

# Hot topics in aquaculture research

Experts agree that the rising demand for fish for human consumption cannot be met without a major expansion and sustainable intensification of aquaculture. Our WorldFish authors describe the areas in which research plays a particularly important role in this context.

Meeting the future demand for supply of fish for human consumption will require the expansion and intensification of aquaculture, whilst maintaining growth within ecological limits. Future fish supply-demand scenarios suggest that farming of fish and other aquatic animals will need to double production by 2030 to meet growing global demand (World Bank, 2014). Given that production of fish from fisheries is projected to decline or remain at current levels under optimistic projections, the vast majority of future growth will need to come from aquaculture. Aquaculture now provides around half of the fish eaten by humans, and recent analyses (OECD/FAO, 2015) suggest that aquaculture supply will overtake capture fisheries within the next decade. The shifting consumption from wild to farmed fish has important nutritional, environmental, and economic implications. Aquaculture is already the world's fastest growing food production sector, growing at approximately 8 per cent per year, and the relative youth of the sector in many parts of the world offers opportunities for research to identify models that maximise different types of benefits for humans and the environment. This article highlights five "hot topics" for attention, with special reference to aquaculture development in Africa and Asia. We focus first on nutrition, a key area for



A woman cleaning fish at her house in Jessore, Bangladesh.  
Photo: Y. Tushar

the future, followed by four other topics for attention.

## ■ The role of fish in improving nutrition and health outcomes

The world faces multiple challenges to sustainably meet the food and nutritional requirements of a population that is projected to reach over nine billion people by 2050. While challenges of undernutrition, including micronutrient deficiencies, and infectious diseases continue to be the main focus of attention for low – and middle-income countries, problems of overnutrition and non-communicable diseases are rapidly rising in prevalence and placing an increasing burden on health systems. Addressing this "double burden" of malnutrition will require a significant shift in current approaches to food systems to increase production and consumption of the foods known to benefit human health, including fruits and veg-

etables, nuts and seeds, whole grains, and fish. Indeed, low consumption of each of these foods are important contributors to global death and disability (Ezzati 2013).

Fish and other aquatic animal products are a commodity of key significance in global diets. Food balance sheet data suggest that at least one billion people depend on fish as the main source of animal food, and three billion people rely on fish for at least a fifth of their intake of animal source foods, though these figures are subject to great uncertainty. For rural inland poor populations in Asia and Africa, dried fish is a particularly important food; such fish are often small, and consumed whole. As a result, they contain higher levels of nutrients including calcium, zinc, iron, and vitamin A than normally are available in larger fish. Fish is also an important source of vitamin B12, which is only found naturally in animal source foods and plays an important role in the

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function of the brain and nervous system. Fish also contains a factor, sometimes called the “meat factor”, which enables greater absorption of micronutrients from other parts of the diet.

While the micronutrient profile of many fish species remarkably fills many of the same gaps that are limiting in the cereal-based diets of the rural poor, the public health world recognises fish largely for its rich content of omega-3 fatty acids, including EPA and DHA. It has been estimated that a quarter of all disability-adjusted life years lost (DALY's) due to ischemic heart disease and one per cent of all worldwide DALY's are due to low intake of these nutrients. Recent analyses revealed that 80 per cent of the world's population had mean intakes of less than 250 mg/day, with extremely low levels (<100 mg/day) prevalent in sub-Saharan Africa, South America, and Asian mainland nations (Micha et al., 2014). These results led the authors of the study, published in the British Medical Journal, to call for “concerted public health and policy initiatives ... to increase both supply and consumption.”

Increasing the impact of fish on human nutrition in a food system changing from wild to farmed production systems represents a special challenge and opportunity for aquaculture, with more “nutrition sensitive” approaches required. Whilst it can be argued that increasing supplies of a nutrient rich product – fish – is in itself a nutrition-sensitive action, there are further positive measures that can be taken to secure improved nutritional outcomes from aquaculture. Some key areas of attention for research include:

(1) The development of aquaculture farming systems that **increase the supply and access of nutritious fish to poor consumers**. The introduction of micronutrient-rich fish into home-stead pond polyculture systems in Bangladesh for home consumption and sale provides one example (see Thilsted, 2012), but further research on enhancing nutritional outcomes from aquaculture, such as through optimisation of fish species combina-

tions, pond management and harvesting systems, across the developing world is necessary.

(2) The development of feeding systems that **increase the nutritional value of fish**. Whilst there has been some research around enhancement of omega-3 fatty acids in Atlantic salmon through feed ingredients and fish feeding systems, very limited work has been done on developing country aquaculture species such as tilapia, carps and catfishes. The manipulation of fish diets, and feeding and fertilisation systems, where possible through use of locally available feed and fertilisers, is an area of research with much potential for increasing the nutritional value of fish.

(3) **Harnessing fish to meet nutritional needs during the first 1,000 days of life**. Evidence, largely from developed countries, suggests that fish consumption during pregnancy is particularly beneficial, and is associated with reduced risk of preterm delivery and higher performance on multiple tests of brain development by children. As a rich source of multiple micronutrients including zinc and iron, fish can also play an important role in meeting the considerable micronutrient needs of children aged 6–12 months, who are growing rapidly but have limited gastric capacity. Yet evidence from multiple settings in Africa and Asia suggests that animal source foods are often withheld from the diets of young children and women. Behaviour change communication and food processing technologies can play an important role in overcoming the barriers inhibiting these sub-populations from benefiting from fish.

(4) **Improvements in preservation and food safety of fish to ensure greater access for poor people**. As a perishable commodity, fish is believed to be highly subject to waste and food safety issues. Yet little reliable evidence exists to document the extent of such problems, or the burden that they place on human health. There is an important need to build evidence and to put in place thoughtful interventions that can reduce waste from both fisheries

and aquaculture, improve fish safety, but at the same time keep fish affordable for poor populations.

