



Advancing research and development outcomes with fish in regional food systems

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Food systems encompass the range of actors and interactions along the food supply chain, from production, processing, distribution, preparation, consumption and disposal of food, as well as outcomes such as food and nutrition security, prosperity and environmental sustainability. Food system transformation is increasingly recognized as critical to achieve these outcomes, with significant roles for fish and other aquatic foods in doing so. But fisheries, aquaculture and aquatic foods research and intervention are only beginning to engage with food systems frameworks and concepts.¹

The CGIAR Research Program on Fish Agri-Food Systems (FISH) focused on advancing knowledge on the role of fisheries and aquaculture in food systems to enhance food and nutrition security, with a focus on three regions: the coastal fisheries-dominated **Pacific Islands**, the rice-dominated regions of the **Ayeyarwady and Mekong Deltas** and the environmentally and demographically dynamic region around the **Great Lakes of Africa**. The unique pathways for fish and other aquatic foods to contribute to food and nutrition security in each of these distinct regions were examined to

1. illuminate hidden values, actors and opportunities of fisheries in regional food systems, with an emphasis on small-scale fisheries;
2. improve governance for equitable and nutrition-sensitive distribution and trade of fish and other aquatic foods;
3. create policy conditions and structures for food system resilience to externalities and shocks.

Illuminating overlooked values, actors and opportunities

For policy, investment and transformative agendas to be effective and equitable they must account for currently overlooked values, actors and opportunities in food systems. The [Illuminating Hidden Harvest Initiative](#) explored the values and opportunities of small-scale fisheries for reducing poverty, improving food and nutrition security, promoting gender equality and sustaining life below water.² In Malawi and Zambia, researchers found where and for whom fish provides critical nutrition, including for [up to 82 percent of children who live close to fished lakes](#) in rural areas. In Malawi, Tanzania and Uganda, living close to fishing grounds reduced inequalities in fish consumption between rich and poor households by 34 percent. Further from lakes, fish are not sufficiently accessible for up

Key messages

- Food systems encompass actors and interactions from production to consumption and disposal of food as well as social, economic and environmental outcomes. Food systems frameworks provide a holistic approach for research and innovation to enhance the role of fish and other aquatic foods in improving social, economic and environmental outcomes.
- Illuminating roles and experiences of diverse actors in food systems highlights new leverage points to increase value, reduce loss and waste and increase equity. This includes development of high-quality, accessible fish-based products and processing innovations as well as use of gender-transformative approaches and institutional reform.
- Governance of fish distribution and trade must prioritize equity, especially for nutritionally vulnerable populations. Efforts to achieve this include fish trade reforms, Big Data innovations for global analysis of nutritional flows, and evidence-based principles to guide nutrition-sensitive governance of fisheries and aquaculture.
- Policy conditions and social structures mediate impacts of external drivers of change, which must support and prioritize the inclusive development of adaptive capacity.
- Moving forward, institutional and investment environments must enable small-scale actors to thrive and recognize diverse local knowledge, roles and foods to ensure that high quality, diverse fish and other aquatic foods contribute to food systems for decades to come.

to 79 percent of poor people and 94 percent of children. In these contexts, dried fish and fish-based products become increasingly important.³ In collaboration with government and civil society in Malawi,⁴ Nigeria and [Zambia](#), these and other findings informed policy recommendations that valorize small-scale fishers as central actors in food system transformations, because even with high levels of investment in aquaculture, capture fisheries will continue to be the main source of fish for decades to come.⁵



Food systems of the Pacific Islands

Over 95 percent of people living in Pacific Island nations live less than 10 km from the coast.⁶ Coastal fisheries provide 50 to 90 percent of animal-source food and on average 50 percent of household income. High annual national fish consumption rates (47–126 kg per person) mask disparities, such as low consumption of fish by those living farther from the coast⁷ and by children less than 5 years of age and women of reproductive age, even in coastal areas.^{8,9} The region is experiencing declines in fish consumption and dietary transition to processed and nutrient-poor foods. Pathways to improve nutrition include securing coastal fisheries as the foundation of animal-source food supplies, addressing beliefs, knowledge and behaviors that limit fish consumption among certain groups (despite access), securing knowledge and natural resources that support local and cultural food systems, extending supply chains inland, and addressing broader aspects of dietary transition that limit or overshadow the nutritional potential of fish.



