CGIAR

RESEARCH PROGRAM ON
Fish

Led by WorldFish

Enhancing sustainable, productive and resilient fisheries and aquaculture

ANNUAL REPORT 2019

Citation

This publication should be cited as: CGIAR Research Program on Fish Agri-Food Systems. 2020. Annual Report 2019. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Annual Report: FISH-2020-14.

Photo credits

Front Cover: Finn Thilsted/WorldFish; Page 4: Sara Fouad/WorldFish; Page 8: Clayton Smith/WorldFish; Page 10: Filip Milovac/WorldFish; Page 14: Noor Alam/WorldFish;Page 15: Heba El Begawi/WorldFish; Page 16: WorldFish; Page 17: Quentin Hanich/WorldFish; Page 18: Finn Thilsted/WorldFish; Page 19: Foto Agencies/WorldFish; Page 20: Mike Akester/WorldFish; Page 21: Fani Llauradó/WorldFish; Page 22: Finn Thilsted/WorldFish; Page 23: Arabinda Mahapatra/WorldFish;Page 24: Foto Agencies/WorldFish; Page 25a: Heba El-Begawi/WorldFish; Page 25b: Stevie Mann/WorldFish; Page 26: David Mills/WorldFish; Page 27: Sara Fouad/WorldFish; Page 28: Mohammad Mahabubur Rahman/WorldFish; Page 29: Joctan Lopes/WorldFish; Page 30: Doina Huso /WorldFish; Page 31: Yousuf Tushar/WorldFish; Page 32: David Mills/WorldFish; Page 33: Chosa Mweemba/WorldFish; Page 36: Mike Lusmore Duckrabbit/WorldFish; Page 38: Leah Jimenez/WorldFish;

Contents

FISH at a glance

The CGIAR Research Program on Fish Agri-Food Systems (FISH) is a multidisciplinary research program led by WorldFish, in partnership with the International Water Management Institute (IWMI), James Cook University, the University of Greenwich and Wageningen University & Research. A fish agri-food system is an interconnected and interdependent system involving components of fish production, through to processing, marketing and consumption. FISH, in collaboration with our research and development partners and a diversity of stakeholders, develops and implements research innovations that enhance the role of aquaculture and small-scale fisheries to reduce of poverty, improve food and nutrition security and sustain natural resources and ecosystem services upon which the fish food system ultimately depends.

Our vision

Resilient fish agri-food systems that deliver sustainable increases in socially and gender-inclusive production and equitable distribution of nutritious fish to those most in need.

Our mission

To deliver evidence-based solutions that address the complex challenges and opportunities in fish agri-food systems in the developing world.

Our beneficiaries

FISH works to reduce poverty and improve food and nutrition security for fish-dependent households and communities as well as the processors, traders and consumers of the fish they produce.

Our research primarily targets the needs of small-scale fishers and fish farmers in low-income, food-deficit countries in Africa, Asia and the Pacific. We focus particularly on developing the capacity of women and youth to participate in decision-making around aquaculture technologies and small-scale fisheries management, as a key enabler of impact.

As fisheries and aquaculture adapt to changing ecological challenges and opportunities, our work on climate-smart technologies and production systems and mitigation strategies is building adaptive capacity and resilience to external shocks for fishers, farmers and other stakeholders in fish value chains, and a better response to the COVID-19 pandemic.

Message from the Chair of the Independent Steering Committee

Nigel Preston
Chair, Independent Steering Committee

The two FISH flagship programs, Sustainable Aquaculture and Sustaining Small-Scale Fisheries, continue to deliver realized impacts contributing to CGIAR's System Level Outcomes: reduced poverty, improved food and nutrition security for health, and improved natural resources and ecosystem services. This Annual Report highlights specific examples of this, including:

In Bangladesh, community co-management means fishers are catching more and bigger fish, resulting in higher household incomes.

In Egypt, two projects that ended in 2019 provided women with the training and equipment to reduce food waste and improve their livelihoods. Integrated aquaculture and farming are boosting productivity while making efficient use of water in a highly water-stressed region.

Private sector partnerships in Timor-Leste are providing small-scale producers with access to high quality tilapia seedling fish that they need to take full advantage of the country's commitment to aquaculture.

These exemplary results were obtained by delivering the Program's priority outputs and outcomes as defined in the Plan of Work and Budget. Among the international public goods the program shared during the year were 63 peer-reviewed publications, including journal articles, books and book chapters, 73 percent of which are open access. In addition, FISH disseminated 110 policy briefs, technical notes and other knowledge products, in 16 languages overall.

Innovation remains crucial to progress. During 2019, FISH reported 44 innovations at various stages, from proof of concept to uptake by next users. It is particularly pleasing to see how the evidence from small-scale fishers and aquaculture fish farmers has influenced decision-makers in shaping policy. In 2019, FISH research influenced the development of at least 27 policy changes and investment decisions at several levels. The African Development Bank agreed to invest USD 10.7 million in an aquaculture project in Malawi. The Southern Africa Development Community is supporting a regional tilapia genetics program. And nine countries—Bangladesh, Cambodia, Egypt, India, Malawi, Myanmar, Solomon Islands, Timor-Leste and Zambia—used FISH research to adapt their national policies on sustainable aquaculture, land and water management, and fisheries during the year.

FISH made important progress in integrating a transformative approach to gender across the Program. This includes the development of tools and methods to examine women's empowerment and their participation in value chains, as well as a coaching program for gender integration and an active push to nudge a range of policies to be more gender transformative.

In total, evaluations during 2019 revealed that FISH research helped more than 297,000 people escape poverty and improved aquaculture and small-scale fisheries increased the fish consumption or dietary diversity of more than 211,000 vulnerable women, children, and men. More than 673,000 hectares of water now benefit from ecologically-based co-management of fisheries and aquaculture.

These evaluations, which increased across the portfolio and which the Independent Steering Committee (ISC) strongly supports, are providing solid evidence for the crucial part that aquatic foods will play in the transformation of global food systems so that they provide people with healthier diets while sustaining the planet as a whole.

Message from the Director

Michael Phillips
Director, CGIAR Research Program on Fish Agri-Food Systems

The fish agri-food system is increasingly recognized as a key component of the global food system. Some 800 million livelihoods are estimated to depend on fisheries and aquaculture. More than 3.2 billion people rely on fish and other aquatic foods for at least 20 percent of their animal source food. FISH research works to sustainably enhance productivity of small-scale fisheries and aquaculture across Africa, Asia and the Pacific, enabling the fish agri-food system to meet rising demand for aquatic foods in climate-resilient and sustainable ways.

This Annual Report recounts how FISH operates at multiple levels, tackling global problems with a focus on solutions that can be grounded in the farming and fishing communities we serve. Our research on the Tilapia Lake Virus addresses an emerging global disease risk by identifying opportunities for breeding fish that are genetically resistant. This research has also provided new understanding of viral transmission pathways that can be translated into management solutions and new products that will reduce risks and improve food and economic security for producers. Work on the "Lab in a Backpack" innovation helps local service providers and farmers diagnose and respond to fish diseases rapidly, even when remote from reliable electricity and internet. New data pipelines from these disease surveillance and diagnostic tools will enable researchers to better understand fish disease risks and improve treatments, whilst helping to mitigate antimicrobial resistance.

In 2019, FISH made good progress on disseminating sustainable solutions to feeding farmed fish, by applying nutritious pond technology across a growing group of counties. This novel technology, developed with Wageningen University & Research partners, is resulting in more productivity, profits and enhanced efficiency of feed ingredients. It has also caught the interest of private sector partners, who are helping to reach scale in Bangladesh and Zambia.

Developing the capacity of communities to manage aquatic resources sustainably and equitably continues to be important. Much of our work with communities focuses on the empowerment of women, namely in ecologically-based pond management and post-harvest processing. This year's report also highlights the essential role in capacity building within FISH, with record numbers achieved during this year. The WorldFish African Aquaculture Research and Training Center in Abbassa, Egypt plays an important role in aquaculture training for young entrepreneurs, notably as part of a cooperation with the African Development Bank's Aquaculture Compact of Technologies for African Agricultural Transformation.

Our research also strives to ensure that the voices of small-scale producers—fishers and farmers—are heard by national, regional and global policy makers. Notably, FISH research has informed a number of high-level policy papers during the year, including *The Future of Food from the Sea*, from the High-Level Panel for a Sustainable Ocean Economy. The Illuminating Hidden Harvests research now being drawn together into a set of landmark analyses and policy documents will further reveal the under-appreciated and importance of small-scale fisheries.

