



CGIAR Research Program on Fish Agri-Food Systems

Annual Report 2021



RESEARCH
PROGRAM ON
Fish

Led by WorldFish



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In partnership with



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List of abbreviations

2DI	Two Degree Initiative
AAS	Aquatic Agricultural Systems (CRP)
AICCRA	Accelerating Impacts of CGIAR Climate Research in Africa
AMR	antimicrobial resistance
APART	Assam Agribusiness and Rural Transformation
ASF	animal-source food
BANA	Bangladesh Aquaculture and Nutrition Activity
BAU	business-as-usual
BMGF	Bill & Melinda Gates Foundation
BMP	better management practice
CCAFS	Climate Change, Agriculture and Food Security (CRP)
CGIAR	Consultative Group for International Agricultural Research
CIAT	International Center for Tropical Agriculture
COP26	26th UN Climate Change Conference
CRP	CGIAR Research Program
DiD	difference-in-difference (framework)
ECOFISH II	Enhanced Coastal Fisheries in Bangladesh II
EU	European Union
F&ARD	Fisheries and Animal Resources Development Department (State of Odisha)
FAO	Food and Agriculture Organization
FISH	CGIAR Research Program on Fish Agri-Food Systems
FP	flagship project
GENDER	Generating Evidence and New Directions for Equitable Results
GHG	greenhouse gas
GIFT	Genetically Improved Farmed Tilapia
GLDC	Grains, Legumes and Dryland Cereals (CRP)
GTA	Gender-Transformative Approach
HLPE	High Level Panel of Experts on Food Security and Nutrition
ICARDA	International Center for Agricultural Research in the Dry Areas
ICT	information and communications technology
IDEA	Aquaculture: Increasing Income, Diversifying Diets and Empowering Women in Bangladesh and Nigeria
IDO	intermediate development outcome
IFPRI	International Food Policy Research Institute
IHH	Illuminating Hidden Harvests
IITA	International Institute for Tropical Agriculture
IRRI	International Rice Research Institute
ISC	FISH Independent Steering Committee

ISI	Institute for Scientific Information
IWMI	International Water Management Institute
JCU	James Cook University
KIT	Royal Tropical Institute
LCA	life cycle assessment
M&E	monitoring and evaluation
MC	FISH Management Committee
MEL	monitoring, evaluation and learning
MELIA	monitoring, evaluation, learning and impact assessment
MYSAP	Myanmar Sustainable Aquaculture Programme
NGO	nongovernmental organization
NRI	Natural Resources Institute
NSAAH	National Strategy on Aquatic Animal Health
OICR	outcome impact case report
PeskaAS	Automated Analytics System for Small Scale Fisheries in Timor-Leste
PIM	Policies, Institutions and Markets (CRP)
PMU	Project Management Unit
POWB	Plan of Work and Budget
PPP	public-private-partnership
Pro-WEFI	Women's Empowerment in Fisheries Index
RFF II	Feed the Future Cambodia Rice Field Fisheries II
RTB	Roots, Tubers and Bananas (CRP)
SADC	Southern African Development Council
SDG	Sustainable Development Goal
SIS	small indigenous species
SLO	system-level outcome
SNP	supplementary nutrition program
SPC	The Pacific Community
SRF	Strategy and Results Framework (CGIAR)
TAAT	Technologies for African Agricultural Transformation
TiLV	tilapia lake virus
UNFSS	UN Food Systems Summit
USAID	United States Agency for International Development
W1/W2	CGIAR funding windows 1 and 2
W3	CGIAR funding window 3
WEFI	Women's Empowerment in Fisheries Index
WFP	World Food Programme
WLE	Water, Land and Ecosystems (CRP)
WUR	Wageningen University & Research

Executive summary

This 2021 annual report describes the key achievements of the CGIAR Research Program (CRP) on Fish Agri-Food Systems (FISH). During 2021, FISH focused on several key areas to achieve a successful and impactful closure of the program: (i) completing key lines of research, (ii) accelerating the transition from discovery to enable the uptake of research and policy advances, (iii) assessing impacts and analyzing projected benefits, and (iv) managing the multiple challenges of the COVID-19 pandemic across the FISH portfolio.

Highlights of FISH achievements in 2021 are as follows:

1. Advances continued to be made in fish breeding, feeds, and health and production systems that are progressively enhancing the production efficiency and sustainability of fish farming enterprises in multiple focal and scaling countries.
2. Water management innovations in multifunctional rice-dominated landscapes and improvements in policies are being widely communicated, influencing policies and investments that can enable more productive and equitable management of inland and coastal fisheries.
3. New insights into the role of fish in nutrition in across three sub-regions—the African Great Lakes, Pacific Islands and Mekong—are providing critical evidence of the value of fish in sustainable and healthy diets.
4. Influential inputs in a number of global, regional and national policy forums have led to a new level of awareness of the importance of fish—and aquatic foods more broadly—in the future of food systems.
5. Research on COVID-19 has continued to influence and support policy development across Africa, Asia and the Pacific to provide the special focus on fish and aquatic foods.
6. FISH's gender research has become increasingly influential.
7. Research into the UN Food Systems Summit (UNFSS) and the [26th UN Climate Change Conference \(COP26\)](#) has also highlighted the importance of fish and aquatic foods and the millions of people who depend on them.

The independent review of FISH in 2020 highlighted the quality and effectiveness of science and the impacts that the CRP's research is having on shaping policies on sustainable aquaculture, land and water management, and fisheries and nutrition in multiple focal and scaling countries. It also noted that FISH's gender research program has significantly increased recognition of the participation of women in fisheries and aquaculture, their empowerment in family contributions, their income and their access to nutritious foods.

During 2021, cooperation with the CGIAR COVID-19 Hub continued to integrate fish agri-food systems into the collaborative effort to assess and develop solutions to the impacts of the pandemic on livelihoods and food systems. The FISH team completed impact assessments across five countries, integrating findings into policy and management guidance. Results were disseminated through multiple channels, including a dedicated [COVID-19 portal](#). A collaboration in Africa assessed the impact of the pandemic on [women fish traders in 13 African countries](#), identifying key [policy and investment actions](#) for the 2.5 million women in Africa who depend on fish trade.

