and consumer demands, Green and Blue Revolution trends, user conflicts for land and water (freshwater and oceans), environmental concerns, labour issues, as well as present and new aquaculture technology will be highlighted.

Future Global Considerations

What will aquaculture look like in the future? What will be some of the issues that the industry will face as it continues to develop to meet the needs of the world's growing population and seafood shortage? Having

spent the past few decades visiting and liaising with projects in Canada, Norway, Vietnam, Cambodia, Malawi, Kenya, and others, I will present an international perspective on aquaculture. This essay discusses issues that impact the scale and type of aquaculture, while Table 1 summarizes comparisons of agriculture historical trends and similar aquaculture evolution.

Global Population Growth

Aquaculture, the farming of fish and plants, is the fastest growing food sector in the world, growing exponentially to meet increasing population and declining/steady wild fish stock availability. Aquaculture growth is about six times faster in developing countries than developed ones. The global wild fishery for 2006 remained stable at about 80 million metric tonnes, with aquaculture production increasing to approximately 59 million; the Proceedings of the National Academy of Sciences suggested that as of 2009 aquaculture accounted for 50% of fish consumed globally. China accounts for about 70% in quantity (mainly freshwater carp production) and 50% by value for global aquaculture production. Seven of the top producing countries are Asian (order: China, India, Vietnam, Thailand, Indonesia, Bangladesh, Chile, Japan, Norway, Philippines), while many African countries are in the top producers in terms of growth. World human consumption of fish is about 15-16 kg/person, with Asian developing countries having much higher consumption rates than North American and other developed countries.

Green and Blue Revolution Trends

The Green Revolution, a term coined by William Gaud, Director of the United States Agency for International Development, describes increases in agricultural crop yields, which began in the 1960s. Dr. Norman Ernest Borlaug pioneered a wheat breeding program in the 1940s in Mexico, which extended into the USA and other developed countries for the selective breeding of different crops. Similar intensification of aquaculture began in the 1970s, with Asian developing countries leading the way (see Table 1, item a).

Types of Aquaculture and Species

When we view aquaculture in Canada, the USA or the European Union, we often see intensive farm operations (i.e. high stocking densities in contained cage or tank systems, high feeding rates) culturing such finfish species as salmon (see Figure 1), trout, marine fish such as bass and bream, as well as shellfish species of mussels (see Figure 2), oysters and clams. Automation aims to reduce labour costs, and minimize the footprint of the tank/cage-type farm operation for land and water resources. Trends include consumer awareness information about the sustainability of farm practices and strong government environmental monitoring. Pressures on wild stocks (i.e. estimates for the EU and USA suggest that high percentages of fish in the marketplace are illegally caught) and seasonal availability are also driving the farming of fish, as with agricultural plant/animal production. Aging populations are also dictating consumer health concerns (see Table 1, items c-f), with the demand for omega-3 fatty acids expected to increase to address physical and mental health issues. For example, several British scientists indicate that fish oils will be critical to child development and learning capacities, as well as for reducing the costs of mental health to the EU health care system in the next decades.

Figure 2: Blue mussel farm in Notre Dame Bay, Newfoundland. Mussels are suspended in the water column using longline technology; they filter-feed on natural ocean plankton; and vessels grade and harvest using hydraulics/automation.

practices where plants, livestock and/or fish are cultured in a mutually beneficial and sustainable process. Agriculture-aquaculture systems may share resources such as water, land, feeds, management and other infrastructures. Semi-intensive farming practices reduce the stocking densities and require lower feed/fertilizer input, but use more land/water resources. A typical type of family-based integrated farm operation includes rice-fish-animal culture having a synergistic relationship. Diversification of crops

Asian culture of carp, tilapia and *Pangasius* (catfish) species, as well as shrimp and seaweed, tend to also be intensively or semi-intensively cultured (i.e. high or moderate feeding rates, high or medium stocking densities) in earthen ponds or tank systems, utilizing cheap local labour, using agriculture or coastal lands, and requiring capital investment from private/government sources. These products are generally exported to the EU and North America as high valued cash crops; monitoring of exported fish quality necessitates control of water quality, chemicals, etc. but there is often less stringent environmental monitoring than in the developed countries. What will be the issues as Asia's population continues to pressure the water, land and other environmental resources?