FISH research is influencing policy change as we watch. Last year, I mentioned the Nay Pyi Taw Agreement, a policy to integrate rice-fish farming in Myanmar's development initiatives. In 2019, based on FISH evidence, the government extended the agreement so that now in the Ayeyarwady region up to 15 percent of a farmer's holdings can be converted into fish culture. Other countries in South Asia and the Mekong region are paying similar attention to these new approaches to integrate fish within rice-dominated landscapes. Next year, I hope we will be able to report on some successful South-South cooperation between Africa and Asia with rice-fish systems.

The combination of on the ground research that directly improves production and livelihoods, while at the same time influencing high-level evidence-based policy change is helping to boost the contribution of fish and aquaculture to livelihoods, health and sustainability. Three years into the Program, we are confident that our FISH research is having a positive impact on the lives of people who depend on fisheries and aquaculture in the food system, and look forward to building on our achievements in the future.

The continued support or our partners and donors during another successful year is gratefully acknowledged.

Highlights
from 2019

Disseminating research innovations

The most prominent novel research innovations in 2019 address the productivity of aquaculture and the role that aquatic foods can play in sustainable and healthy diets and nutrition. A new digital tool allows us to gather detailed disaggregated data about the performance of aquaculture systems and the particulars of how they are being operated. Because it standardizes assessments, the tool allows us to compare different fish production systems in different countries, which will enable us to identify opportunities for improvement and focus on increasing the contribution of aquaculture to CGIAR's key impact areas. This new performance assessment tool was developed in Bangladesh and Egypt, piloted in Myanmar and Nigeria, and is now being made available for use globally.

Complementing the digital performance assessment tool, our online epidemiology and health economics tools are ready for use at scale. Rapid disease diagnosis coupled with online therapeutic advice offers an efficient route to significantly improve management of risks to small-scale farmers from disease and improve farm productivity and incomes.

Our efforts to persuade policy makers to pay more attention to small-scale fisheries and the importance of aquatic foods took a great leap forward in 2019. We provided research for *The Future of Food from the Sea* report from the High-Level Panel for A Sustainable Ocean Economy, and its recommendations. Our ground-breaking research with partners to model the nutritional value of global marine fisheries clearly showed that diverting even a small portion of the micronutrients in the catch to local populations would produce large benefits for nutrition and health.

Generating new knowledge and thinking on fish

New molecular genetic tools target specific resilience traits in Nile tilapia. Disease resistance and feeding efficiency are vital for aquaculture productivity. In addition, climate change might result in lower levels of dissolved oxygen in the water, thus fish farmers need fish that can cope better with low oxygen. A single nucleotide polymorphism (SNP) chip developed in 2018 permits rapid analysis of genetic differences associated with particular traits. This new tool will let us start the selection of tilapia with new resilience traits, a step change in the genetics of tilapia. In addition, tools and knowledge developed with tilapia are being transferred to new species, initially rohu and silver carp in Bangladesh, to produce new generations selected for better performance.

Similar technology underlies the Lab in a Backpack, which won the 2019 Inspire Challenge of CGIAR's Platform for Big Data in Agriculture. The innovation puts advanced technology at the edge of the pond. It contains a miniaturized DNA sequencer that sends data to artificially intelligent software in the cloud. That diagnoses any problems and returns actionable results to pondside operators. This will improve productivity while also helping to stem the rise in antimicrobial resistance caused by the inappropriate use of antibiotics for disease treatment.

Another set of invisible data is being brought into the light by a project with the Food and Agriculture Organization of the United Nations (FAO) and Duke University. Small-scale fisheries, despite their importance for food and nutrition security, are commonly hidden in policies at national and global levels. Illuminating Hidden Harvests developed an innovative method to assess the social, environmental, economic, nutritional and governance contributions of small-scale fisheries to sustainable development. Information from 52 countries will feed into the FAO's Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication, ultimately supporting the development of socially and environmentally sustainable small-scale fisheries.

Informing global policies guides sustainable development

Research published in Nature with partners calculated for the first time the nutritional value of coastal marine fish catches. It reveals that many of the world's poorest people would see huge benefits if only a small part of the micro-nutrients in coastal fisheries catches were diverted to local consumption.

We drafted Blue Papers for the High-level Panel for a Sustainable Ocean Economy. The Panel's report, *The Future of Food from the Sea*, shows that aquatic foods can make a much greater contribution to human well-being while being a climate-smart option for nutritious and sustainable food production that helps the world respond to the climate crisis.

MEL
monitoring
evaluation and
learning

Robust monitoring and evaluation guides learning and innovation

The Monitoring, Evaluation and Learning Platform (MEL) is fully operational, enhancing our results-based management. We continue to work with other CGIAR Research Centers and Programs to refine and develop MEL as a widely applicable and accessible CGIAR tool.

At the same time, FISH is conducting more impact assessments and evaluations. Independent evaluations of the Fish Trade project in Africa and EcoFish in Bangladesh were completed, as well as several Outcome Impact Case Reports.

With the Royal Tropical Institute (KIT) in the Netherlands, we improved the Women's Empowerment in Fisheries Index (WEFI). The index provides a rigorous framework to evaluate empowerment before and after interventions, helping us to achieve gender transformative change.

SUSTAINABLE DEVELOPMENT GOALS

FISH's contributions to the Sustainable Development Goals

FISH contributes directly to no poverty (SDG 1) and zero hunger (SDG 2) by increasing the productivity of fisheries and aquaculture to provide poor and marginalized women, men and youth with more food, nutrition and income. It also addresses a range of related goals targeting improved human health and reduced disease (SDG 3), gender equality (SDG 5), decent work (SDG 8), reduced food waste (SDG 12), climate adaptation (SDG 13), life below water (SDG 14), sustainable ecosystems (SDG 15), effective institutions (SDG 16) and global partnerships (SDG 17). Within the CGIAR Research Portfolio, FISH makes unique contributions to protecting and restoring water-related, marine and coastal ecosystems (SDGs 6.6, 14.2, 14.5) and encouraging economic growth of small island developing States (SDG 14.7).

Contributing to the Sustainable Development Goals

FISH research **contributes directly** to 10 SDGs:

FISH research also **contributes to aspects** of two other SDGs:

FISH in numbers

62 private sector partnerships: **30 increase** from 2018

240 active **partnerships: 98** new for **2019**

775 million people highly dependent on marine **fisheries, FISH** evidence shows

47,314 households in **6 countries** adopted improved aquaculture and **fisheries** practices

177,474 people **received short-term training**, of which **145,441** were women

27 improved policies and **investment decisions** at various levels

40 partners focused **on scaling**

CRP impact pathways & theory of change

Research flagships and outputs

FP1. Sustainable Aquaculture
- **Cluster 1** Improved and more resilient elite breeds of fish (tilapia and carp)
- **Cluster 2** Improved feeds, disease screening and management practices for fish health
- **Cluster 3** Improved fish farming practices and farming systems; business and enterprise models for smallholders and value chain actors

FP2. Sustainable small-scale fisheries
- **Cluster 1** Localized coastal fisheries management and broader-scale governance improvements
- **Cluster 2** Adaptation and mitigation actions to minimize and reverse ecological impacts and negotiate tradeoffs between fish production and alternative landscape uses
- **Cluster 3** Analysis and scenario development at regional scales to accelerate adoption of appropriate policy and institutional innovations

Change mechanisms

A Enabling adoption and dissemination of validated technologies, models and innovations

B Partnership and resource mobilization for research

C Change in investments

D Policy influence and institutional change

E Capacity Development for strategy change

Crosscutting development outcomes

Gender and youth
- Gender-equitable resource access, control of assets, and participation in decision-making
- Enhanced capacity of youth and women to engage in decision-making

Climate change
- Enhanced capacity to deal with climatic risks and extremes
- Reduced net greenhouse gas emissions

Policies and institutions
- Increased capacity of beneficiaries to adopt research outputs
- Conducive agricultural policy environment

Capacity development
- Enhanced individual capacity in partner research organizations through training and exchange

Target SLOs and IDOs

Reduced poverty
- Increased productivity
- Increased incomes and employment

Improved food and nutrition security for health
- Improved diets for poor and vulnerable people
- Improved food security

Improved natural resource systems and ecosystem services
- Enhanced benefits from ecosystem goods and services
- More sustainably managed agroecosystems