FISH continued to progressively deliver system-level outcomes (SLOs)—poverty reduction, nutrition and diets, and climate change and environment—that made contributions to the transformation of fish agri-food systems. These ranged from securing fish supplies from sustainable aquaculture and small-scale fisheries through to value chain and products developed from fish and aquatic foods for poor and vulnerable consumers. The connection with a strong bilateral portfolio of donor investments continued to link research and innovations to on-the-ground impacts. A major effort in 2021 was made to support policy change and put research into use—specifically in the continued responses to the COVID-19 pandemic influencing the policy environment for uptake of fish agri-food innovations in the future. Overall, this accelerated the delivery of outcomes from the program and prepared a foundation for expanding the impact within the new One CGIAR portfolio.

Part A: Narrative section

1. Key results: Highlighting global progress and achievements

1.1 Progress toward SDGs and SLOs (sphere of interest, with research results frequently predating the CRP)

FISH contributes to CGIAR's Strategy and Results Framework (SRF) across all three SLO domains: reduced poverty (SLO1), improved food and nutrition security for health (SLO2) and improved natural resources and ecosystem services (SLO3). FISH contributes through investments in research for development in two flagship projects—Sustainable Aquaculture (FP1) and Sustaining Small-Scale Fisheries (FP2)—within the context of fish and aquatic foods in global food systems. Evidence supporting this section is provided in Table 1 and online (<https://fish.cgiar.org/>).

Sustainable aquaculture research has delivered results through adoption of various innovations that enhance the productivity of fish farms and contributes to SDGs and SLOs. These innovations include improved tilapia and carp breeds, genomic tools, aquafeed ingredients, feed management systems and tools, biosecurity and fish disease control measures, farm management systems, value chain business models and digital tools. Dissemination and uptake of some of these innovations were accelerated during 2021 to maximize impact from the FISH program. Improved tilapia breeds, such as Genetically Improved Farmed Tilapia (GIFT), are being widely disseminated in Bangladesh, India, Myanmar and Timor-Leste, and preparations are being made for disseminating the latest GIFT generation from Malaysia to Nigeria. [Recent assessments in Bangladesh](#) have shown that GIFT has delivered faster growth rates on farms (27%–36% faster) than non-GIFT tilapia, leading to better pond yields and profitability. The production of the first selected generation of catla carp from the [third selected generation of rohu carp \(*Labeo rohita*\)](#) was completed in 2021 in Bangladesh. The release of the new Generation 3 (G3) of rohu carp was also started in Bangladesh. It showed excellent on-farm growth performance compared to existing strains, as G3 rohu is expected to grow 30% more rapidly than river-sourced fish. Uptake of carp-based fish polyculture systems, aquaculture feed and health innovations, and business models via public and private partners was also accelerated, and new private sector partners and partnership models are opening new pathways for scaling key innovations and impacts.

Research on sustaining small-scale fisheries has delivered results through better management of fisheries, and partnerships operating at various scales, from community to regional levels. Innovations being scaled with partners include (i) inclusive co-management and governance models for small-scale fisheries, (ii) water management in multifunctional rice-dominated landscapes and (iii) policy improvements that are enabling more productive and equitable management of inland and coastal fisheries in food systems. The Illuminating Hidden Harvests (IHH) research has provided new insights into previously hidden benefits of small-scale fisheries for nutrition, livelihoods and women, and foundational work on integrating findings into national policies started with Malawi, Nigeria and Zambia in 2021.

A major push in 2021 was integrating FISH agri-food system learning and innovations into global policies. This included a landmark [UN Nutrition paper on the role of aquatic foods in healthy sustainable diets](#), which fed into new recognition of aquatic foods at the UNFSS. Climate innovations were also highlighted at COP26, which increased the overall visibility of fish and aquatic foods within food, health, water, and policies and investments.

Evidence from evaluations of FISH's overall achievements in 2021 related to SLOs 1.2, 2.3 and 3.3 indicates the following:

- A total of 462,863 households have adopted improved fish breeds and/or aquaculture or fisheries management practices.
- More than 776,306 people were assisted to exit poverty.
- More than 691,349 vulnerable women, children and men have increased fish consumption and/or dietary diversification because of aquaculture and small-scale fisheries interventions.
- A total of 350,510 ha of water was brought under improved fisheries co-management and aquaculture management.

In 2021, FISH completed a series of impact assessments, including third-party evaluations. These were done to capture the multiple outcomes and impacts of aquaculture and fisheries innovations and build a stronger evidence-based case of the critical role of fish and aquatic foods in food systems for the future. The goal is to ensure that key innovations emerging from FISH research provide the foundation for new fisheries and aquaculture investments that contribute at scale to transforming food systems.

A set of strategic synthesis briefs was prepared covering all major FISH innovations, with one widely circulated brief, "[CGIAR Research Program on FISH Agri-Food Systems: A Synthesis](#)", providing a program-wide overview.

1.2 CRP progress toward outputs and outcomes (spheres of control and influence)

1.2.1 Overall CRP progress

FISH focuses on producing benefits in developing countries in Africa, Asia and the Pacific by improving scientific and practical knowledge on sustainable aquaculture and small-scale fisheries. Positive progress was made in 2021 through delivery of priority flagship outputs, outcomes and milestones in the 2021 Plan of Work and Budget (POWB), with 11 out of 14 planned milestones¹ (79%) met, while 3 milestones were partially completed (Table 5). International public goods on fish agri-food systems in 2021 included 71 peer-reviewed publications, of which 68 were indexed by the Institute for Scientific Information (ISI), including journal articles, books and book chapters. In addition, more than 51 policy and technical briefs and knowledge products were disseminated widely, in multiple languages, and data products were made available in open access formats.

In 2021, FISH research continued to respond to the support request from our partners in countries following the COVID-19 pandemic. We continued to conduct impact assessments across FISH countries and produce knowledge and policy guidelines in various accessible forms, including a dedicated [COVID-19 portal](#), all of which recognized the important role that fish and aquatic foods play in health, nutrition and livelihoods. FISH operations continued on the ground with a strong emphasis on developing and delivering knowledge in digital formats to diverse stakeholders. Additionally, the program has continued to increasingly take a digital approach to data collection with extensive use of mobile devices and apps among other digital solutions, such as [The Right Haat](#), [block chain](#) for genetic dissemination, and [FishScores](#).

