

## REVIEW

# Fish in Sustainable Food Systems of the 21st Century: Role of WorldFish Research on Food and Nutrition Security, Gender Equity, and Natural Resource Conservation

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### Abstract

Fisheries research and development challenges have diversified significantly as we entered the 21<sup>st</sup> century. The 2030 Agenda for Sustainable Development demands that agriculture research communities take more holistic approaches towards addressing global issues, such as poverty alleviation, environmental conservation, and food and nutrition security. There remains a growing need for considering both fisheries and fishing communities as part of social-ecological systems. In this paper, we review how over the last two decades WorldFish has framed its research, with an emphasis on small-scale fisheries in low- and middle-income countries, and the contribution Japanese researchers have made in topics relevant to the Sustainable Development Goals (SDGs): sustainable fisheries management and conservation; resource access and benefit-sharing; and food and nutrition security. Research in the past has shown collaborative forms of natural resource governance, social inclusion and gender equity play a critical role in ensuring food production translates to income and livelihoods outcomes, and to food and nutrition security in low- and middle-income country contexts. To fulfill its potential in a wider range of SDGs, future research needs to consider fisheries and aquaculture as an integral component of “food systems”, encompassing production systems, their environments, post-harvest value chains, and consumer behavior and diets.

**Discipline:** Fisheries

**Additional key words:** Aquatic foods, environmental sustainability, fisheries, aquaculture, SDGs

### Introduction

Fisheries research and development challenges have intensified and diversified significantly as we entered the 21<sup>st</sup> century. The members of the United Nations collectively signed on to the 2030 Agenda for Sustainable Development in 2015, with 17 Sustainable Development Goals (SDGs). The SDGs list global issues requiring attention of the international community as a whole, such as poverty, environmental degradation, climate change, and food and nutrition insecurity, and establish targets and deadlines to collectively work towards. The SDGs also demand that agriculture and fisheries research communities take more holistic strategies towards formulating research for development objectives.

In this paper we review how over the last two decades WorldFish has viewed and understood changes within

social-ecological systems and framed its research for a range of SDGs. As a member of the CGIAR (formerly the Consultative Group on International Agricultural Research) and an only global research institute specialized in fisheries and aquaculture in low- and middle-income countries, WorldFish has played an important role in drawing attention to the issues that are often overlooked in international development discourse: the contribution small-scale fisheries make to food and nutrition security and income generation of rural communities, and the challenges in achieving environmental sustainability and equity in the governance of aquatic environments. In this paper we also examine the contribution Japanese researchers and research investment has made, particularly in improving the understanding of inland fisheries in multiple use landscapes, the contribution of fish in nutrition of vulnerable people, importance of gender

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equity in fisheries livelihoods and governance.

### Transition in fisheries research priorities

WorldFish, since its inception as the International Center for Living Aquatic Resources Management (ICLARM) in the 1970s, previously emphasized productivity improvements through technological and institutional interventions in coastal fisheries and aquaculture mainly in Southeast Asia and the Pacific. The ICLARM 2000-2020 strategy acknowledged the need for broadening its research scope to address equity, sustainability, and efficiency considerations (ICLARM 1999). The 2000-2020 strategy also made reference to external drivers and cross-cutting issues, such as climate change, women in fisheries, and resource conflicts in multi-use landscapes.

In the advent of the Millennium Development Goals (MDGs) in 2000, there was a growing recognition amongst researchers and policy makers that the world's fisheries resources were becoming overexploited and in need of better management (Kura et al. 2004). The fisheries research and development community gradually shifted its emphasis towards environmental sustainability and poverty alleviation. Seminal research involving WorldFish researchers described fisheries as part of social-ecological

systems, highlighted the need for shifting the management strategies, and indicated future research directions beyond the sectoral boundaries (e.g., Andrew et al. 2007, Béné et al. 2007).