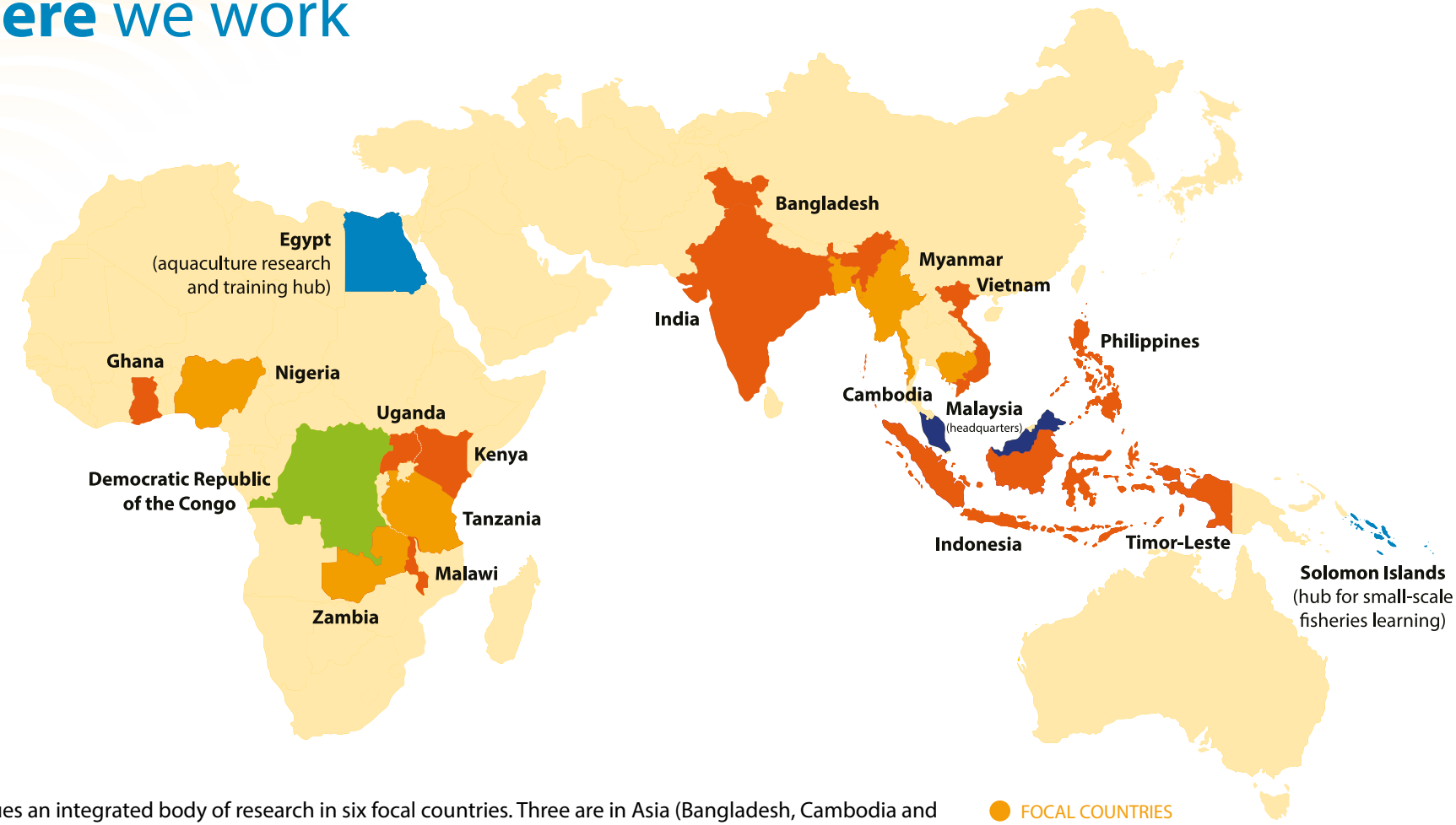
CRP-level learning processes

Foresight analysis addressing global, regional and national policy and economic drivers; climate change; priorities and opportunities for technology and institutional innovations

Outcome evaluation to consolidate program-level learning on impact pathways and refine theories of change

Impact assessment addressing progress in program-level contributions to SLOs and IDOs at scale

Where we work



FISH pursues an integrated body of research in six focal countries. Three are in Asia (Bangladesh, Cambodia and Myanmar) and three are in Africa (Nigeria, Tanzania and Zambia). In addition, the Program focuses on Egypt as a research hub and training center for our aquaculture capacity development in Africa, and Solomon Islands as a hub for our learning networks on small-scale fisheries governance in the Pacific.

Successes and lessons learned from research are scaled with partners to achieve impact and are being progressively expanded to several countries. In 2019 that included cooperation in Angola, DR Congo, Ghana, India, Kenya, Malawi, Timor-Leste, Uganda and Vietnam.

- FOCAL COUNTRIES
- SCALING COUNTRIES
- LEARNING HUBS
- OTHER COUNTRIES WITH SIGNIFICANT PROJECTS
- PROGRAM OFFICE

Regional highlights

Africa

Informal trade across Africa plays a hidden but key role to supply fish widely across the region. Our research innovations seeks to better understand and facilitate improvements in trade and market systems for fish and aquatic foods. Our research supported the inclusion of fish among the products that can be easily traded between Kenya and Uganda through the One Stop Border Post in Busia. Three-way trade among Mozambique, Zambia and Zimbabwe likewise benefited from investment in the COMESA Green Card process, which certifies for traders that their smoked and dried fish meets sanitary and phytosanitary standards.

To facilitate internal trade in Malawi, we worked with the Malawi Bureau of Standards (MBS) to standardize quality evaluations of dried fish from small-scale fisheries. MBS is now able to certify fish dried in solar tents as safe for human consumption, allowing women fish processors to supply safe and nutritious fish to supermarkets.

Our project on the Sustainable Transformation of Egypt's Aquaculture Market System came to an end with significant sector-wide improvements. Almost 4500 households adopted Better Management Practices, as a result of which an additional 400,000 metric tons of fish were supplied with significantly lower greenhouse gas emissions. Jobs and higher incomes benefitted 26,032 farming households, and amendments were proposed to law 124/1983 to permit integrated aquaculture on agriculture farms.

Another project in Egypt, Youth Employment in Aswan Governorate, has led to demonstrable gains in incomes and empowerment for women, who gained new skills in processing and selling fish. Fish waste has been reduced and fish made more accessible to the general public. In consultation with the General Authority for Fish Resources Development and local fisheries associations, a management plan was prepared to cover 500,000 hectares of Lake Nasser behind the Aswan Dam.

The Technologies for African Agricultural Transformation (TAAT) Aquaculture Compact continued to be a key partnership for scaling aquaculture research innovations in Africa. FISH worked with the government of Ghana to support the preparation of a loan from the African Development Bank to invest in aquaculture and fisheries and to support the Aquacultural Association of Kenya to formulate a petition that advocates for greater independence of the fisheries sector. Uganda's government is also finalizing its National Fisheries and Aquaculture Policy. Our research provided technical input to the National Aquaculture Policy draft, which will support a much-needed growth in aquaculture as well as internal and export trade.

Asia

Fish health is of huge importance to aquaculture globally. The Lab in a Backpack innovation will help to diagnose, monitor and treat outbreaks of fish diseases in small and larger-scale aquaculture farms. The effective management of aquaculture health also requires supportive policies. Our research provided scientific evidence on fish health management to the development of Bangladesh's National Fish Health Management Strategy during 2019.

Cambodia is developing a ten-year strategic plan for fisheries conservation and management. Our research has demonstrated that co-management of community fish refuges can enhance fish production, nutrition, water security and resilience to climate change. In one year, the amount of fish caught increased by 30 percent and the proportion of young children under five eating small fish increased by 50 percent in communities adopting the community fish refuge innovation. Cambodia is now taking these

results into account as the new strategic plan is finalized.

Myanmar too is making progress in incorporating community fisheries management innovations into legislation. The 2019 reform of the Ayeyarwady fisheries law accepts the legal standing of community fishery associations, using findings from FISH research. Future research will help to ensure that fisheries are sustainably managed and that benefits are distributed fairly and equitably. At the same time, our research helped the government of Myanmar to extend the Nay Pyi Taw Agreement in furtherance of its Agricultural Development Strategy. As a result, small farmers can now convert part of their rice paddy to rice-fish production more easily, with state and regional governments now promoting such conversion and farm diversification.

FISH pond polyculture innovations being scaled in Odisha State in India have demonstrated an increase in production of fish for market and the home, with concomitant increases in women's incomes and family fish consumption. It is also creating a demand for improved fish seed stocks. We helped the Fisheries and Animal Resources Department in Odisha prepare an application to establish a multiplication center and hatchery for genetically improved farmed tilapia (GIFT). In 2019, construction of the USD 225,000 facility began at the government's fish farm in Kausalyaganga, to begin operation in 2020.

Efforts to improve the formulation of locally sourced fish feed continued with research in Bangladesh, Malaysia and Myanmar, as well as Egypt, Nigeria and Zambia in Africa. In partnership with the global feed company Skretting, we are analyzing existing and potential feed ingredients with a view to compiling an open access database for low-cost feed formulation of tilapia feeds. In future, information on digestibility will be included to further improve feed formulation, and incorporated into a digital tool to help farmers adopt better fish feeding practices and overall improve fish pond productivity.