Large segments of the rural population of Asian countries such as China, Vietnam and Cambodia are reliant on agriculture and fisheries/aquaculture crops produced locally, or within the family farm systems. Often linked to agriculture activities are integrated farming

thus reduce the risks for marketing, disease and pesticide use, costs of feed/fertilizer, and labour costs outside of the family, while more efficiently utilizing their existing family farmsteads. However, intensive monoculture of species will probably escalate under the pressures of population growth and land/water limitations.

One of the projects being lead by MI International (Fisheries and Marine Institute of Memorial University), through CIDA (Canadian International Development Agency) funding and ACCC (Association of Canadian Community Colleges) coordination, is the Cambodian Sustainable Rice Fish Integration (SRFI) Project. Cambodia is one of the poorest countries in the world (130th out of 177 on the Human Development Index). Poverty is widespread, affecting over five million people (35% of a population of 14.5 million). Government efforts to reduce poverty at the rural community level are linked primarily to rice security and secondarily to fish security. Regional studies have found that integrating

Figure 3: A young Cambodian girl feeding fish in her family's rice field and fish refuge. Fish may also eat other organisms in the rice fields, while nitrogenous fish wastes provide nutrients to the rice. Farmer training and monitoring are ongoing activities for the Sustainable Rice Fish Integration Project in Takeo Province.

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rice fish operations (a) increases the annual yield of rice and the fish population; (b) increases health by providing complementary sources of carbohydrate and animal protein; (c) enhances livelihoods by providing an additional source of food and income; and (d) is environmentally friendly because pesticide use is virtually eliminated because the fish feed on insects. The project leaders of Prek Leap National School of Agriculture and MI, as well as a team of cross-linked provincial fisheries and agriculture extension officers, are working with villages in Takeo Province (south of Phnom Penh) to slightly modify their rice fields to integrate fish refuges (see Figure 3) and to incorporate other agriculture-aquaculture technology for organic composting (see Figure 4), mushroom farming and village fish breeding refuges. With the new regional water reservoir controlling seasonal flooding and drought phases, these villages are hoping to extend the growing season and avoid critical food shortages.

In September 2000, at the United Nations Millennium Summit, world leaders agreed to a set of time-bound and measurable goals and targets for combating poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women. The goals are collectively referred to as the Millennium Development Goals (MDGs). Approximately 70% of the MDGs target group lives in rural areas particularly in Asia and Africa, and for

Figure 4: Composting of animal and plant farm wastes creates a rich fertilizer for the gardens and the fish ponds, as well as producing methane gas to fuel the kitchen cooker. The fertilizing of the pond water promotes phytoplankton and zooplankton blooms that become food for herbivorous fish.

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most of the rural poor, agriculture is a critical component in the successful attainment of the MDGs. Many Asian populations have higher fish protein consumption rates (see *Global Population Growth* in this essay) than in developed countries, thus declining wild fish stocks and population growth are driving the development of sustainable farming systems to provide food security for the family. The Cambodia SRFI project is developing one such model.

Global Demand for Seafood and Consumer Preferences

The list of top ten seafoods consumed in the USA has shifted over the past decade to now mainly be comprised of aquaculture reared species (2008 list: shrimp, tuna, salmon, pollock, tilapia, catfish, crab, cod, flatfish, and clams). Consumer trends, as observed at the recent 2010 Boston Seafood Show, include high quality products available throughout the year, with fresh or IQF (Individually Quick Frozen) portions. Traceability, eco-labelling and product certification trademarks (see Table 1, item f) are emerging as marketing strategies for major fish companies to gain consumer confidence and a price premium. Consumer awareness of health and environmental issues are also gaining momentum in North America and the EU. Also noted was the growing presence of species, such as *Pangasius* from Vietnam that can replace other marine white fish species, is cheap and neutral tasting.