The Strategy Update for 2005-2008 (WorldFish 2007) aligned its research objectives to the MDGs and re-organized its research programs to facilitate thematic integration within the center. Yet the integration took many more years to realize. In 2012, 15 new CGIAR Research Programs (CRPs) were launched (See Kanamori and Iiyama of this Issue). Of these, three CRPs were designed with a production system approach, instead of traditional crop commodity-based approach. WorldFish led the CRP Aquatic Agriculture System (AAS), covering fisheries and other crop systems occurring in aquatic environment, notably rice. AAS also placed great emphasis on stakeholder engagement, including gender mainstreaming and participatory processes in the research design and execution (CGIAR Research Program on Aquatic Agricultural Systems 2012). In the subsequent phase of CRPs, CRP on Fish in Agri-food systems (FISH, 2017-2021) moved the pendulum back towards traditional areas of competence for WorldFish, namely fisheries and aquaculture research. As shown in Figure 1, emphasis on food and nutrition security, climate resilience, and gender as cross cutting issues remained (WorldFish 2016).

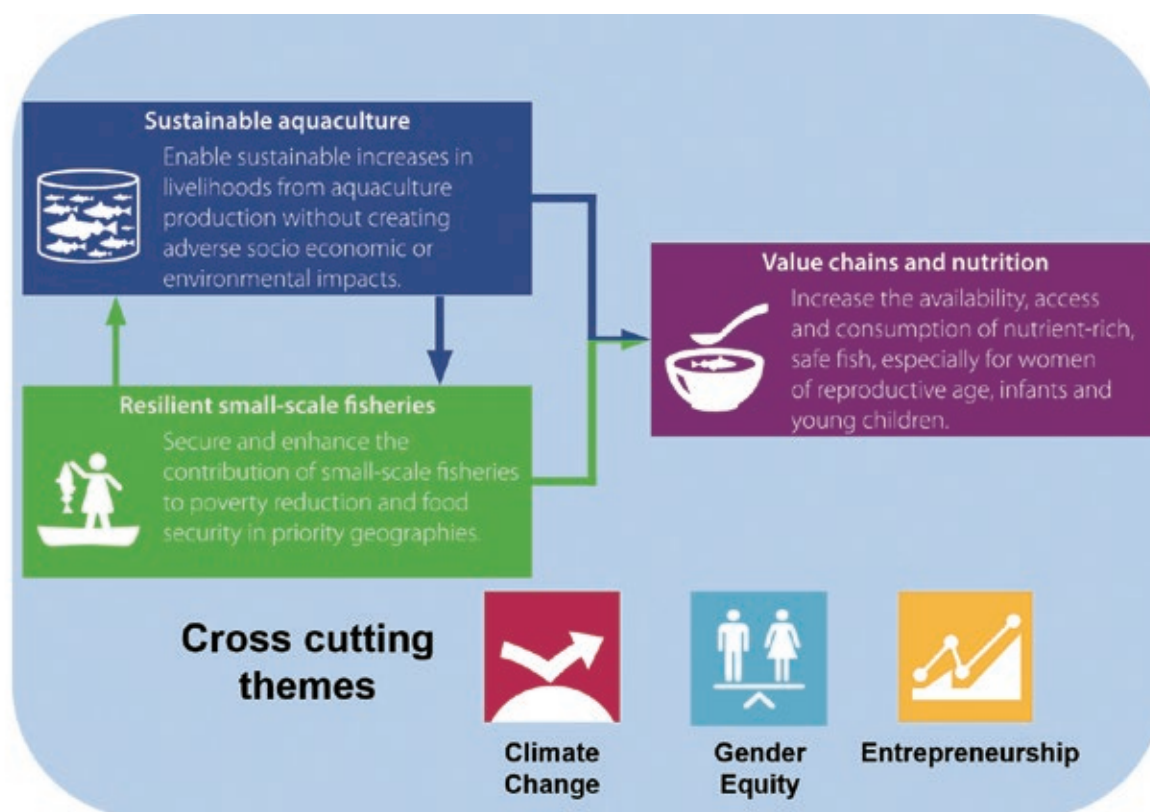


Fig. 1. Thematic research areas of WorldFish

## Findings from key thematic research areas

The following section summarizes findings from the research areas where the authors had direct contribution through WorldFish research programs. Kura led numerous research projects in Southeast Asia between 2005 and 2019, and led or co-authored fifteen publications cited in the four research areas below. Kawarazuka worked in both Africa and Asia and led four publications cited in the areas 3 and 4.