Pacific

Small innovations post-harvest can reduce fish loss and waste and improve women's empowerment and incomes. In the Solomon Islands, we have worked with women and solar-powered freezers. The freezers overcome the problems associated with the geographical isolation of small island villages. With them, women can store fish in good condition, improving the profit from sales and even rent out freezer space to others. The provincial government now wants to extend similar initiatives to other communities within the country.

The Coral Triangle is a hugely important but little understood fisheries resource. Working with the Coral Triangle Initiative, we have supported Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste to create an independent Coral Triangle Atlas, building from WorldFish's global ReefBase. The new database provides governments, NGOs and researchers within the region with access to open source geospatial solutions for greater decision making and resource sustainability.

Data management on a smaller but no less important scale is vital to manage small-scale fisheries. Our integrated data pipeline for small-scale fisheries won the Inspire Challenge of the CGIAR Platform for Big Data in Agriculture in 2018. That enabled us to pilot the devices, which track the location and activities of more than 300 fishing boats in Timor-Leste. As a result, Timor-Leste adopted the system, which went on to win the scaling-up award in 2019. The project is now being extended to small-scale fisheries in seven additional countries.

Community leadership and empowerment is essential to local actions to sustainably secure small-scale fisheries and manage the challenges of climate change. Using FISH learning from our co-management research, we worked with the Pacific Community and other partners to develop a guide, *A New Idea for Coastal Fisheries: Asking the Right Questions to Enhance Coastal Livelihoods*. The guide collates experiences from the Solomon Islands and Timor-Leste to outline a practical and gender-sensitive participatory approach to guide conversations on enabling new livelihood opportunities in coastal fisheries communities.

Stories of change

Reduced poverty

Fish from small-scale aquaculture makes a vital contribution to not only the diets of producer households but also for families who buy fish from farmers and local markets. Our goal for small-scale fish farmers is to sustainably improve the productivity and profitability of aquaculture. The combination of household fish and sales results in better nutrition and higher incomes. Bangladesh and Myanmar provide new results on small-scale aquaculture's potential for poverty reduction.

Ecopond carp-based polyculture supports greater incomes, increased fish consumption and production

BANGLADESH

Many rural houses in Bangladesh have a small pond, often no more than 500m^2. These ponds are not designed for aquaculture but are often the result of digging earth for agriculture or housebuilding. Some households produce a few fish in their ponds, but many do not. Starting in 2017, FISH has been working with women to improve the productivity and use of household ponds, using an ecopond model.

Natural features in the household pond such as tree roots, branches and pond plants can provide food and shelter for multiple species, increasing fish diversity and the productivity of the pond as a whole. Working through women's groups in rural communities in Khulna and Barguna districts of Bangladesh, training was provided on the so-called ecopond innovation, but also more generally on women's empowerment. Overall, 3377 women transformed 3500 underused backyard ponds into productive ecoponds.

An assessment of the ecopond innovation during 2019 showed that this innovation results in higher household income as a result of improved fish production. Ecoponds provided greater diversity of fish production, though the impact on dietary diversity was low, despite a moderate increase in the diversity of fish consumed.

Focus group discussions revealed that quantity and preferences were more important than diversity. "We have to feed children according to their choices," said one participant, "otherwise they don't want to eat."

Women also preferred to invest in future productivity rather than dietary diversity now. As another participant put it, "spending the extra income on increasing productivity will give me more profit. Then I can use the profit for family welfare."

Effects of the training on empowerment were not as clear-cut as on productivity and income. There were hints that women who managed productive ecoponds enjoyed greater freedom to contribute to household decisions.

Aquaculture supports poverty reduction in Myanmar

MYANMAR

FISH activities in the Ayeyarwady Delta in Myanmar, funded by the European Union and USAID, in collaboration with CGIAR partners, the International Water Management Institute and International Rice Research Institute, have shown clearly how integrating fish into rice farming systems, along with aquaculture, can lift people out of poverty and improve their health and well-being.

Generally, the approach involves devoting part of the land to fish production, in some cases with a community-based refuge where fish can survive when the paddy fields are dry. Refuges are designed to provide shelter for spawning fish. Improved management of canals, which have to be kept open at certain times, allow the fish to move out into the flooded rice fields where they can be caught for household consumption and for sale.

Following best management practices, households in the pilot areas reported increased incomes, more fish in the diet and greater dietary diversity. Incomes doubled, thanks to the integration of fish into rice fields, while maintaining total rice yields.

The project also helped villagers to develop the governance structures needed to manage community-based fish refuges. To make best use of the water, communities have also been encouraged and trained to advocate for their needs with regional water control managers.

About 45 percent of the land in the Delta is suitable for rice-fish farming. Our pilot studies suggest that if just 10 percent of the suitable area were given over to rice-fish systems, it would yield 100,000 metric tons of nutritious fish and an additional USD 100 million in income each year. The government of Myanmar was initially reluctant to divert land from rice production, but the evidence from FISH research has helped to convince them in 2019 to permit farmers to convert up to 15 percent of their rice land to fish production. The government also enacted changes to the Ayeyarwady fisheries law in 2019 to legalize community fishery associations for more equitable and better managed fisheries.

The people of Myanmar stand to gain increased employment, especially for women and youth, while farm families see increased incomes and better nutrition. The ecosystem of the Ayeyarwady Delta will also benefit from reduced pesticide pollution and more efficient use of water for food production.

Improved food and nutrition security for health

We know how important fish is for good nutrition, but if people are going to eat more fish, they need affordable access. Polyculture farming systems offers the chance to grow larger fish for the market and small indigenous species for domestic and local consumption. In Cambodia, community-managed fish reserves increase fish production, whilst sustaining rice yields. Polyculture ponds in Odisha have improved fish production and nutrition and are now being expanded under government programs with the potential to feed four million school children.

Cambodia sees the benefits of community fish refuges

CAMBODIA

Community fish refuges are the heart of FISH research on rice multifunctional landscapes in Cambodia being implemented through the Rice Field Fisheries II project. Our research is having a measurable impact on food and nutrition security in the four provinces where we work (Battambong, Pursat, Kampong Thom and Siem Reap).

Rice field fisheries supply a quarter of inland fish production in the country. Research seeks to ensure that fish refuges within rice-dominated landscapes are managed effectively for long-term sustainability, while working closely with households on social behavior change to optimize nutrition fisheries.

The year 2019 started unusually hot and dry, with the rainy season delayed by two or three months. As a result, the area of flooded rice fields was lower. Fewer fish moved out of the refuges, so fewer fish were available to be caught in the rice fields. Overall, the average household catch dropped 18.5 percent from 2018 to 2019, and with it the amount of fish eaten. Despite the decline, however, the proportion of children under five eating small fish species remained higher in 2019 than in 2017.

This result is a strong indicator that our work with women and older children, who often take care of their younger siblings, is bearing fruit. So is the decline of 86.5 percent in the number of households that remove the head and guts of small fish before cooking them. As we stress, these parts are rich in nutrients: fish left intact contribute much more to a better diet. More than four times as many households now make small fish species an integral part of their diet than in 2017.

In total, we estimate that around 110,000 individuals in Cambodia have directly benefitted by being close to a community fish refuge and catching fish and other aquatic animals in the rice fields.

Safe drinking water is also vital for good health and nutrition. The project has established 12 stations where local entrepreneurs purify water from the refuges and elsewhere to bottle and sell to community members at a reasonable price.

Neath Sokneth, one of the women who buys clean water, is persuaded of the benefits. "My small kids don't face the issue of diarrhea," she told project surveyors. "It is also more convenient for us because we don't need to boil water anymore."

Scaling nutrition sensitive fisheries technologies

INDIA

The people of Odisha state in eastern India eat about 15.6 kg of fish each per year, considerably higher than the national average of 9.3 kg, but lower than the global average. However, despite Odisha's plentiful water resources, fish productivity is low and the State imports 40,000 metric tons a year to meet demand. FISH has been working with Odisha's Fisheries and Animal Resources Department since 2015 to boost production in order to improve food and nutrition security.

One target has been private and communally-owned fish ponds that are present in most communities. Ponds can supply carp, mostly for market, and small indigenous species such as mola, which provide accessible and affordable micronutrients for better nutrition.

Many of the communal ponds in the State have long been neglected. A primary policy change, introduced in 2018, allowed for longer-term leases of 3 to 5 years instead of 1 year to be given to women's self-help groups (SHG) as a priority. The longer lease provides an incentive to improve the resource. About 2400 SHG are now managing ponds and more than 40 percent of the ponds are managed by the women alone, with no help from men.