Consumer trends in the developing countries, as observed in Vietnam, Cambodia and Malawi, revolve more around locally available, cheap fresh fish protein sources, as there are limited icing/refrigeration facilities and the population densities can dictate immediate sales of all product. However, seasonal spoilage (e.g. rainy season preventing storage and drying) remains an issue for both agriculture and seafood produce. Family and local village consumption is often dictated by transportation resources and cash crops to provide funds for other family commodities. Rice and corn are primary sources of carbohydrates, with farmed and/or wild fish being the preferred protein source for many Asian and African populations. As discussed earlier in *Types of Aquaculture and Species*, fish is also critical for its omega-3 human health benefits (e.g. mental disorders, depression, cardiovascular), particularly for the poor who have limited nutrition and health resources.

Land and Water Limitations

User conflicts over natural resources (e.g. land, water, feed sources) will demand diligence in aquaculture site and species selection to avoid environment and resource conflicts. Fisheries and Oceans Canada indicates that global salmon production is estimated to increase until about 2015; Canada's production is projected to be about 350,000 tonnes, utilizing an area of about 800 hectares, only about twice the size of Stanley Park in Vancouver, British Columbia. This intensive farming of salmon will provide substantial employment and economic benefits to rural, coastal regions, while minimizing the footprint and demand on land/water resources.

The growth of megacities in Low Elevation Coastal Zones has been a trend observed over the past decades. This puts large populations of the world at risk due to the potential impacts of climate change (e.g. rising sea levels, storm surges), as well as food and health security (e.g. malaria, dengue). Climate change will also impact agriculture climate zones (e.g. northern and central European areas will be more 'Mediterranean') and flood events. Suggestions of a second agriculture 'Green Revolution,' coupled with the aquaculture 'Blue Revolution,' will need to adapt to climate change impacts to stabilize food security.

Rural to Urban Population Shifts and Worker Availability

As discussed in Table 1 (items b, d, o, p), population shifts have created megacities in coastal regions, causing food market supply changes, agriculture-aquaculture labour issues, and potential land and water user conflicts particularly for coastal zones. The World Bank indicated that migration is less strong for the poorest population sectors, who will probably be the sector involved in small-scale family-based integrated farming in developing countries and are those to address for food security in relation to achieving the MDGs. Since often women and children remain closer to the home and farm, non-governmental organizations have suggested that micro-credit strategies and training should target women and community groups, as the rate of loan repayment and re-investment back into the family is stronger.

In contrast, labour requirements for intensive agriculture and aquaculture farm systems necessitate education and training for highly specialized technology and automation. Canada is presently developing linkages with Asian universities and institutes (e.g. Marine Institute-Memorial University linkages with China universities); this type of educational linkage may serve the future human resource needs of both countries for an educated industry-oriented labour force. Developed countries have already experienced an influx of seasonal migratory workers from developing countries to meet labour demands for lower wage occupations (e.g. Canadian agriculture and fish processing sectors utilizing workers from Mexico and Russia). The aging populations and out-migration of young people to urban, higher paying employment will be a major constraint for continued aquaculture development.

Aquaculture Technology, Feeds and the Environment

Aquaculture intensification technology (see Table 1, item d) mirrors agriculture animal husbandry development, with control over the environment, feeds (see Table 1, items g, h, i, k, l) and breeding stocks (see Table 1, item j). Global population growth and land/water user conflicts will require intensive farming methods. However, trends (see Table 1, items e, f) for affluent, educated consumers from developed nations suggest a desire to revert to locally available, organic produce due to environmental and human health concerns. Both agriculture and aquaculture reliance on feed sources from wild marine fishmeal and oil (see Table 1, item k, l) is unsustainable. Aquaculture will soon utilize 100% of the global meal/oil supply, with agriculture reverting to agriculture grains or by-products of the aquaculture processing industry. Alternate protein sources are also being researched for the aquaculture industry, particularly for carnivorous and marine species.

Sustainability for much of aquaculture's future growth will probably hinge on herbivorous species that rely on low trophic level feeding strategies (i.e. phyto/zoo-plankton, micro/macro-nutrients from the water). Mussels, oysters and other bivalves employ these 'filtering' strategies and are essentially 'organic' or natural. Seaweeds can extract nutrients from the water column and become an important agent in the Integrated Multi-Trophic Aquaculture (see Table 1, item l) model to re-use nutrients and reduce risks of eutrophication. New feed technology will probably rely on 'ocean gardens' to culture various species and to grow feed ingredients for carnivorous fish species, terrestrial animals and/or human consumption. However, global warming impacts (see Table 1, item m) may reduce the primary productivity of the oceans as coastal upwelling action may decline and limit nutrient availability. Issues related to using the ocean as a dumping ground for industrial, human and animal wastes may also negatively influence the ocean environment (e.g. toxic algal blooms, hypoxic conditions). Eutrophication and pollution of freshwater sources are also increasing in many Asian countries, thus putting at risk the global production of freshwater carp and tilapia species.