FISH reported 38 innovations during 2021, either by developing new innovations or building on previous work in all stages. These innovations range from discovery/proof of concept, to successful piloting, to ready for direct uptake, and uptake by next users. They also contribute to various fish agri-food system outcomes—from securing fish supplies via sustainable aquaculture and small-scale fisheries, through to value chain and product development for poor and vulnerable consumers. In addition to informing government policy responses to the COVID-19 pandemic, FISH research teams and partners continued to shape the policy environment for uptake of fish agri-food innovations in 2021, accelerating the emphasis on putting research into use and delivering substantive outcomes. FISH contributed to the development of at least 16 policies and investment decisions at various scales. Highlighted policy contributions include the following:

- shaping multiple investments by the Odisha government in India into sustainable fisheries and aquaculture within the state, including a major investment in women-led pond farming
- informing and supporting the development of the aquaculture and fisheries sector in Egypt, resulting in the issue of law 146/2021 on the Protection and Development of Lakes and the development of the National Strategy on Aquatic Animal Health (NSAAH) management
- integrating fish and aquatic foods within nutrition and health policies in India and Cambodia
- contributing to key national fisheries policy revisions in Bangladesh, such as the country's National Fisheries Policy (1998).

Overall, in 2021, FISH research helped directly shape policies on sustainable aquaculture, land and water management, small-scale fisheries and nutrition in Bangladesh, Egypt, India, Nigeria and Zambia.

1.2.2 Progress by flagships

1.2.2.1. Sustainable Aquaculture (FP1)

The Sustainable Aquaculture Flagship (FP1) made significant progress in delivering research outputs and outcomes in line with the multi-annual research plan toward SLOs in 2022 and the seven 2021 milestones listed in Table 5. FISH research on genetics continued with the development of the next generations of the faster-growing GIFT and Abbassa tilapia strains in Malaysia and Egypt, respectively, and the production of the first selected generation of catla carp in Bangladesh. The third selected

¹ This includes two milestones carried over from earlier years.

generation of rohu carp, only partially achieved in 2020, was completed in 2021. The first generation of silver carp in Bangladesh was successfully measured at harvest and will be used to produce selected Generation 2 in 2022. G3 of rohu carp was released to hatcheries and nurseries in preparation for release to farmers in 2022, and for performance assessment in the farming system. Each of the achievements is a key step toward producing technologies that help achieve sustainable intensification of aquaculture production that will assist in generating increased productivity, income, employment, and food and nutrition security, while decreasing environmental impact.

New knowledge was produced and made available detailing the relationships of molecular markers to feed efficiency, oxygen reduction and related exercise efficiency and to tilapia lake virus (TiLV). Major molecular markers associated with resistance to TiLV were published, and challenge tests were developed. Analysis of the relationships between these characteristics, which could be undertaken with the available data, were used to develop and assess strategies for genomic selection of these traits. This will advise their suitability for practical genetic improvement programs in the future. Incorporating these traits into genetic improvement programs will contribute to climate resilient aquaculture by having tilapia strains better adapted to stressful environments. The GIFT genome sequence was completed at high quality and submitted for publication, showing marked differences from the currently available Nile tilapia genome as a result of hybridization with other tilapia species in its formation. The availability of this genome sequence will provide a strong basis for further technology development in GIFT and provides a base platform for better understanding the gene pathways underlying the resilience performance. Laboratory analysis of the Abbassa strain was completed and will be published in 2022. The first paper on gender disaggregated information of smallholder trait preferences in India and Bangladesh was published in the journal *Aquaculture* in collaboration with the CGIAR Gender in Breeding Program. The data confirmed the relevance of traits currently selected but provided new possibilities related to fish shape that need further investigation.

Alongside partners, the FISH animal health research team focused on developing, validating and scaling data collection and diagnostic and biosecurity tools to support evidence-based decisions in 2021. Our research outputs on fish epidemiology, disease diagnostics, better management practices (BMPs) and genetic determinants of disease resistance provide a strong foundation for fish farmers, value chain actors, national authorities and researchers in Asia and Africa to reduce losses caused by disease ([FISH CRP Strategic Brief](#)).

The FISH Aquaculture System research team finished producing benchmarking data on aquaculture systems at country level in [Bangladesh](#), [Cambodia](#), [Egypt](#), [India](#) and [Nigeria](#) in 2021. This data provides a holistic view of system performance and enable comparisons across geographic, agroecological, socioeconomic and cultural contexts. It also represents a key baseline to assess current and future interventions and development of aquaculture practices. On-farm performance of genetically improved fish strains, such as GIFT in [Bangladesh](#) and [India](#) and other improved or local strains in [Kenya](#), was assessed in terms of productivity, profitability, gendered employment, food security and dietary diversity, and climate change adaptation. A paper has been published exploring the [foundation for understanding the contributions](#) of aquaculture research and innovation to improve the productivity and environmental performance of global aquaculture and also to achieve future food security. Another key achievement was the formulation of recommendations for improved dissemination of GIFT seed in [Africa](#), [Bangladesh](#) and [India](#), as well as producing key data on disseminating [genetically improved carp seed in Bangladesh](#). This work was also integrated in the CGIAR [Seed Systems Strategy](#), which traditionally has not included fish seed.

Aquaculture system researchers and partners made major progress in consistently generating aquaculture data. They developed a set of open-access digital tools and standard methods for assessing aquaculture system performance, including the life-cycle assessment tool [FishScores](#). The adoption of the digital survey tools developed by FISH research—such as [an on-farm performance digital tool](#)—by local and international stakeholders is helping to generate consolidated and comparable data on aquaculture production at both farm and system level.

1.2.2.2 Sustaining Small-Scale Fisheries (FP2)

FISH research into resilient coastal fisheries aimed to improve the efficacy, inclusivity and sustainability of fisheries, with a strong focus on inclusive governance, improving nutrition and enhancing gender equity in processes and outcomes. In 2021, the geographical focus continued to be on the coastal fisheries systems of Timor-Leste and Solomon Islands, rice-field fisheries of Cambodia and Myanmar,

the hilsa fisheries systems of Bangladesh and Myanmar, and the fish agri-food systems of the Great Lakes Region of Africa.

The emphasis on delivering gender equitable resource governance continued with the publication of an [innovative methodology to assess and respond to gender inclusivity in management](#). This added to the package of practice guides and policy briefs that FISH developed in 2021 (as well as in preceding years), such as the FISH and CARE [good practice guide](#), [policy brief](#) and [Pacific regional paper](#) to advance gender equitable livelihoods in coral reef social-ecological systems. Innovations responded to gaps in policy and shortcomings of practice that FISH research had identified, including those documented in 2021 in [World Development](#) and [Global Environmental Change](#). These are becoming the “go-to” resources for Pacific agencies, including the University of the South Pacific and the Pacific Community, which are integrating the innovation package into training, program design and delivery in the more than 20 Pacific Island nations those institutions serve.