### 1. Water infrastructure and fisheries

Under the CGIAR Challenge Program on Water and Food (2002-2012) (CPWF 2018) and the CRP on Water, Land, and Ecosystems (2013-2021) (WLE 2020), WorldFish carried out research on the interaction of fish and water as part of multi-use landscapes, with the International Water Management Institute (IWMI). Water development infrastructure, such as hydropower and irrigation, has been expanding at an unprecedented speed in the Mekong River Basin, with a wide range of negative impacts predicted on inland fisheries and fisheries-dependent livelihoods of rural communities in Cambodia and Lao PDR. The research initially focused on assessing the potential impacts on migratory fish, which constituted over 80% of commercial fisheries in the Mekong River (Baran et al. 2007), and collaborated with Kyoto University and the National Institute of Environmental Studies (NIES) in Japan (Baran et al. 2012). However, the research objectives gradually shifted toward how to avoid or mitigate the negative impacts (Baran et al. 2009), as informing decision-makers of negative impacts on fisheries had almost no influence over the water development decisions driven by growing energy demand and economic incentives.

In mitigating negative impacts of hydropower development, studies to understand the diverse livelihoods of fishing communities affected by resettlement (Kura et al. 2014), and their coping strategies (Kura et al. 2017) provided insights into how to improve compensation programs and support livelihood rehabilitation. It was found that allowing continued access of the local communities to natural resources, including forests and rangelands, as well as the newly-created hydropower reservoir for fishing and irrigation water, was critical for enabling wider variety of coping strategies. The current state of the research builds on the improved understanding of local livelihoods, and responds to the need for practical approaches to mitigate negative impacts on fisheries. Creating “fish-friendly” hydropower reservoirs and irrigation facilities, based on ecosystem approach to the design and operation of water infrastructure and equitable

benefit-sharing, is a concept that has gained some traction in recent years (McCartney et al. 2018, FAO et al. 2020).

### 2. Small-scale fisheries co-management

The importance of fisheries, especially the role of small-scale, artisanal fisheries sub-sector, is often overlooked in international development discourse. In collaboration with World Bank and FAO through the Global Program on Fisheries (PROFISH) funded by Japan, WorldFish made the first attempt at understanding the relative size and contribution of small-scale fisheries, including inland fisheries, in comparison with large-scale, industrial fisheries using larger vessels and modern fishing technologies. The study found 97% of all fishers in the world are in developing countries. At least 36 million full-time and part-time fishers were in developing countries, and 93% of them were in small-scale fisheries. The majority of them operated in lakes, rivers, and wetlands. Small-scale fisheries produced 55% of the total fish catch in developing countries and therefore required increased attention towards its sustainable management (Mills et al. 2011).

Bangladesh, Cambodia, and Myanmar have been highly dependent on inland fisheries for supporting local livelihoods and food security (Funge-Smith & Bennett 2019). Long-term presence of WorldFish programs in these countries, with collaborators including the Japan International Cooperation Agency (JICA), culminated in a regional synthesis paper highlighting the diversity of fisheries-based production systems that are adapted to local social-ecological conditions and evolving to the changes in climate as well as market demands (Freed et al. 2020b). Research on inland fisheries co-management and ecosystem-based enhancement of wild fish populations in the Mekong River and in rice field environments in Cambodia (Fiorella et al. 2019, Freed et al. 2020a) contributed to the government’s new draft *Strategic Plan for Fisheries Conservation and Management 2019 - 2028*. Similarly, research on inland fisheries in Myanmar (Tezzo et al. 2016) provided much-needed information for the government’s ongoing decentralization in the fisheries sector. Future research needs to address simple methods for monitoring and evaluating the social-ecological outcomes of co-management, and how to sustain these community-based institutions by reducing financial dependence on external assistance and building own technical capacity (Cohen et al. 2021).

### 3. Food and nutrition security

The role of fish and other aquatic animals (OAA) as a major source of animal protein has been well-known, while its role as an important source of micro-nutrients was

lesser known (Roos et al. 2007). Small-sized fish species are known to contain high levels of micronutrients, such as vitamin B12, vitamin A, iron, zinc, and calcium, and can be consumed whole (Thilsted et al. 2016). However, much of aquaculture research in developing countries has focused on intensive production of non-native carps, catfish, and tilapia, that have advantages in supplying protein in large quantities, but are limited as a source of micronutrients to children (Bogard et al. 2016).