Food systems of the Ayeyarwady and Mekong Deltas

The Ayeyarwady and Mekong Rivers flow through six countries, underpinning economies, livelihoods and food systems. The associated inland fisheries are among the most biodiverse and productive globally,¹⁰ providing the dominant supply of animal-source food for tens of millions of people. However, these waterways and fisheries are substantially altered by water, energy and agricultural development. Despite rapid social and economic development,¹¹ malnutrition and poverty remain unacceptably high. Malnutrition rates among children under 5 years of age are some of the highest in the region,^{12,13} and diets are deficient in the micronutrients found in fish. This is compounded by social and geographic disparities in resource access.^{14,15} Significant opportunities exist to improve access to nutrient-rich foods, livelihoods and environmental integrity in both river deltas through enhanced integration of fisheries and aquaculture within water and agricultural policy, investment and management decisions.



Food systems of the Great Lakes of Africa

The African Great Lakes Region spans 11 countries and seven major lake basins. Capture fisheries provide the most accessible animal-source food, which complements relatively starchy diets of low diversity. However, fish supplies do not sufficiently reach all parts of society¹⁶ and are impacted by high rates of loss and waste,^{17,18} land- and water-use changes, poor ecosystem governance,¹⁹ and the export of small nutrient-rich fish, including for animal feeds.²⁰ Important pathways to improve nutrition include innovations that manage trade-offs in the distribution and use of small fish, the scaling of fish-based products for consumption by nutritionally vulnerable people, particularly those farther from water bodies, increasing fish supplies by reducing loss and waste, and complementary and sustainable developments in appropriate aquaculture.

Improvements to post-harvest fish processing are necessary to deliver safe, affordable, high-quality products that improve nutrition. Applying an [approach first developed in Bangladesh](#), FISH developed and tested [fish-based chutneys and powders in Zambia](#), finding their nutritional content and safety were as good as other dietary supplements. These fish-based products extend shelf life, allow distribution farther from fishing grounds and markets, and offer potential as emergency, locally accessible micronutrient sources. With national and local partners, FISH piloted local preparation and integration of such products in Timor-Leste, Bangladesh and Zambia, where early evidence suggests they address nutrient deficiencies experienced by women and children in the first 1000 days of life.

Within supply chains, women, especially low-income or marginalized women, experience greater hardships, lower economic returns, and less agency and opportunity than men.^{21,22} To begin addressing this, FISH integrated technical [innovations in fish drying](#) with [gender-transformative approaches in Zambia](#), which helped overcome gendered barriers to finance and technology and reduce fish loss and waste.¹⁷ FISH is exploring wider scaling of gender-transformative approaches in, for example, Malawi, where up to [69 percent of the nutritional value of small fish is lost](#) along the supply chain. FISH initiatives have also focused specifically on women's groups. The installation of solar powered freezers, accompanied by training on hygienic fish handling, was piloted with [women's collectives and savings groups in Solomon Islands](#). As a result, women-led micro-enterprises were able to generate income while providing safe, nutritious fish for families and communities. In sum, FISH research has shown consumption, access and supply of nutrient-rich fish can be improved where the introduction, development and scaling of technical innovations are sensitive to gender norms and the diverse roles, opportunities and challenges experienced by different women and men.