Progress in applying digital tools in small-scale fisheries was also accelerated, with work spanning all three clusters. These included completing an impact evaluation of the Inspire Challenge-winning Automated Analytics System for Small Scale Fisheries in Timor-Leste (PeskaAS) digital tool. The tool has been taken up by the government of Timor-Leste for ongoing monitoring and management of small-scale coastal fisheries. With growing interest in information and communication technologies (ICTs), we examined the “[opportunities for inclusion, and risks of exclusion,](#)” for example, as [ICT uptake accelerates in India](#). FISH and partners developed FishNutrients, a database and predictive model of nutrient composition of over 5000 fish species. The [methods](#) and data were [launched](#) on FishBase, a CGIAR/WorldFish innovation first developed in 1988 that now receives 700,000 visits per month. FishNutrients has been since applied in further FISH analyses of the distribution of fish-derived nutrients in relation to international trade, justice and equity, and affordability.

The Cluster 1 team synthesized research and development outcomes, and future priorities, in a strategic brief called “[Increasing social and ecological resilience of coastal fisheries](#).” Three evaluations of the co-management models applied in Solomon Islands came to fruition in 2021: (1) [patterns of catch and trophic signatures that illustrate diverse management requirements of coastal fisheries](#), (2) the [hidden benefits and risks of partial protection for coral reef fisheries](#), and (3) 10 years of dynamic co-management of a multispecies reef fishery. Each analysis identifies key strengths and shortcomings of co-management models being applied across the Pacific, and uptake of these insights could improve sustainability and productivity across the hectares of reef currently managed under these regimes.

Learning on livelihood innovations as pathways out of social-ecological traps in small-scale fisheries was drawn together in the 2021 [editorial synthesis](#) of a special issue published in *Ecology and Society*. A report on the FISH (bilaterally funded) investment in [participatory planning and implementation of fish-based livelihood innovations in Timor-Leste](#) found that (i) women experienced greater availability of quality fish, (ii) women and men felt that “they had sufficient equipment and skills to continue the new livelihood activity” (novel processing and marketing), and (iii) the access to training and building capacity has been critical to the success they experienced. Also, an aggregative systematic review on [livelihood diversification as a microeconomic development strategy was finalized](#). The review found that outcomes on poverty alleviation and environmental sustainability were mixed, and it identified research and development priorities to improve outcomes.

Cluster 2 research and development outcomes were synthesized in two FISH strategic briefs: one on [integrated rice and fish systems](#), and the other about [enhancing productivity and resilience of water systems by integrating fish](#). The 2020 guidelines published with the Food and Agriculture Organization (FAO) and the CGIAR Research Program on Water, Land and Ecosystems (WLE) were integrated into investments by the Government of Cambodia and the Asian Development Bank. Building on the FISH-led, multi-CGIAR analysis and perspective from 2020, and a hosted mini-symposium in 2021, FISH prepared a report titled “[Rice-fish pathways to sustainable development impact in Cambodia and the Lower Mekong](#),” which has been taken up as influential by at least two CGIAR Initiatives. This work was paired with a multicountry, systematic compilation of “rice-fish” innovations to further guide strategic investment into research and development. To complement 2020 and earlier work on rice-fish systems that focused on ecological and production goals, a results report called “Integrating nutrition and gender into community fish refuge-rice field fishery system management” was published based on FISH field learning from the preceding 5 years. In addition, FISH research helped establish the [Inland Fisheries Alliance](#), which promotes sustainable inland fisheries and has contributed to increased awareness of inland fisheries at the UNFSS and elsewhere.

The Cluster 3 team synthesized insights and outcomes on [advancing research and development outcomes with fish in regional food systems](#). This synthesis encompassed FISH's work in the three focal regions of the Pacific, the Mekong and Ayeyarwady Deltas and the African Great Lakes. Drawing together researchers from partner organizations and all six FISH clusters enabled the development of a systematic review and resultant research agenda titled "[Nudging fisheries and aquaculture research towards food systems](#)."

The Cluster 3 focus on fish in regional food systems made substantial adjustments to account for COVID-19 as an external driver of food system change, but was also used to gather data and knowledge for the release of major policy recommendations into the UNFSS. FISH contributed to five Blue Foods assessments, through presentations and by co-hosting multiple pre-summit dialogues.

The IHH initiative completed an analysis from 58 country case studies. [The key findings were presented in a well-attended event](#) and translated into five languages. The findings were then published as [infographics](#) and in a report in three languages. The full report is scheduled for release in Q3 2022, and five peer review papers led or co-led by FISH have already been published or submitted. In 2021 and 2022, the attention of the initiative shifted to translating the IHH study into national policies, supported by policy dialogue and data. This included drawing insights from the IHH initiative (and vice versa) to briefs published in 2021 for [Malawi](#), [Zambia](#) and Nigeria to inform policy that is more sensitive to the nutrition, livelihoods and stewardship values of small-scale fisheries. With FAO, the Southern African Development Council (SADC) and the Malawi government, FISH co-hosted a special event on Africa's fish food systems as part of the SADC's Industrialisation Week. For the event, FISH provided a [discussion paper](#) and expert contributions and supported the drafting on the Lilongwe Declaration that developed.

1.2.2.3 Relevance to COVID-19 by flagship

All through 2021, FISH and its partners faced continued challenges caused by the COVID-19 pandemic. This required adjustments in operations and management, but the continuation of core lines of research was ensured. Following the 2020 monthly panel of 768 respondents from aquaculture and fisheries value chains in Bangladesh, Egypt, India, Myanmar and Nigeria, a further survey of 585 respondents was conducted in 2021 to evaluate the medium impacts of the pandemic. This research was complemented by more participatory approaches that focused on women traders in Africa who work in both aquaculture and fisheries supply chains. These insights were, in turn, complemented by ad hoc demand-led research in several countries on fisheries, aquaculture and community responses as well as methodological guidance, such as "[Ten strategies for research quality in distance research during COVID-19 and future food system shocks](#)." WorldFish established a dedicated COVID-19 portal to share content rapidly and disseminate relevant documents and material related to COVID-19. A strong emphasis in our approach to COVID-19 has been to work closely with national partners and to feed results back quickly to users. This approach has provided benefits with influential inputs to a number of national COVID-19 policies, such as recommendations on securing fish value chains in Bangladesh and the state of Odisha in India and for women working in supply chains of African nations. Through these efforts, a strong cooperation emerged with the CGIAR COVID-19 Hub. Early investment in COVID-19 research by FISH leveraged later investment in six further projects tracking the impacts of COVID-19 on aquatic food supply chains in India, Nigeria, Kenya and Egypt. This subsequent investment was supported by the CRP on Policies, Institutions and Markets (PIM), the CGIAR COVID-19 Hub and the Japan International Cooperation Agency.