FISH partners helped to train the women in carp-mola aquaculture, including the production of feed, a major input cost, from locally available agricultural waste, and worked with them to increase awareness of the importance of small fish in the household diet.

The focus for better nutrition, aside from working directly with women, is school meals. We worked with 24 institutional feeding programs to develop different recipes that incorporate small fish in traditional dishes. There was some initial resistance, but after awareness raising, children and staff now readily consume the fish, including the head and bones. As project staff noted, "it is a blissful experience seeing the happy and smiling faces of children at the end of their meal."

Results of research have helped to persuade the Kalinga Institute of Social Sciences to pilot small fish in their Mega kitchen, which supplies the entire school feeding program for 30,000 young tribal children.

At present only the private sector can maintain the constant supply of high-quality fresh small fish for school meals. Our current research is assessing how women's SHG can participate in fish supply. It will be a challenge, but one with a great upside for all concerned.

This effort will need to move beyond fresh small fish to fish-based products, such as fish powder and fish chutneys, that can be stored for longer at ambient temperatures. We worked with women from SHGs to improve their ability to produce high-quality dried fish under hygienic conditions and hope to broker agreements for the private sector to purchase dried fish from the self-help groups.

If all state schools adopted fish in their feeding programs, which is under serious consideration by the Women and Child Development department of Odisha, the project benefits could extend to improved nutrition for about 4 million children.

Improved natural resource systems and ecosystem services

Aquaculture has huge potential to meet demand for fish in an environmentally efficient way. Aquaculture feed is a key constraint to productivity, but may bring its own set of problems. FISH research on nutritious ponds is paving the way for a more sustainable, more profitable approach to fish feeding in small-scale fish farming. Fish diseases represent a further risk and the spread of Tilapia Lake Virus, the first major disease epidemic of tilapia, is a key area of research intended to mitigate its impact and help to bring the epidemic under control.

Feed the fish and the pond

BANGLADESH, VIETNAM, ZAMBIA

Commercial fish food is commonly designed to meet the nutritional needs of fish and contributes to rapid improvements in aquaculture productivity. Even so, less than 40 percent of the feed ends up in the harvested fish. The rest is essentially waste or fertilizer for the pond: commercial feeds, in particular, make very poor fertilizer. A five-year project within FISH is examining an alternative approach to fish feeding. The project was originally funded by the Netherlands Organization for Scientific Research and has now been recognized by the Rockefeller Foundation and private sector partners as promising for scaling in Bangladesh and Zambia.

The early, experimental phase of the nutritious pond project focused on alternative feed formulations for shrimp in Vietnam and tilapia in Bangladesh. The basic idea is to consider the whole pond as well as the fish and shrimp within it. Increase the amount of carbohydrate relative to protein in the feed and you effectively feed the micro-organisms in the pond. The micro-organisms boost the entire pond's food web, which makes up for any protein not present in the feed.

Low protein diets do not reduce aquaculture productivity in nutritious ponds. In experiments on tilapia in Bangladesh, nutritious pond feed, with much of the protein replaced by carbohydrates of different kinds, produced yields 21 percent higher than conventional feed. About 64 percent of growth came from food supplied by the pond, rather than directly through the conventional feed. Shrimp in Vietnam gave essentially similar results, with no loss in productivity compared to conventional feeds.

Financial savings averaged 10 to 15 percent in feed costs, largely because carbohydrates are cheaper

than proteins. Properly fed ponds also have more stable water quality, so the growth period is longer and disease risks are reduced. Nutrient efficiencies are also improved.

The project is now moving forward on several fronts with private partners. New partnerships with De Heus Animal Nutrition (The Netherlands) and Aller Aqua (Denmark) are conducting on-farm trials and scaling in Bangladesh and Zambia respectively. De Heus is sponsoring PhD candidates to conduct field research to extend the nutritious pond technology to carp polyculture. Tools are also being developed that will help fish farmers and local entrepreneurs formulate feeds using low-cost ingredients.

Feeding the pond to create food for the fish will not only help to intensify the production of aquatic foods while reducing environmental impacts, it will also place aquaculture more firmly within the circular food economy.

Taking steps to control a global disease epidemic

AFRICA, AMERICAS, ASIA

In 2019, FISH continued to deepen understanding of Tilapia Lake Virus (TiLV). Two new discoveries will help farmers to mitigate the effects of TiLV and control its spread.

TiLV was first reported in Israel in 2014 and has since been detected in many countries in Asia, Africa and the Americas. Mortality can be very high, up to 90 percent in the field, and at the moment there is no treatment and no vaccine. Tilapia is the foundation of many small-scale aquaculture enterprises, so the epidemic threatens both the livelihoods of fish farmers and people who rely on the fish as a low-cost source of animal food in their diet.

The first discovery depends on our long experience breeding Genetically Improved Farmed Tilapia (GIFT). In 2018, a pond stocked with almost 2000 offspring of 124 different GIFT families suffered an outbreak of TiLV, killing about 40 percent of the fish. Because each fish carried an individual identity tag, we knew which family it came from. In one family, every single fish died. In three others, none of the offspring died of TiLV. The rest were somewhere in between.

The result is a clear demonstration that resistance to the disease is at least partly genetic. In fact, we were able to calculate that the heritability of TiLV resistance is relatively high. Therefore, as this key paper notes,

"selective breeding to increase resistance and reduce mortalities due to TiLV is a feasible and promising approach."

Tilapia breeding, however, carries its own risks. In 2017, researchers at Suan Sunandha Rajabhat University in Thailand demonstrated the presence of TiLV in newly fertilized eggs. In 2019 we partnered with those researchers to show that the virus is present in the eggs and sperm of diseased fish. The conclusion is clear: hatcheries and multiplication centers must ensure that their broodstock is negative for TiLV if they wish to produce TiLV-free tilapia fry. We have already tightened biosecurity for our own GIFT broodstock and are helping others to do the same.

These two discoveries will contribute to eventually bringing the epidemic under control. In the meantime, cooperation and vigilance are essential to ensure that the disease does not spread further. Our Lab in a Backpack should make diagnosis quicker in future.

Crosscutting impacts

Climate change

Climate change directly threatens the living conditions of people who depend on aquatic resources, through temperature change, flooding, storms and saline intrusion. Although aquaculture has less impact on climate than many other systems of food production, even that impact must be reduced. Two FISH projects show how we improve resilience and reduce greenhouse gas emissions, contributing to both climate change adaptation and mitigation.

Reducing greenhouse gas emissions from fish production in Egypt

EGYPT

Sustainable Transformation of Egypt's Aquaculture Market Systems (STREAMS), a project funded by the Swiss Agency for Development and Cooperation, came to an end in 2019. Quite apart from increasing productivity and profitability, the project also sought to make Egyptian aquaculture more climate-smart. An end-term evaluation concluded that the project had been effective in reducing greenhouse gas (GHG) emissions of tilapia production by 22 percent.

Climate-smart ideas featured in many of the project's activities, but most of the gains came from two important changes in how fish farmers managed their ponds. Training in Better Management Practices helped them to achieve greater productivity with lower feeding rates. The feed conversion ratio (kg of feed needed to produce each kg of fish) decreased from 1.8:1 in 2016 to 1.41:1 in 2018. Feed is a major source of GHG emissions in aquaculture, in its manufacture and the ingredients used.

During training, fish farmers also learned that they can reduce water use by pumping less often. As a result, their ponds used 37 percent less water overall and less fuel for pumping. Lower feed use and water consumption together reduced calculated GHG emissions from 3 metric tons of CO^2 equivalent per ton of fish to 2.35 metric tons of CO^2 equivalent per ton of fish.

None of this would be sustainable if it did not benefit farmers directly. The evaluation estimated that production increased by 16.6 percent and profits by 35 percent, offering a good incentive for farmers to continue to deploy climate-smart aquaculture.

A further benefit is that many small-scale farmers use their fish pond as a source of nitrogen-rich water as fertilizer for their fields. Thanks to advocacy by the project, Egypt's General Authority for Fish Resources Development changed its policy to permit integrated smallholder aquaculture. The reduction in purchased fertilizer will further reduce GHG emissions, as well as enhancing farm productivity and incomes.

For larger fish farms, FISH has continued to study an innovative technology known as an In-Pond Raceway System (IPRS) with a demonstration setup at WorldFish's Africa Aquaculture Research and Training Center in Abbassa, Egypt. IPRS uses pumps to circulate and oxygenate water, producing more fish with less feed and water. It also directly captures nutrients not eaten by the fish for use as crop fertilizer. Early indications are that productivity can be doubled or even tripled without increasing GHG emissions.