FISH research on gender also examined institutional structures, finding that while gender is increasingly mentioned in policies and programs focused on fish and fisheries, gender equality is undermined by persistent sexist data structures that do not account for women's labor. In fact, FISH and collaborators found that 44 million women worldwide make up 39 percent of documented small-scale fisheries labor in pre-harvest, harvest and post-harvest roles.²³ To challenge sexist data that perpetuate the cycle of invisibility and inequality, FISH recommends (i) broadening the definition of fisheries systems to include pre- and post-harvest activities, (ii) implementing sex- and age-disaggregated data standards, (iii) delivering women-focused research to rebalance policy perceptions of labor and (iv) facilitating inclusive governance.²

Improving governance for equitable fish distribution and trade

Across all three regions, policies and investment tend to focus predominantly on [drivers and patterns of fish production](#) relative to those of processing, distribution and consumption. As a result, food loss and waste, economic losses, distributional inequities and malnutrition persist, [even where fish production may be sufficient](#) to address regional or national nutritional needs. These relatively overshadowed leverage points within food systems are key to improve food and nutrition security with fish and other aquatic foods.

External and personal factors that mediate food acquisition and consumption (the food environment) are critical to improve nutrition. FISH found that in the African Great Lakes Region, fish is purchased because of affordability and taste preferences. However, [accessibility and consumption vary based on seasonal, demographic and economic factors](#), but understanding of the implications and appropriate responses to these factors remains limited.

The diverse nutritional attributes of different fish species and fish-based products significantly influence their potential to address different forms of undernutrition. To begin quantifying these attributes, FISH and partners developed [FishNutrients](#), a [database and predictive model of nutrient composition](#) of over 5000 fish species. This data shows that [nutrients available from marine fish catches exceed the dietary requirements for children](#) under 5 years of age in more than 50 percent of coastal countries that experience moderate to severe risks of nutrient deficiency. In countries where the distribution of nutrient-rich fish is more equitable, policies had explicitly corrected for social factors, such as gender, age and wealth, that otherwise perpetuate food system inequities.²⁴ Therefore, to increase equity in global food systems, policies in fish-producing nations must more explicitly address inequality and distributive mechanisms. These recommendations were provided to the [Blue Food Assessment](#) and the [2021 UN Food Systems Summit](#).

FishNutrients was also used to examine catches from the African Great Lakes Region, finding that a 100g portion of wild-harvested small fish meets over 40 percent of daily calcium, selenium, zinc and omega-3 fatty acid requirements for women of reproductive age.⁹ Yet, small fish are increasingly exported as sources of fishmeal and fish oil for animal feeds, a trend that has raised concern as nutrients are directed away from local human consumption.²⁵ The Food and Agriculture Organization, FISH and stakeholders in nine sub-Saharan African countries scoped the economic and nutritional trade-offs of the growing feed sector. Collectively, it was determined that ensuring availability of fish for local consumer needs, identifying alternative animal feed ingredients, and scaling research on nutrition and income trade-offs are essential, particularly in the African nations where export markets and aquaculture are expanding rapidly.²⁶

In contrast, the food systems of the Pacific Islands maintain high national averages of per capita fish consumption. Yet, these averages obscure insufficient fish consumption by women of reproductive age and children in the first 1000 days of life in [Solomon Islands](#) and [inland populations of Timor-Leste](#). To reduce micronutrient deficiencies and improve livelihoods, FISH tested [social and behavior change interventions](#), supported [local development of fish-based products](#), and collated [local and traditional knowledge of preparations of fish and other aquatic foods](#).

Policy conditions and social structures mediate impacts of external drivers of change

Across the three regions, FISH examined the impacts of climate change, international trade, demographic change, and economic, environmental and social shocks, including the COVID-19 pandemic.