(Opposite page) Table 1: Comparison of agriculture and aquaculture farm practices, with considerations of past and future trends.

Characteristic	AGRICULTURE	AQUACULTURE
a. Historical	Green Revolution – Dr. Norman Ernest Borlaug pioneered a wheat breeding program between central and northern Mexico beginning in the 1940s; was awarded Nobel Peace Prize in 1970.	Blue Revolution – Dr. Modadugu V. Gupta was the 2005 World Food Prize Laureate for being a prime architect of Asian blue revolution for aquaculture.
b. Developed versus Developing Country Technology	Developed countries utilize technology for larger farm operations, automation, selective breeding of seed/stock. Out-migration from rural agriculture occupations to urban jobs also requiring automation and migratory workers. Developing countries still generally use simple farming techniques and manual labour.	Aquaculture intensive farming technology is similarly based on reducing labour requirements, selective breeding programs and automation. Similar issues of out-migration of young people also forcing automation and migratory workers.
c. Asian Domestic and Export Production and Global Impacts	Asian countries, particularly China, account for majority of global agriculture production and consumption. Population growth for China has shifted imports (e.g. cars from Japan) to surpass exports. China is actively buying agriculture operations in African and South American countries to boost production. The cost of food today in the U.S., as a percentage of disposable personal income, is lower than it has been for decades (i.e. about 14% in 1970 and only 10% in 2007). Consumer demands for cheap, high quality products negatively impact farmer earnings, labour salaries, intensive farm practices, etc.	Demand for seafood exports to USA and EU presently driving intensive fish culture in China, Vietnam, etc. as a cash crop. Demand for seafood products will probably shift the markets from export to domestic as Asian populations expand. Similarly, aquaculture market demands are for cheap, high quality, regularly available products. Production of fish in developing countries may reduce production and labour costs but may increase contaminant risks (e.g. unregulated chemicals, disease treatments, pollution, less stringent environmental and human health monitoring).
d. Intensification and Automation	In developed countries, the Green Revolution saw a shift from small family based farms with local markets to large companies and farm machine automation. Some recent reversal of this trend with 'Eat Local' (see item e).	Similar trends emerging as it did for agriculture. Being driven by need to reduce operational costs and labour requirements, while increasing production for global population growth. Emerging of small farm systems for local production of select species (e.g. live fish to Asian customers).
e. New Trends for '100 km Diet,' Eat Local	North America is presently seeing a trend for consumers willing to pay a premium for agriculture crops grown locally, within 100 km and utilizing seasonal selections. Organic farm products also have an increasing profile in the grocery stores.	Similar trends are emerging for seafood products raised by aquaculture methods, with traceability of all inputs into the farming (e.g. diets, disease treatments). Integrated farming, recirculation systems and aquaponic systems are developing to provide small, local fish and plant crops.
f. Consumer Health Trends	Organic, non-GMOs, free-range and other agriculture farm methods are being driven by consumer demands.	Food certification, eco-labelling, traceability, organic and other aquaculture product certifications are similarly being consumer driven.