In FP1, a key challenge was again maintaining the core breeding programs for tilapia and carps despite limited movement and disruptions to logistics. Therefore, adjustments were made to workplans in order to accommodate these restrictions and ensure the health and safety of staff. In Bangladesh, plans for carp breeding were mainly focused on the new rohu generation and on testing its performance in farm trials. The pandemic also affected the rollout of the field studies on fish feed ingredients, epidemiology research and system surveys. As such, workplans were adapted to the restrictions on movement, while face-to-face meetings were shifted to virtual approaches and data was collected digitally.

In FP2, field research and scaling was inhibited or halted entirely at various points as a result of COVID-19 movement restrictions. Key adjustments were made to research programs to identify points of vulnerability and resilience within fisheries and food systems exposed by COVID-19. Participatory research was conducted across 13 African nations, identifying key [policy and investment actions](#) for the 2.5 million women in Africa who depend on fish trade. The report, policy brief and videos gained the

attention of policymakers and investors and are now attracting donor interest to focus on this largely hidden but critical value chain.

1.2.3 Variance from planned program for 2021

(a) Were any promising research areas significantly expanded?

The work of FP1 proceeded broadly in line with the major themes in the FISH proposal and the 2021 POWB priorities. During the year, attention was given to completing key lines of FISH research and preparing a series of strategic briefs used to synthesize learning and prepare the foundation for future investments in research and scaling.

In FP2, the following research areas were given more focus in 2021:

- Research into the impacts and adaptation strategies associated with COVID-19 containment measures received a higher level of attention than anticipated—in terms of allocating resources in many country programs, all three regions and also at the global/synthesis level.
- Greater focus was given to Cluster 3 research, synthesis and communications (including but not limited to the outputs and activities of the Blue Food Assessment) to ensure uptake of innovations and policy influence in the UNFSS.

Investments into monitoring, evaluation and learning (MEL) were also increased across the portfolio, as well as policy outcomes and projected benefits analysis.

(b) Were any research lines dropped or significantly cut back?

For FP1, no major changes were made to the planned work in 2021, which had already focused on key priority areas.

For FP2, a continued low allocation of CGIAR funding window 1 and window 2 (W1/W2) to FP2 was partially made up by strong matching fund commitments from managing partners, bilateral funding and notably the continuation of an Oak Foundation grant that supported areas of partnership, collaborative governance, monitoring and evaluation (M&E) and translation of research. Multiple cooperative efforts, including small contributions of funding, with FAO have provided a substantial lift capacity and traction to delivering policy-oriented research and policy influence.

For both flagships, the political tensions in Myanmar meant the closure of CGIAR offices in the country, and the cessation of field-based work and policy influence.

(c) Did any flagships or research areas change directions?

FP1 continued to pursue research related to the genetic response of tilapia to TiLV and continues to lead to major discoveries related to the genetics of disease resistance.

Research on micronutrients in coastal fisheries in 2019 opened substantial new awareness and opportunities to enhance the nutritional outcomes from small-scale fisheries. These opportunities came to fruition in 2021 through delivery of data innovations, new insights on inland fisheries values for nutrition, and justice and equity goals around the distribution of nutrition. These insights have been translated into discussions, communications and innovations with the World Food Summit, with varying degrees of uptake.

The shift to online working, including the proliferation of online dialogues, conferences and webinars, provided more opportunities to share the FISH learning among some audiences, though outcomes from the virtual approach to working remain to be assessed.

1.3 Crosscutting dimensions (at CRP level)

1.3.1 Gender

(a) CRP research findings, methods or tools, capacity development, policy changes or outcomes

COUNTRY HIGHLIGHTS

- **India:** While women self-help groups have been highly touted as development “solutions”, including in aquaculture and fisheries, their challenges and limitations have often been overlooked, which risks stalling progress or even masking perverse outcomes. In response, a unique study applied FISH’s Reach-Benefit-Empower-Transform framework within a systematic literature review in order to illuminate and evidence outcomes and knowledge gaps (in publication). Another study analyzed policies on women self-help groups in fisheries and aquaculture and provided an overview of the policy landscape, framing, design and implementation for future policies. The study is expected to be published in 2022.
- **Bangladesh:** Through 20 new women business centers, the Women Business Gillnet initiative provided technical training for 100 women business entrepreneurs, who in turn provided knowledge and support to about 10,500 members of women fish producer groups. A novel [gender analysis](#) was produced to investigate the aquaculture value chain in northwestern Bangladesh.
- **Myanmar:** FISH and the WLE partnered to conduct gender studies in the Gulf of Mottama. The partnership produced an [article](#) and also guidance for the impacts of COVID-19 and political instability in the country on various groups of women and men along the [fish value chains](#).
- **Zambia:** FISH conducted a series of aquaculture training seminars by piloting business models for smallholder fish farmer projects. By increasing women’s access to training and resources, the initiative helped rural women adopt fish farming as an income-generating activity. FISH led an aquaculture technical, vocational and entrepreneurship training program for aquaculture students, six of whom were awarded USD 1000 in seed money to help them collectively set up a business.
- **Solomon Islands:** While community-based and participatory approaches to fisheries, such as community-based fisheries management, are vitally important in many ways, policies and programming often mistakenly assume that these are automatically inclusive. This overlooks patterns of intracommunity exclusions, especially of women, youths and migrants or minority groups. FISH took on this challenge. In particular, it developed [a novel and much needed framework](#) that clarifies participation from attendance and breaks “inclusion” into five measurable dimensions. This methodology complements other FISH guides relating to inclusive coastal resource management, such as a [gender-facilitation guide](#).
- **Cambodia:** As part of the Feed the Future Rice Field Fisheries II (RFF II) project, analyses from activities to empower women as leaders were carried out with results in 2021. The collective learnings were captured in “[Integrating nutrition and gender into community fish refuge-rice field fisheries system management: A practitioner’s guide](#),” contributing an important resource for the development of natural resources sectors in Cambodia.