Securing the hilsa ecosystem in Bangladesh

BANGLADESH

Hilsa (*Tenualosa ilisha*) is a vitally important fish resource for coastal people in Bangladesh, both for their own nutrition and as a source of income. However, a combination of unregulated overfishing and the effects of climate change threatened the hilsa fishery, and with it, peoples' livelihoods. Enhanced Coastal Fisheries (Ecofish) is a project funded by USAID that has put the management of the hilsa fishery onto a sound scientific footing as the basis of a more widespread effort to make communities and the hilsa fishery more resilient.

A key outcome of improvements to community management among 136 villages along the coast has been to contribute to the country's increased production of hilsa, from 526,000 metric tons in 2016 to 721,000 metric tons during 2019. Together with sanctuaries for spawning grounds in the rivers and an increase in the minimum mesh size of hilsa nets, the harvest is now close to the theoretical maximum sustainable yield. More than 4000 hilsa-fishing households have seen their incomes increase by an average of 65 percent.

An important aspect of the project has been to explore livelihood diversification for the villagers. The ban on fishing in certain areas and at certain times of year would otherwise impair their livelihoods. The project introduced the idea of growing vegetables and livestock—goats are a favorite—that can feed the family as well as provide an income. Some households also adopted alternative entrepreneurial opportunities such as tailoring and small grocery businesses with the support of the project. Women especially have benefitted from these alternative sources of income.

Protecting the enhanced hilsa fishery in future is crucial for sustainability. The project trained more than 400 community fish guards who patrol the sanctuaries and contribute to improvements in adherence to fishery regulations. Further boosting sustainability, the project and the Department of Fisheries created a Hilsa Conservation and Development Fund that will support the fishers and community guards. The Department of Fisheries is now seeking to scale the approach to more than 100 villages through a World Bank loan.

The Ecofish investment in Bangladesh has shown how co-management of the resource and socioeconomic resilience go hand in hand. The hilsa fishery has been strengthened, with almost 125,000 hectares of water area under sustainable ecosystem management. At the same time, poor families that depend on hilsa have seen improvements to their livelihoods, savings and ability to cope, which together boost their ability to weather climate-related shocks.

Gender and youth

Although women and youth are often aggregated as vulnerable groups of people, FISH research recognizes their specific needs and constraints. The results of our comprehensive survey of youth engagement in fisheries, aquaculture and value chains was published in 2019, highlighting both the challenges and the opportunities. The survey is informing policy advocacy and our own youth strategy. In Bangladesh, through the Suchana project, we focus nutrition-sensitive interventions on women and children in their first 1000 days. Roughly halfway through the project, we are seeing evidence of improved nutrition and women's empowerment in more than 40,000 households.

Understanding youth in aquaculture and small-scale fisheries

AFRICA, ASIA, PACIFIC

Although there is little agreement on who exactly constitutes "youth," there is a consensus that growing numbers of underemployed youths represent a challenge for many societies. With our FISH partners at the International Water Management Institute, we undertook a wide-ranging analysis of youth participation in small-scale fisheries, aquaculture and fish value chains in order to understand the issues and outline possible ways forward.

The study looked at Africa and the Asia-Pacific region, particularly the FISH focal countries: Egypt, Nigeria, Tanzania and Zambia in Africa and Bangladesh, Cambodia, Myanmar and Solomon Islands in Asia-Pacific.

Governments tend to categorize youth by age, an easy marker, but our analysis revealed a wide range of limits, as low as 15- and as high as 35-years old. By contrast, societies use many factors to define youth, including age at starting work, education, gender, legal and marital status and others.

In many respects, the issues faced by youth in small-scale fisheries and aquaculture are the same as those faced in other sectors of agriculture, although even less well studied. Perhaps most important, fisheries and aquaculture are not the first choice of livelihood. There are many reasons for this, including access to land and other resources such as finance and expertise. Power dynamics enshrined in gerontocracies can be very difficult for youth to navigate. The work is often physically hard and not well-rewarded. All of these constraints are even harder on young women than on young men.

Despite the challenges, our survey also identified potential opportunities. Young people are generally more agile in thought and behavior and more willing to take risks. At the same time, they have new knowledge and are familiar with modern technology. This suggests that there may be more opportunity for them downstream in the value chain, processing and trading in aquatic foods. Young people may consider aquaculture a more modern business than fishing and hence more attractive.

Policies do often focus on entrepreneurship as a pathway to youth engagement. However, like most aspects of youth-oriented policy, evidence on the matter is scarce. Lumping youth with, for example, women as members of a vulnerable class risks ignoring the specific needs and aspirations of young people.

Many FISH projects contain activities aimed at greater youth engagement, which the analysis recognizes. Nevertheless, it is clear that this is an area where policy changes, informed by better evidence, are essential to building a youth-oriented approach to small-scale fisheries and aquaculture.

Empowering women to improve nutrition and livelihoods

BANGLADESH

In Bangladesh, malnutrition and poverty in the eastern districts of Sylhet and Moulvibazar are amongst the worst in the country. In part that is because women have little agency in managing household decisions, even with respect to diet. Suchana, a project funded by the European Union and UKAID, aims at Ending the Cycle of Under-nutrition in Bangladesh. WorldFish is leading Suchana's work on nutrition sensitive fisheries and aquaculture. An independent report at roughly the halfway stage shows an encouraging impact on family nutrition and women's sense of empowerment.

In more than 44,000 households, knowledge from FISH research has informed the development of better management guidelines for fish ponds and fisheries. These are combined with vegetable seeds distributed by the project, including thousands of vines of nutritious orange-fleshed sweet potatoes, and raising awareness of the importance of dietary diversity for nutrition. Women have learned how to harvest and prepare small indigenous fish species for household meals and how to take care of their aquaculture ponds to give a greater yield of marketable larger fish, including carp and tilapia.

According to the report, average fish harvest and horticultural production both roughly doubled from 2018 to 2019. The households ate about three-quarters of their fish harvest, gave some to relatives and neighbors and sold the rest at market. Higher household income allowed women to invest in their future, for example buying a goat or a sewing machine to bring in additional income. Money is also available for children's education and medicines.

Extra income and food throughout the year are helping women to be heard during household discussions. About 35 percent said that they felt more empowered thanks to their participation in food production and markets.

Nutrition is improving too. More than half the households—56 percent—are now classed as food secure, compared to only 14 percent before the project, with corresponding decreases in the less food secure categories.

Dietary diversity, a proxy for greater nutritional value, has increased. For children under two years old, 44 percent now eat an adequately diverse diet, compared to 30 percent before. Dietary diversity has increased for adult women too, albeit more slowly: 39 percent versus 35.

The impacts of the Suchana project on women's empowerment and family nutrition are important because they are weakening intergenerational constraints, whereby the children of poor and malnourished families do not themselves do well. With its focus on replicability and scalability, Suchana can bring Sylhet and Moulvibazar closer to Bangladesh's impressive record in tackling poverty and malnutrition.

Capacity development

In 2019, FISH continued to give special attention to capacity development in Africa. The continent has the fastest growing aquaculture sector in the world, albeit from a very low base. Capacity development is thus essential to improve fish supplies in Africa, which in turn will increase consumption and reduce imports, leading to greater sustainability. To that end, among other activities, we are promoting high-level innovative planning in Nigeria and ensuring that the latest research gets into the hands of people who can put it to use through training courses in Abbassa, Egypt.

Improved innovation for aquaculture in Nigeria

NIGERIA

Nigeria has enormous untapped potential for aquaculture. Production and consumption of fish both are lower than global averages and more than half the fish consumed has to be imported. An expanded and vibrant aquaculture sector is vital to sustainable development for the country and would generate benefits all along the value chain, quite apart from providing people with employment and access to more affordable nutrition.

Transforming aquaculture in Nigeria will require a strategic approach to innovation. To lay the groundwork, we have been working with the Bill and Melinda Gates Foundation on a scoping study for aquaculture in Nigeria. In September 2019 we also hosted a two-day workshop in Ibadan with the Feed the Future Fish Innovation Lab at Michigan State University and the International Food Policy Research Institute. About 30 aquaculture stakeholders from Nigeria's South Western Region, representing government, private sector, civil society, research and academia, took part in the workshop, which was designed specifically to explore capacity building for innovation.

A succession of interactive exercises helped participants to identify factors that could ease the way to greater capacity, from the regulatory environment to information flows among stakeholders. A particular focus was to examine connections among stakeholders who operate at different points along the fish value chain, looking for opportunities for strategic change and growth.

Participants worked through a series of exercises on institutional reform, development scenarios and

change pathways. Together, these fed into a shared vision for the aquaculture sector in the South Western Region in 2030. While there remain differences among stakeholders as to exactly who is responsible for which aspects of innovation and growth, consensus on the shared vision offers a solid basis for future collaboration and partnership.