	Use of unregulated pesticides and herbicides has become a human health and environmental issue.	Agriculture and industrial chemical use have effects on the water quality, fish health and chemical residuals in the fish products. Demand for omega-3 fatty acids for child learning capabilities, mental health issues, heart and other human health issues will enhance aquaculture production as wild fish stocks will be insufficient.
g. Biofuels	Use of agriculture crops (e.g. corn, sugar cane, sugar beet) for ethanol fuel production rather than for human and animal feeds has altered the economics of crop production. Future alternate fuel sources may affect agricultural production.	Processing of fish wastes from wild and farmed fish into biofuels for industrial application (e.g. automobiles, small generators) may compete with use of fish oils for human and animal feeds.
h. Genetically Modified Organisms	Various countries have enacted regulations to prevent agricultural use of GMOs.	Aquaculture use of GMO feedstuffs may limit marketing potential in some countries. Organic certification of fish farm products will preclude use of GMOs in fish feeds.
i. Other Additives	Use of antibiotics and growth enhancement additives are issues in some animal husbandry practices.	Aquaculture has developed husbandry and fish vaccine treatments to limit antibiotic use; only 2.5% in British Columbia salmon industry compared to 50-90% in the hog sector, and an increase of 300% in the poultry sector.
j. Strain Selection	Agriculture genetic breeding practices have resulted in the decrease in species and strains being domestically and globally farmed. Efforts have begun to create gene banks to preserve rare strains of plants and animals.	Similar breeding programs are enhancing the farm production of fish species. Biodiversity of strains of fish may be put at risk, as with agriculture crops. Issues of interbreeding of wild and farmed fish stocks have raised concerns for farm systems that allow escapees (e.g. cages/pens, open pond systems, exotic species introductions into water bodies).
k. Sources of Feeds	Animal husbandry (e.g. pigs, chickens) has included the use of wild fishmeal protein and oil sources to improve growth and breeding conditions. The shift back to traditional grain-raised animals will require more land use. Utilizing farmed fish by-products instead of wild sources will allow wild fishmeal/oil products to go to the aquaculture sectors. Mad-cow disease (bovine spongiform encephalopathy or BSE) brought about changes to animal feed regulations that prevent feeding of parts back to the same animals.	China is the world's largest importer of fishmeal; trends suggest China will control global fishmeal and oil sources. Aquaculture's dependence on wild fishmeal/oil sources will limit development, as demand is expected to exceed availability in the next decade (i.e. ~6 mmt fishmeal, ~1 mmt fish oil). Alternate sources include agriculture (e.g. soybean), marine phytoplankton, yeasts, etc. Demand for agriculture crops for fish feeds may put further pressures on land and water resources, as well as labour requirements. As with agriculture, fish feeds cannot contain ingredients from the same species. Aquaculture fish processing wastes are generally directed to agriculture animal operations.

l. Trophic Level Nutrients and Feed Conversion Rates (FCRs)	Agriculture has primarily focused on vascular plants for crops. Legumes utilize soil nutrients (i.e. fixation of nitrogen, high protein content, e.g. beans, lentils) not readily available to other plants. FCRs for animals are 3:1-8:1 (kg of grain fed to produce 1 kg of flesh growth) for chickens, pigs, cows.	Herbivorous species – low trophic level plankton feeders (e.g. tilapia, shellfish) will probably have long-term sustainability whereas carnivorous species – high trophic level feeders (e.g. salmon, bass) will be limited by marine protein and lipid/oil sources for fish feeds. Mariculture and IMTA (Integrated Multi-Trophic Aquaculture; e.g. salmon-mussels-seaweed) includes the development of seaweed culture methods, as well as phyto/zooplankton production for larval fish feeds. Human health nutrient supplements and future sources of omega-3 oils may require 'gardening' of the oceans. Fish FCRs are much lower (about 1.2:1) than other agriculture animals, thus protein efficiencies are much more economic.
m. Environmental Issues	Global warming, pesticides, eutrophication caused by agriculture nutrients, human and industrial wastes, GMOs, animal disease treatments, introduced exotic species, etc. will affect environmental sustainability for agriculture practices.	Aquaculture is similarly affected. Global warming of the oceans (i.e. CO_2, iron-based N enrichment for phytoplankton) may affect the stratifying of the waters, reduce coastal upwelling and the resuspension of nutrients from the bottom, and adversely affect trophic level productively, particularly of phytoplankton and predator-prey match-mismatch mechanisms.
n. Water Resources	Population growth in Asian countries will continue to pressure the water and land resources, particularly for pollution impacts, as well as global warming/climate change and potential ecosystem collapses. China has begun to purchase agriculture farm operations in African and South American countries to meet future demands.	Fish are like 'the canary in the mines' in that they detect or are adversely affected by chemicals in the water. Most of these chemicals result from industrial or agricultural run-off from the land, or from human waste sources. Aquaculture will require sourcing of pollution-free waters.
o. Land Resources	Intensive farm practices and the Green Revolution have increased agriculture production. Increased population growth, migration to megacities in Low Elevation Coastal Zones, global warming (i.e. rising sea levels, more arid land), user conflicts and labour demands will put pressures on agricultural production.	Alternate plant protein sources, land-based aquaculture systems and labour demands will also pressure agricultural production and land resources.