FISH built on traditional practices to develop innovations within integrated rice and fish systems that can improve environmental integrity, social inclusion, and food and nutrition security. These include fish culture techniques, community fish refuges, landscape changes to reconnect waterways and development of institutions for resource access, a complete database of which is to be released in 2021. For Cambodia, Bangladesh, Myanmar and Vietnam, FISH outlined attributes of the environmental and sociopolitical [contexts that mediate rice-fish systems and the contributions that innovations can make](#) to nutrition and livelihoods.²⁰ In Myanmar specifically, despite the productivity of inland fisheries, FISH found that people [had low dietary diversity and limited access](#) to nutrient-rich fish and other aquatic foods. Sustaining capture fisheries and enhancing aquaculture, within and alongside agricultural development, can help ensure supplies of much needed micronutrients, essential fatty acids and quality protein with smaller water and carbon footprints than livestock. Achieving these gains in Myanmar required reconfiguration of legislative and institutional arrangements for land tenure—changes that [emerged as a result of processes and dialogues facilitated by FISH](#).

In Africa, research across 21 countries and four trade corridors made visible the challenges and opportunities within informal, cross-border fish trade.^{27,28,29} In the Southern African Development Community region, these findings [informed national and regional policy and infrastructure developments](#), including a legislative framework to improve fish quality for domestic and export markets.

Globally, four of the six nations at greatest risk from natural hazards and societal vulnerability are within the Pacific Islands.³⁰ Because of the flexible and adaptive nature of fisheries management in the Pacific, fisheries provide a [coping mechanism for Pacific Island communities](#) in the face of disasters. The high degree of localization of Pacific food systems [allowed for rapid changes in food production](#) during COVID-19.¹³ However, other constraints to food production, like limited access to arable land and disrupted supply chains, meant some [atoll communities experienced increased hunger and hardship](#) even with good access to fish and fisheries.

FISH and partners developed and [applied a framework for understanding adaptive capacity](#) in fishing and farming communities across all three regions.³¹ The framework was also applied to understand how supply chain actors adapted during the COVID-19 pandemic.³² Applying this framework to understand the adaptive capacity of [women fish processors and traders in sub-Saharan Africa](#) to COVID-19 allowed FISH and partners to respond with recommendations to build forward better and more equitably. Recommendations included (i) securing women's assets and access to financing to enable recovery, (ii) transforming governance of fisheries, food systems and COVID-19 recovery processes to ensure inclusion and equity, and (iii) investing in women fish processors and traders' technical, human, digital and collective capacities.³³

Next steps

Policies and investments for food systems transformation with fish as entry points

FISH research on the three regional food systems illustrates vastly different pathways through which fish and other aquatic foods can contribute to food and nutrition security. Moving forward, institutional and investment environments must enable small-scale producers and other supply chain actors to thrive and continue to supply fish and other aquatic foods within regional food systems for decades to come. Across all regions, this requires (i) protecting a diversity of production systems and the distinct ways they contribute to nutrition, well-being and resilience, (ii) increased attention to storage and processing innovations to reduce fish loss and waste, (iii) measures to improve food safety, (iv) developing and scaling acceptable fish-based products that retain nutrient quality and extend shelf life and geographic reach, (v) governance of intraregional, informal and/or domestic trade for improved nutrition outcomes, and (vi) changes to policy and practice to ensure the availability of fish and other aquatic foods for nutritionally vulnerable groups and emergency feeding programs.

Principles to guide fish and food systems research toward greater impact

FISH researchers have distilled seven principles to guide future aquatic foods research toward improved food and nutrition security and human well-being. They are (i) sustaining the wide diversity of fish and other aquatic food supplies, (ii) accounting for and including under-reported food system actors, (iii) conducting whole-of-diet assessments, including to understand the specific role of fish and other aquatic foods in diet quality, (iv) addressing opportunities and barriers in supply chains, access and consumption, including food safety, loss and waste, (v) examining distribution patterns and access barriers to the nutritional potential of fish and other aquatic foods, (vi) identifying trade-offs between sustainability, income and nutritional benefits of different food system configurations, and (vii) focusing on the nutritional needs of the most vulnerable.

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