WorldFish made strides in building the knowledge of small wild fish and OAA in supplying these critical nutrients in the first 1000 days of human life (Bogard et al. 2015). Kawarazuka and Béné (2010 & 2011) described pathways through which fish can contribute to nutritional security at household level, and also compiled emerging evidence that locally available small fish have considerable potential as cost-effective food-based strategies to enhance micronutrient intakes or as a complementary food for undernourished children. WorldFish continued to build evidence at global scale (Hicks et al. 2019) and regional scale (Freed et al. 2020b), and has collaborated with other CGIAR Research Centers to strengthen integration in crop production systems, animal feed, and nutritional products (Atkins et al. 2020) and with the Japan International Research Center for Agricultural Sciences (JIRCAS) on stock enhancement of small indigenous fish species (SIS) (Kura 2019). Further research needs to rigorously assess the role of fish consumption as part of broader diets and health, considering the nutritional qualities and availability to the most vulnerable population. Food security programs also need to encompass SIS that are nutrient-rich, locally available, and cost-effective to produce.

#### 4. Gender equity

In the late 1990s WorldFish initiated a network of researchers who understood the importance of applying gender lens in fisheries research in order to enhance the role of fisheries and aquaculture in poverty alleviation and food security (Williams et al. 2001). Over the years, researchers have addressed a wide range of topics and highlighted gender and social inequalities that persistently determine access to and distribution of fisheries resources. Earlier studies contributed to recognizing the important roles of women in small-scale fisheries, especially in the informal sector (Choo et al. 2008, Mills et al. 2011, Weeratunge et al. 2012). Research areas further developed to understand gender norms and relations in fishing and trading practices, which helped identify specific risks of and vulnerabilities to food insecurity among fishers and women traders (Kusakabe et al. 2008, Cole et al., 2015, Kawarazuka et al., 2019).

Research on adoption of technologies and innovation

has shown the importance of considering social suitability as well as constraints and enabling factors in facilitating innovation by women (Kantor et al., 2015, Locke et al., 2017). In response to this knowledge gap, WorldFish has developed concepts, practical tools and methodologies for gender transformative approaches (e.g., Farnworth et al., 2015, Kawarazuka et al. 2017, Mehar & McDougall, 2017). More rigorous inter-disciplinary and transdisciplinary research are required to inform the fishery sector towards truly equitable and inclusive technology development and resource management.

#### Future directions

The latest WorldFish research strategy (WorldFish 2020) outlines its thematic alignment to the Sustainable Development Goals (SDGs), with an emphasis on *SDG 2: Zero Hunger* and *SDG 14: Life Below Water*. In addition, the new strategy offers potential for contributing to a range of other SDGs, by addressing both environmental sustainability and governance aspects of “aquatic food systems”. Aquatic food systems refer to a complex web of activities and the outcomes of these activities, and includes all the people and the environment that play a part in capturing, growing, transporting, supplying and, ultimately, eating aquatic foods. Aquatic foods include aquatic animals and plants from the wild or farms for direct human consumption and those used as animal feeds. The concept of “food system” encompasses crop production systems as well as post-harvest value chains and consumer behavior and diets (HLPE 2017). The new strategy states that, in order to meet the SDG targets by 2030, countries need “evidence and support to (1) reduce the cost of nutritious aquatic foods, (2) make healthy diets with diverse aquatic foods affordable for everyone, and (3) enable vulnerable women, men and young people working in aquatic food systems to earn decent incomes that enhance their own health and well-being”.

Fish and other aquatic foods are among the world’s most traded food items, and the global demand for aquatic foods shows no signs of slowing down (FAO 2020). Research in the past has shown collaborative forms of natural resource governance (co-management), social inclusion, and gender equity play a critical role in ensuring food production translates to income and livelihoods outcomes, and to food and nutrition security of vulnerable groups in low- and middle-income country contexts. To fulfill its potential in a wider range of SDGs, future research needs to consider fisheries and aquaculture as an integral component of “food systems”. Major knowledge gaps remain in: environmental sustainability of production systems, including aquaculture seed and

feed; equity in, and optimization of value chains; food distribution and waste; and consumer behavior and diets. Further research collaboration with Japanese partners in filling these knowledge gaps, especially with regards to food and nutrition security, is expected in coming years.

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