p. Human Resources	Developing countries tend to use the family structure to support agriculture activities. This often means that women and children do most daily activities (e.g. planting, harvest, feeding animals), while men may be migratory workers or available for certain heavy labour activities (e.g. plowing, digging). Micro-credit directed to women or community groups are being fostered in many countries to support agriculture entrepreneurs. Industrial models tend to utilize cheap labour and/or automation. Out-migration and low wages are issues in developed and developing countries, but the poorest tend to be less migratory.	Aquaculture in developing countries, like agriculture, is often family-based. Integrated farming practices provide crop diversification and stability to the family unit. The additional cash crops from aquaculture may empower the women, while supporting the men to work at/near home. Protein sources for children would also be improved with fish crops. Aquaculture in developed countries has begun to experience labour shortages as has been observed in the wild seafood processing and agriculture sectors. Migratory, seasonal labour will be sought from poorer countries.
q. New Technology	Alternate sources of plant nutrients (i.e. non-petroleum based fertilizers), another Green Revolution phase, aquaponics ('liquid soil' concept, water based plant culture, e.g. vegetables, herbs, flowers plus fish species), new seed varieties, etc. will be needed to meet global demands. Global warming may reduce rich agriculture lands in Asian river delta regions as sea levels rise. Crop developments include low water/short season rice and saline tolerant plants for marginal coastal lands.	Ocean 'gardening' and open ocean technology will probably be developed/enhanced as land and freshwater resources become limited. Improvements of Recirculation Aquaculture Systems would reduce escapee concerns and control factors for water use, effluent discharge/reuse, disease, etc. However, production costs would probably increase market price. Adoption of Better/Best Management Practices (BMPs) will prevent disease and stress, while ensuring food, environment and economic sustainability (e.g. shrimp farming BMPs).

Concluding Comments

What will aquaculture look like in 2050? How will we meet the demands of the world's population through sustainable farm practices? Land conflicts were and are the causes of wars, while the future is expected to see wars over freshwater and oceanic resources (e.g. Mekong River neighbouring countries – China, Vietnam, Cambodia). Integrated agriculture-aquaculture farming systems using herbivorous species and synergistic use of wastes are probably ecologically sustainable, but will require Best Management Practices to monitor environmental conditions. User conflicts of land and water resources will likely force aquaculture to use marginal regions, to reduce its footprint through intensive farming practices and to harness the potential of the oceans. Phytoplankton, seaweeds and bivalves (i.e. relying on natural feed extraction from the oceans) may provide human and animal nutrients as the wild fish stocks fail to meet global seafood and fishmeal/oil demands. Offshore and deep ocean technology may also be developed for high valued finfish species, but this comes with high risks that may limit its economic potential. Global warming and trophic level impacts may further reduce the primary productivity of the oceans.

Dr. Laura C. Halfyard has over 20 years experience as a fisheries/aquaculture specialist. She is presently the Chair of the Advanced Diploma in Sustainable Aquaculture program at the Marine Institute. Provincial, national, and international research efforts have been directed to the husbandry and nutritional requirements of various marine and freshwater finfish species. A strong working knowledge of Canadian, Asian, African, and European connections has been the basis of cultured and wild fisheries activities, as well as extension/outreach, gender, aquaculture education and training programs (e.g. industry, community, university, college, school). International efforts have involved integrated farming practices for aquaculture and agriculture. Internationally funded projects (e.g. CIDA, ACCC, AUCC, World Bank) have been in Malawi, Vietnam, Cambodia, Sri Lanka, Kenya, etc. Over the years, Dr. Halfyard has also been involved in various Newfoundland/Canadian female recruitment activities into non-traditional careers. She is the past-president and a director of Women in Science and Engineering Newfoundland and Labrador (WISE NL).