GLOBAL GENDER

- In an article in *Nature Climate Change* (and featured in [The Conversation](#)) FISH highlighted the need to [disrupt limiting gender assumptions to move toward gender equality in climate change policy and practice](#). The article features four recommendations: (1) greater specificity in the theories of projects/policies to recognize gender equity, (2) collection and communication of gender research and sex-disaggregated data, (3) improved M&E examining processes and outcomes, and (4) further recognition and challenging of the hard-to-quantify and more intractable barriers to gender equality.
- A demand-based FISH-led partnership was set up to respond to the challenges women fish processors and traders faced from COVID-19 and its measures. This transdisciplinary gender and COVID-19 research spanned 14 countries and resulted in [10 policy recommendations](#) that Edith Lukanga (secretary of AWFishNet) shared at a ThinkTank event in November. Recommendations included applying well-designed gender-responsive social protection mechanisms and investing in collective organizations and networks. [A video in which women fish speak for themselves about their experiences and needs for governments](#) was also produced.
- Addressing the gap in measures to assess women’s empowerment in fisheries and aquaculture, FISH developed two lines of work:
 1. First, it created a bespoke [Women’s Empowerment in Fisheries Index \(WEFI\) called Pro-WEFI](#). This instrument and guidance was inspired by the Women’s Empowerment in

Agriculture Index and was adapted in three key ways: (1) to fit the fisheries and aquaculture context, (2) to include modules to assess changes in gender attitudes so that it can be used to track changes with gender-transformative approaches (GTAs) (3) expanded to include qualitative measures to include the quantitative survey. Pro-WEFI was built from earlier pilots in Zambia, Egypt and Bangladesh, and cognitive testing of this instrument was carried out in 2021 in India.

2. Second, complementing but taking a more qualitative and endogenous approach, FISH also partnered with Includovate to develop an approach to measuring empowerment, a methodology that embraces intersectionality and puts local women at the center.
- In “Gender integration in research: A guide for the CGIAR Research Program on Fish Agri-Food Systems,” FISH produced a guide that offers cutting-edge guidance, strategies and key principles for effectively integrating an intersectional gender lens in research for development, drawing on lessons from FISH since its inception.
 - FISH produced a review article on a conceptual framework for gendered aquaculture value chain analysis and development in cooperation with the Royal Tropical Institute (KIT) that embeds an explicit gender social relations approach with functional and economic value chain analysis. This complements other FISH gender value chain analyses, including one assessing market constraints in informal fish retailing in [Egypt](#) and this well-received review article with FISH’s partners at KIT.
 - FISH contributed to an article that emphasizes the importance of sex-disaggregated and gender data for a gender-inclusive COVID-19 response in aquatic food systems. The article will be published in early 2022 as a chapter in a book.
 - FISH was a champion of GTAs in CGIAR and beyond. Achievements in this area include the following:
 - FISH led a working group from CGIAR’s Generating Evidence and New Directions for Equitable Results (GENDER) Platform on GTAs and, within this, GENDER’s working paper on GTA methods (for release in 2022).
 - FISH led the chapter on GTAs for the [CGIAR-wide book](#). The chapter summarizes gender weaknesses in research for development to date and signals the need for GTAs in One CGIAR research.
 - FISH published evidence-based articles on [GTA pilots in Zambia](#), and findings from this and earlier Bangladesh GTAs informed FISH programming, including the Bill & Melinda Gates Foundation (BMGF) project.
 - Agendas were set and boundary partners were informed on GTAs. This includes contributions to the joint program (FAO, the International Fund for Agriculture Development and World Food Programme) on GTAs, as well as the UNFSS. The ideas were also scaled into coral reef systems, through the CARE-WWF Alliance’s invitation to FISH. This led to a [good practice guide](#), [policy brief](#) and [Pacific regional paper](#) about GTAs to advance gender equitable livelihoods in coral reef social-ecological systems. The guidance was shared by CARE International at a side event at COP26 and will be taken up by the Coral Reef Rescue Initiative, which could influence up to 30 million fishers relying on coral reefs.
 - Sarah Lawless received her PhD and the Glenn Almany award for her work on gender in fisheries. In 2021, her work included publications in both [World Development](#) and [Global Environmental Change](#) on policy and programming gaps and opportunities to better address gender. Meanwhile, Ruby Grantham completed research on [spatiotemporal determinants of seasonal gleaning](#). In her research, she illuminated new insights on the (what is largely) women’s fishing and how co-management might be adjusted to improve inclusion of diverse women and men in the Timor-Leste context.
 - FISH continued to progress its gender integration in its work on breeds and feeds. This includes publishing a first-of-its-kind analysis of gender-disaggregated trait preferences for rohu fish and submitting a FISH-led CGIAR collaborative journal article investigating gendered trait preferences across four commodities and nine countries. FISH has also completed a first-of-its-kind review of

gender and social risk relating to alternative fish feeds, to be released as a working paper and an article in 2022.

- Many of these findings were presented at the [CGIAR Gender Platform 2021 conference, Cultivating Equality](#).

(b) Important findings that have influenced the direction of the CRP's work and how things have changed

Findings that have influenced the CRP's work in terms of gender relate to COVID-19, the gendered impacts of the pandemic and the risk of gender-blindness and loss of rigor in research and response. FISH has responded with guidelines on maintaining gender integration and research quality, as noted above. The transdisciplinary research cooperation that was established with a pan-African women's network, the African Women Fish Traders and Processors Network, delivered a landmark assessment of the impacts of COVID-19 and contributed to gender-inclusive policy responses in aquatic food systems among women fish traders within the African region.

(c) Did any problems arise in relation to gender issues or integrating gender into the CRP's research

Gender staffing and capacity (research expertise) shortages and the continued COVID-19 pandemic continued to hinder progress in gender integration and delivery, especially where country offices and projects are entirely dependent on bilateral funding. Pro-WEFI field testing was delayed because of COVID-19 related lockdowns.

Where W1/W2 was available and applied, there were improvements in both gender integration and gender strategic research. Loss of the gender theme leader and key staff in 2021, as well as One CGIAR transition processes, also added to the stresses and strains that the gender teams faced in continuing, wrapping up and reporting.