Of course, it helps to know the challenges that face aquaculture. Early work with our partners in the Fish Innovation Lab has shown up opportunities for improvement at every step of the aquaculture value chain, from waste of raw material inputs right through to postharvest loss through spoilage.

Can these problems be overcome by innovative thinking? We certainly think so and are now working

with colleagues to apply lean production systems, pioneered by the Toyota car company, to the aquaculture value chain. This innovative project will directly train 200 farmers and processors to apply tailor-made lean tools and technologies in fish production and processing. These innovations will improve the profitability and efficiency of aquaculture, making farmed fish more available and more affordable. Success and subsequent scaling beyond the life of the project will improve the health and wealth of small-scale aquaculture farmers and contribute to sustainable development in Nigeria.

Developing a new generation of aquaculture entrepreneurs

AFRICA

A lack of skilled staff is one of the main factors holding back improved aquaculture in Africa. Recognizing this, Technologies for African Agricultural Transformation (TAAT) launched its Aquaculture Compact, which is implemented by WorldFish. The compact's goal is to benefit 1.15 million aquaculture value chain actors over the next five years. Crucial to achieving this is the training and capacity development that participants receive at the WorldFish African Aquaculture Research and Training Center at Abbassa in Egypt.

The Center has trained more than 2000 people from 105 countries since its launch in 1999. In 2019, numbers swelled by 40 participants from the ten TAAT countries: Democratic Republic of Congo, Ghana, Kenya, Nigeria and Zambia (focal countries) and Benin, Burundi, Cameroon, Cote d'Ivoire and Tanzania (satellite countries).

Training at the Center covers all aspects of the aquaculture value chain, from pond construction to effective sales operations. It is viewed as vitally important to boosting the contribution that aquaculture can make to sustainable food systems and better nutrition in Africa.

The TAAT compact expressly focuses on people from the private sector, expecting them to be drivers of growth through uptake and dissemination of improved aquaculture technologies. We have already seen evidence of this from trainees. In Benin and Nigeria, for example, young entrepreneurs who came to the Center under the TAAT compact shared what they had learned with local fish farmer networks. As a result, more efficient hatcheries, feed production from local ingredients, improved fingerling stocking, pond construction and management all show evidence of improvement, playing a part in increased fish production.

Future trainees will continue to multiply the impact of our capacity development activities as they become trainers in their own right. In this way, we are helping TAAT's participant countries to achieve its objectives: 80 percent of fish farmers have access to improved stocking material, a 20 percent increase in production and a reduction of 10 to 30 percent in fish imports. In addition to providing the skilled staff that aquaculture needs, the efforts will also improve nutrition and employment opportunities for young people in the aquaculture value chain.

Communications and knowledge sharing

Communication is a way for us to share knowledge and deliver research evidence to a variety of audiences, including fishers, farmers and traders, policymakers, extension agents and the scientific community. We focus on three areas, with the aim of enabling others to translate our science into action:

Practitioner guidance to enable adoption of technologies and management practices, for example on improved fish feeds or measures to reduce loss and waste in the value chain.

Evidence, learning and exchange on technologies and innovations shared via peer-reviewed literature, outcome stories and evidence-based narratives focused on FISH generated science. For peer-reviewed research publications, we encourage our scientists to publish in open access journals. In those instances where publishing in fee-paying journals is preferred, FISH endeavors to cover open access costs. Of the 63 peer-reviewed articles published in 2019, 46 were open access.

Policy dialogue demonstrating the value of fisheries and aquaculture to address national and regional food and nutrition security and poverty reduction goals, and evidence to support the analysis of policy alternatives, including foresight modeling and scenario analysis.

Raising our digital profile

We provide publicly accessible reporting on our progress, demonstrating accountability and transparency toward investors, partners and beneficiaries. Supporting this is our growing digital presence, which is helping to raise the profile and reach of our work beyond our traditional stakeholders.

In 2019, we saw significant growth in reach and audience through the dedicated FISH social media channels, following the implementation of a new strategy in 2018. The FISH website also had a marked increase in visitors and pageviews, evidence of the value of an improved website and user-centric approach. By the end of the 2019, we had reached more than 1.94 million people on social media and increased the number of new followers by 145 percent.

Supporting quality science dissemination

We regularly share our knowledge and research evidence at scientific conferences and other strategic events. To support our scientists, who are the (co-)producers of our research and ambassadors of our brand, we developed a suite of FISH-specific tools and materials that ensure we are making the case for fish in agri-food systems in the strongest possible way.

In addition, we jointly developed training tools and communication materials with our CGIAR partners on the Monitoring, Evaluation and Learning Platform (MEL) and provided these to all FISH researchers, which enhances the effectiveness of our reporting and understanding of Program impacts.

99,221 pageviews of the FISH **website**

15,076 downloads of FISH publications

1.94 million people reached on **social media**
216% more than 2018

63 peer-reviewed articles published:
46 open access

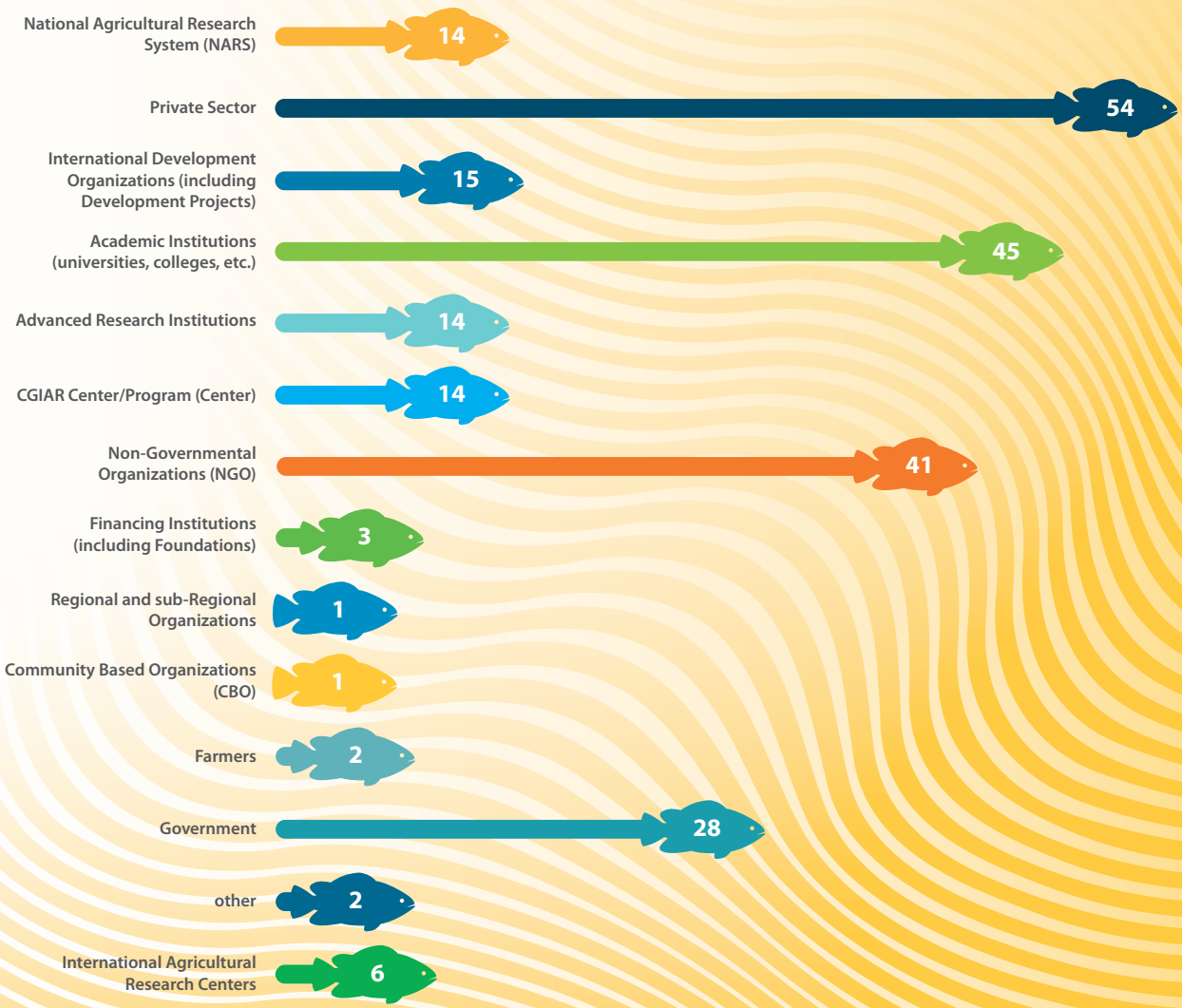
145% increase in **total** followers on

Partners

We work with an extensive network of partners, including international, national, regional and local governmental institutions, universities, private sector organizations and NGOs, who share our commitment to creating positive change for the millions who depend on fish in the developing world.