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## ■ Improving technologies

Aquaculture is a young industry – growing fast, yet still behind livestock in many aspects of technology, such as the **development of improved breeds, feeds and farming systems**. Improvements in breeding technology, disease control, feeds and nutrition, and low-ecological impact production systems are all interlinked areas where research can complement traditional knowledge to improve efficiency and productivity of aquaculture. Increases in agricultural productivity have been achieved through the integration of technologies designed to improve productivity and efficiency. In comparison, the global aquaculture industry has developed intensive production systems for only a few species. As one indicator of the immaturity of the sector, improved breeds contribute just ten per cent of aquaculture production systems worldwide (Olesen et al., 2015). Biotechnical research needs to be combined with analysis of market and supply chains to identify key enablers in upgrading value chains and a policy environment for investment and sustainable growth. These sorts of innovation – whether led by farmers, research institutions, companies, or governments – have been behind productivity gains across the world and need to be further supported in growing aquaculture sustainably into the future.

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## ■ Jumpstarting a Blue Revolution in Africa

Africa represents a region of special challenges for aquaculture. While fish is an important source of nutrients for many populations, particularly those near the Great Lakes and the coastal regions, the vast majority of these fish come from wild fisheries, many of which are experiencing declining productivity. World Bank projections of future fish supply predict Africa as the only region with declining per capita



fish consumption, from an already low consumption, declining at an annual rate of one per cent to 5.6 kilograms/person/year by 2030, with serious implications for nutritional security within the continent. Egypt is the region's largest aquaculture producer, with strong growth that now supplies one fish per week for all Egyptians, yet development of aquaculture at the scale needed has been fairly limited to date throughout sub-Saharan Africa. Aquaculture has been growing fast in some countries in sub-Saharan Africa, such as Nigeria and Ghana, but this growth is from a low base, and a substantial boost in supply will be required to meet future demand. An enabling environment appears essential for successful scaling of aquaculture technologies within the region, and a strong market-oriented approach is emerging as a condition for successful stimulation of commercially-oriented development and investment. Aquaculture expansion in Africa appears to occur only when functional value chains supply quality inputs and market incentives allow investments in profitable commercially-oriented aquaculture production, and where enabling policies are in place. Research is needed on what the enabling conditions are for aquaculture expansion in sub-Saharan Africa and where the priority value chains are for investment in aquaculture growth.

## ■ A greener aquaculture

The necessary doubling of aquaculture production across the developing world in the next few years will face significant environmental constraints (WRI, 2014). Recent WRI/WorldFish research has examined aquaculture's environmental footprint today and explores various scenarios of aquaculture growth to 2050. On average, fish convert feed to food as efficiently as poultry, making them an attractive option for expanding the global animal protein supply. However, as with all forms of food production, aquaculture isn't without its environmental impacts, and the sector needs to be well prepared for climate change. As aquaculture began to boom in the



*A hatchery worker holds Abbassa Nile tilapia grown at a hatchery in Egypt.*

*Photo: H. El-Begawi*

1990s, several concerns emerged, such as the clearing of mangroves to make way for shrimp farms in Asia and Latin America, increased use of fishmeal and fish oil made from wild marine fish, and the generation of water pollution and shrimp and fish diseases. The aquaculture industry has greatly improved performance since the 1990s, producing more farmed fish per unit of land and water, lowering the share of fishmeal and fish oil in many aquaculture feeds and reducing carbon footprints and impacts of mangrove conversion. Implementing improvement across the sector through widespread adoption of current best practices will be needed to significantly reduce its environmental impacts and increase its resilience to climate change. Research on improvements in land and water use efficiencies, reducing greenhouse gas emissions and new developments in feed will be required to reduce the footprint of aquaculture's growth. Reducing reliance on marine resources such as fish meal and oil for fish feeds, a key ecological footprint of aquaculture, will also be essential to increase the positive impact of aquaculture on global fish supply.



*A farmer feeding fish in her household pond in Bagerhat, Bangladesh.*

*Photo: M. Rahaman*

## ■ Engaging the private sector

Aquaculture's growth, focused largely on the developing world, provides multiple new employment opportunities in fish production, marketing and processing, with private investment as a major engine of growth. Improving collaboration between the research community and both private and public sectors will be important to ensure that research creates impact and supports an inclusive and sustainable growth of aquaculture in the future.

Across the developing world, special attention needs to be paid to the many small and medium-scale (SME) aquaculture enterprises, which represent by far the majority of aquaculture producers. Many SMEs lack access to the credit and technology needed to succeed and grow sustainably. Commercial interest in aquaculture investment is probably at an all-time high, yet much commercial investment presently misses small-scale enterprises, a sector that can create significant employment across the developing world, with proper attention. WorldFish has developed an Incubator facility to connect research with SMEs and support the early start-up of scalable small and medium-sized aquaculture enterprises, cooperatives and farmer organisations, which have potential for high positive economic, social and environmental impact. Its primary purpose is to help bridge the current divide between research, aquaculture SMEs in the developing world and investors seeking scalable, high-impact, triple-bottom-line investments in the aquaculture and the seafood business. Due attention to this key component of the aquaculture sector across the developing world provides opportunities for researchers, policy makers and the investment community to accelerate the growth of an inclusive aquaculture sector, creating food, nutrition and employment for many.

You can find out more about the work of WorldFish at: [www.worldfishcenter.org](http://www.worldfishcenter.org). A full list of references is available at [www.rural21.com](http://www.rural21.com)