1.3.2 Youth and other aspects of social inclusion/"leaving no one behind"²

There is unrealized potential for decent and meaningful livelihoods for youths in small-scale fisheries and aquaculture. FISH's findings on youths are especially important as youths are increasingly engaged in non-standard, informal and less secure opportunities, and as youth unemployment rises. In 2021, FISH youth research focused on synthesising results and informing policies, investments and other interventions to address the livelihood opportunities and challenges faced by youths. A synthesis brief, titled "[Youth in small-scale fisheries and aquaculture](#)," published during the year summarized the key achievements and learning on youths throughout FISH. Notable activities and achievements in 2021 include the following:

- A working group from the Committee on World Food Security High Level Panel of Experts on Food Security and Nutrition (HLPE) released a high level policy document, with inputs from the FISH youth team, titled "[Promoting youth engagement and employment in agriculture and food systems](#)."
- Youth training on aquaculture also continued to feature the generation of employment for nearly 30,000 youths and women under the Technologies for African Agriculture Transformation (TAAT) project. This was done with partners in both the project focal countries (Democratic Republic of the Congo (DRC), Ghana, Kenya, Nigeria and Zambia) and satellite countries (Burundi, Cameroon, Cote D'Ivoire, Republic of Benin and Tanzania).
- FISH continued cooperation with the International Institute of Tropical Agriculture (IITA) during the year to integrate aquaculture into the [IITA Youth Agripreneurs](#) program and African Development Bank investments into aquaculture and fish agri-food systems, including an investment in fish farming in Lake Kivu, DRC, that has created youth employment and a new supply of fish for the town of Bukavu.

² Leaving no one behind is a key facet of the SDGs: <https://unstats.un.org/sdgs/report/2016/leaving-no-one-behind>.

- New policy guidance documents on youths were prepared to influence policy and investments in Myanmar and Nigeria. The latter incorporated the documents into a [major assessment of the future of aquaculture in Nigeria](#) with the BMGF.
- Working closely with the PIM CRP, the FISH foresight team assessed opportunities for [aquaculture growth and employment in Africa](#). The research estimated that sustainable growth of aquaculture and fisheries within Africa could create as many as 20 million more full-time jobs, including for youths.

FISH also continued to engage with partners to make knowledge and experience available to target vulnerable populations. These included marginalized groups that are particularly at risk from the COVID-19 pandemic in FISH focal and scaling countries, but with particular attention paid to vulnerable populations in Bangladesh, India and Myanmar.

- In India, policy advice was extended to the government in the states of Assam and Odisha to expand carp polyculture innovations and supportive policy development, extending assistance to women self-help groups in isolated regions of the states.
- In Bangladesh, WorldFish continued to provide technical knowledge on tilapia and carp polyculture systems to the [Suchana project](#), which is funded by the European Union (EU) and the Department for International Development. The project targets stunting in children among 250,000 of the most nutritionally vulnerable households in northeastern Bangladesh.
- In Myanmar, cooperation with the EU and the United States Agency for International Development (USAID) has also introduced aquaculture and small-scale fisheries innovations into remote communities, targeting better nutrition and incomes in highly marginalized communities.
- Collaboration with USAID, FAO and others has also resulted in greater inclusion of fish and fish-based products into school feeding programs and social protection investments in Bangladesh, Cambodia and India.

No particular problems or integration was faced during the year, though concerns exist about the low priority being given to youths in the new FISH-related One CGIAR initiatives. Tracking youth-related outputs and outcomes in the FISH M&E system (noted in 2019) continued to receive attention. Engagement with country and bilateral projects for integrating youth training was also conducted during the year, with the overall aim of supporting and encouraging uptake of youth-oriented research findings into national-level policies and investments.

1.3.3 Capacity development

Capacity development remained a key pathway through which FISH delivered quality outputs, outcomes and impact during 2021. FISH capacity development targeted different users across the fish agri-food system, including researchers, national extension agencies, the private sector, civil society development partners, farmers, fishers, value chain actors and consumers.

More than 3,000 capacity development training sessions and events were recorded during the year, involving a total of 121,183 people, of whom 80,513 (66%) were women. Despite the continued constraints posed by COVID-19, an impressive number of people were engaged, mainly through FISH bilateral projects and partnerships (Table 7), some involving extensive use of virtual digital tools and formats.

Short-term training comprised 121,143 people of whom 80,492 (66%) were women. Bangladesh, Cambodia and India dominate in terms of numbers involved in short-term training, but FISH continues with wide-ranging capacity development across Africa, Asia and the Pacific. Long-term training was also provided for 40 researchers (including 26 PhDs), of whom the majority (21) were women (Table 7). A special feature on young PhD scholars is available on the [FISH website](#).

FISH continued [long-term training, support and collaboration with about 38 scholars](#), of whom 21 were women, and included 26 PhDs (Table 7). In 2021, at least eight FISH-affiliated scholars completed PhDs across aquaculture, small-scale fisheries and gender. Maria Nayfa received her PhD for her thesis, "Domestication in aquaculture fishes: Elucidating the genetic consequences in Nile tilapia

(*Oreochromis niloticus*). Sarah Lawless received her PhD and the Glenn Almany award for her work on gender and small-scale fisheries. Ruby Grantham completed research on [spatiotemporal determinants of seasonal gleanings](#). Daykin Harohau received his PhD for his work on understanding the social dimensions of small-scale tilapia aquaculture in rural Solomon Islands.

In 2021, FISH also embarked on a collaboration with 17 institutions to understand vocational training requirements. This generated a repository of reports, articles, educational posters, and presentations with over 750 documents, many of which can be used for vocational training purposes at the grassroots level. FISH worked with many of its partners to support their vocational training objectives by integrating these documents as key resources for their trainers and students. They are being made available on the FISH website and partner sites.

1.3.4 Climate change

During 2021, in cooperation with the CRP on Climate Change, Agriculture and Food Security (CAAFS) and multiple partners, FISH significantly enhanced its work on climate change. However, the focus was very much on synthesis of progress and learning, policy influence and providing a solid foundation for the future. A strategic brief summarizing [FISH climate change learning](#) was also prepared.