In 2019, FISH was engaged in 240 active partnerships, 98 of which were new. A substantial percentage of these were with academic and research organizations (27 percent). However, there was significant growth in partnerships with the private sector (25 percent), and national agriculture research systems and governments (20 percent), the latter particularly reflecting the more significant policy contributions of FISH in 2019.

Scaling partnerships featured prominently in 2019. Sixteen percent of FISH partnerships in 2017 were focused on aspects of scaling, with the majority (41 percent) focused on the discovery phase within the impact pathway. By 2018, 35 percent of partnerships within FISH were focused on scaling, but this has grown in 2019 to an estimated 67 percent of partners, a shift intended to enable delivery of innovation at greater scale within FISH focal and scaling countries.



Investors and financial summary

The 2019 financial plan provided USD 6.23 million of W1/W2 funding, which combined with a 2018 carry-over provided FISH with USD 6.29 million of W1/W2 funding for the year. The expenditure of W1/W2 funds for 2019 was USD 5.64 million (90 percent), and the W3/bilateral expenditure was USD 22.1 million. A total of USD 656,086 W1/W2 funds have been carried over to 2020. The sourcing of bilateral funds increased during 2019 beyond that predicted in the FISH proposal, with a final budget of USD 29.2 million, of which around 76 percent was spent. The allocation of bilateral funding represents an increase beyond that predicted in the FISH proposal, allowing in particular enhanced investment in research, outcomes and impacts across the Program.

Planned budget 2019[1]	**W1/W2**	**W3/bilateral**	**Total**
FP1 Sustainable Aquaculture	2,309,839	23,057,380	25,367,219
FP2 Sustaining Small-Scale Fisheries	998,238	6,134,652	7,132,890
Cross-program investments	1,694,097		1,694,097
Carry over funding	434,072		434,072
CRP management and support costs	855,987		855,987
CRP total	**6,292,233**	**29,192,032**	**35,484,265**

Actual expenditure 2019[2]	W1/W2	W3/bilateral	Total
FP1 Sustainable Aquaculture	2,286,650	15,785,904	18,072,554
FP2 Sustaining Small-Scale Fisheries	943,604	6,297,402	7,241,006
Cross-program investments	1,582,421		1,582,421
Carry over funding			
CRP management and support costs	823,472		823,472
CRP total	**5,636,147**	**22,083,306**	**27,719,453**

Difference	W1/W2	W3/bilateral	Total
FP1 Sustainable Aquaculture	23,189	7,271,476	7,294,665
FP2 Sustaining Small-Scale Fisheries	54,634	(162,750)	(108,116)
Cross-program investments	111,676		111,676
Carry over funding[3]	434,072		434,072
CRP management and support costs	32,515		32,515
CRP total	**656,086**	**7,108,726**	**7,764,812**

[1] Planned budget 2019 = 2019 CGIAR System Management Organization final approved Budget USD 6.233M + 2018 carryover of USD 0.059M.
[2] Source: Audited lead and participating center financial report.
[3] Additional investment of W2 made available in Nov 2019, carried over for priorities in 2020

Governance and Management

FISH governance involves members of developing and developed country institutions, such as national research institutes, the private sector, fisher organizations and international organizations. The Program has a wide upstream and downstream reach that includes participants and institutions with a key role in defining the fisheries and aquaculture development agenda.

Independent Steering Committee

The Independent Steering Committee (ISC) is responsible for the overall strategic direction of the Program. This includes science quality and priorities, risk management, budget allocation and identification of new investment, partnering and funding opportunities to grow and sustain the Program and enhance impact. Membership consists of scientists, practitioners and representatives from end-user bodies that represent a balance of disciplinary expertise, gender and national diversity.

No changes were made to the terms of reference for the ISC in 2019. Three meetings were held, with reporting lines well established to the WorldFish Board of Trustees for approval of the FISH Plan of Work and Budget, Annual Report and quarterly progress reports.

The ISC again conducted an in-depth review of FISH during 2019, reporting to the WorldFish Board of Trustees and the FISH Director and Management Committee for follow up action. Key areas of attention related to staff strengthening and focusing more attention on the role of FISH research findings in climate change mitigation and adaptation and food systems transformation.

Management Committee

The Management Committee is responsible for timely and effective planning, budgeting and reporting of FISH. The committee is composed of representatives of the five managing partner institutions and the flagship coordinators, and is chaired by the FISH Director.

The committee reviews the annual work plans and budgets developed at regional and global levels to ensure consistency, integration and appropriate budget allocation across the Program. Once cleared by the FISH Management Committee, work plans, budgets, strategies and other program implementation documents are submitted to the ISC for approval.

FISH people

Independent Steering Committee (ISC)

- Nigel Preston, ISC Chair, University of Queensland, Australia
- Editrudith Lukanga, Environmental Management and Economic Development Organization, Tanzania
- Gareth Johnstone, WorldFish, Malaysia
- Ian Cowx, University of Hull, United Kingdom
- M.A. Sattar Mandal, Bangladesh Agricultural University, Bangladesh
- Marian Kjellevold, Institute of Marine Research, Norway
- Mark Smith, International Water Management Institute, Sri Lanka
- Dr Cristina Rumbaitis del Rio, Global Commission on Adaptation
- Tony Haymet, Scripps Institution of Oceanography, Australia

Management Committee (MC)

- Michael Phillips, MC Chair, Director, CGIAR Research Program on Fish Agri-Food Systems and Aquaculture and Fisheries, Sciences, WorldFish
- Ban Swee Tan, Research Finance Manager, WorldFish
- Cristiano Rossignoli, Monitoring and Evaluation Leader, WorldFish
- Cynthia McDougall, Gender Research Leader, WorldFish
- David Shearer, Director of International Partnerships and Program Delivery, WorldFish
- Emily Khor, Program Life Cycle Performance Manager, WorldFish
- Essam Yassin Mohammed, Climate Change Research Program Leader, WorldFish
- Harrison Charo Karisa, Country Director, Egypt and Nigeria, WorldFish (retired)
- Johan Verreth, Head of the Chair Group Aquaculture and Fisheries, Wageningen University & Research
- John Benzie, Sustainable Aquaculture Program Leader, WorldFish
- John Linton, Commercial Director, Natural Resources Institute of the University of Greenwich
- Marc-Antoine Baïssas, Director of Finance and IT Systems (interim), WorldFish
- Marion Barriskell, Director of Finance and IT, WorldFish
- Michael Akester, Country Director, Myanmar, WorldFish
- Muhammad Hafizullah, Research Program Specialist, WorldFish
- Philippa Cohen, Resilient Small-Scale Fisheries Program Leader, WorldFish
- Paola Reale, Research Programs Manager, WorldFish
- Shakuntala Thilsted, Value Chains and Nutrition Program Leader, WorldFish
- Sonali S. Sellamuttu, Head of Southeast Asia Office, International Water Management Institute
- Tana Lala-Pritchard, Director of Communications and Marketing, WorldFish
- Terry Hughes, Director, ARC Centre of Excellence for Coral Reef Studies

Management partner institutions

- WorldFish
- International Water Management Institute
- James Cook University
- University of Greenwich
- Wageningen University & Research

Acronyms

Ecofish	Enhanced Coastal Fisheries
FAO	Food and Agriculture Organization of the United Nations
FISH	CGIAR Research Program on Fish Agri-Food Systems
GHG	Greenhouse gas
GIFT	Genetically improved farmed tilapia
IPRS	In-pond raceway system
ISC	Independent Steering Committee
KIT	Royal Tropical Institute
MC	Management Committee
MEL	Monitoring, Evaluation and Learning Platform
MBS	Malawi Bureau of Standards
NGO	Non-governmental organization
SDGs	Sustainable Development Goals
SHG	Self-help group
SNP	Single nucleotide polymorphism
STREAMS	Sustainable Transformation of Egypt's Aquaculture Market Systems
TAAT	Technologies for African Agricultural Transformation
TiLV	Tilapia Lake Virus
WEFI	Women's Empowerment in Fisheries Index

About FISH

The CGIAR Research Program on Fish Agri-Food Systems (FISH) brings together a unique set of multistakeholder partnerships to harness emerging science in aquaculture and fisheries to deliver development outcomes at scale. The program partners closely with governments, NGOs, the private sector and research organizations to influence national, regional and global policy and development practice.

For more information, please visit fish.cgiar.org

WorldFish