Notable FISH accomplishments during the year included the following:

- Knowledge was collated on [greenhouse gas \(GHG\) emissions from aquaculture](#), together with release of a [new digital tool](#) for assessing GHG emissions from aquaculture systems that can be used to inform low GHG growth and management options.
- Key priorities from a series of regional dialogues on aquatic foods held in 2020 were presented in a report launched at the [Climate Adaptation Summit](#) in January 2021.
- A new collaboration with the CCAFS-led and World Bank-funded Accelerating Impacts of CGIAR Research for Africa (AICCRA) initiative was started to extend FISH innovations in climate adaptation to Africa, with a focus on Mali and Zambia. This builds on collaborative work with the CCAFS in Bangladesh (climate information services) as well as Cambodia and Myanmar (fish-rice systems).
- A global review of climate risks in “blue foods” was published in collaboration with Stanford University as part of the [Blue Food Assessment](#). Several other joint publications and communications products were developed with the CCAFS on climate information services and [climate-smart aquatic food system innovations](#), and a number of events were hosted around [COP26](#) to raise the profile of fish and aquatic foods in climate adaptation.

2. Effectiveness and efficiency

2.1 Management and governance

No changes were made to the management and governance structures detailed in the FISH proposal. FISH's managing partners include two CGIAR centers (WorldFish and the International Water Management Institute (IWMI)) and advanced research institutes (Wageningen University & Research (WUR), James Cook University (JCU) and the Natural Resources Institute (NRI) of the University of Greenwich). Those remain and continue to evolve into active and complementary partnerships.

The FISH Management Committee (MC), which includes all managing partners, met virtually four times during the year, while regular communications were held with members on overall progress between formal meetings. A quarterly performance review, providing deep insights into the status of deliverables across all parts of the program using the MEL system, was developed during the year and helped both the MC and the research teams enhance management oversight of research performance and decision-making.

The FISH Independent Steering Committee (ISC) also met virtually during 2021. Reporting lines were well established to the WorldFish Board of Trustees for approval of the FISH POWB and its annual report, with regular progress reports to the Board provided by the ISC chair.

The management of FISH remained challenging during 2021 with all teams working under various COVID-19 restrictions, overlaid by the engagement of staff in various transition issues related to One CGIAR.

2.2 Partnerships

2.2.1 Highlights of external partnerships

In 2021, FISH was engaged in 407 active external partnerships, of which 115 were new ones established during the year. Academic and research organizations made up about 19% of the partners, but 2021 was again notable for significant growth in partnerships with the private sector (33%) and national agriculture research systems and governments (15%). This reflects greater attention to delivering innovations and outcomes with partners at scale through policy contributions, commercialization and capacity building partners.

In FP1, external partnerships with advanced research institutions have provided significant leverage of research skills in several areas, which have assisted training capability, particularly in relation to postgraduate research for all research clusters. They have also helped to develop private sector partnerships in fish health and feeds.

In FP2, partnerships with national agencies in Solomon Islands, Kiribati, Vanuatu, Bangladesh and Myanmar enabled uptake and scaling of improved and inclusive fisheries co-management solutions. In collaboration with The Pacific Community (SPC), FISH produced guides for inclusive and sustainable livelihood interventions and [a handbook for gender and socially inclusive coastal fisheries and aquaculture](#). The partnership with the SPC extended to identifying challenges and addressing climate change within the Pacific region through the CCAFS's Blue Challenge component of its Two Degree Initiative (2DI). Our work on shifting the policy and investment environment for integrating fisheries into water management investments, including water storage (e.g. reservoirs) and conveyance (e.g. irrigation), led to the launch of a joint [guide for water planners, managers and engineers](#). Through the [Inland Fisheries Alliance](#) and the [V2V Global Partnership](#), FISH also engaged with a diverse range of research and development partners to raise the profile of inland fisheries as components of sustainable global food systems and healthy aquatic ecosystems and multifunctional landscapes. The cooperation with FAO and Duke University on the IHH initiative is nearing completion, contributing to global policy and the [FAO Committee on Fisheries Virtual Dialogues](#). Partnerships are now shifting to enable national agencies to put the novel insights and recommendations into policies and action, starting in 2020 with [Zambia](#) in partnership with the Zambian government.

FISH also worked in close collaboration with FAO and a diverse partner network to contribute to the UNFSS and related high-level recommendations. WorldFish scientists worked on policy with FAO and in research progress with the Stanford Center for Ocean Solutions and the Stockholm Resilience Centre on the [Blue Food Assessment](#). The latter partnership brought FISH research and innovations, such as nutrition modeling, to a new assessment of the role of aquatic foods (a.k.a. "blue food") for planetary health and human well-being. New partnerships in gender and climate change have also helped strengthen the messaging of FISH into wider influential policy and investment audiences. Further details are provided in Table 8.

2.2.2 Cross-CGIAR partnerships

FISH outputs and outcomes benefit from synergies and active partnerships with several CGIAR centers and CRPs, including agri-food system and global integrating CRPs and platforms. These partnerships largely focus on the discovery and proof-of-concept phase. The following are highlights of new areas of CGIAR partnerships in 2021:

- FP1 developed strong partnerships on One Health and the CGIAR Antimicrobial Resistance Hub from an aquatic food systems perspective. This provided a platform for the launch of One CGIAR's One Health Initiative Development Team in Bangladesh from January 2022, and it developed strong interactions in the fish seed dissemination integrated into the CGIAR Seed Systems Strategy.
- Cooperation between FISH and the WLE crossed a range of areas of common interest between fish, aquatic foods and water systems in Myanmar. This includes gender integration in managing a Ramsar conservation area, evaluation of the potential of changing production systems for nutrition, and management tools for integrating fish within food systems and landscapes.

- The International Rice Research Institute (IRRI), IWMI and WorldFish collaborated on the 2DI to transform Asian mega-deltas into climate-resilient and nature-inclusive agricultural landscapes and to extend FISH research into rice systems from the Mekong region to Liberia and Mali with AfricaRice. The latter is a component of the new AICCRA project.

FISH also retained close cooperation in 2021 with CGIAR's GENDER platform and Big Data. The latter falls under the Inspire Challenge for [rapid genomic detection of aquaculture pathogens](#) and for [scaling digital small-scale fisheries](#) innovations. Table 9 provides further highlights of the growth in CGIAR partnerships pursued in 2021.

2.3 Intellectual assets

(a) *Intellectual asset management*: Most of the intellectual assets that FISH generated are maintained in scientific publications (journal articles, books, conference presentations, and reports), data and new technologies and innovations.

FISH research into sustainable aquaculture is generating new innovations, including breeds and health products that might be of commercial significance. In 2021, a commercial consultancy was conducted on the intellectual assets associated with the tilapia and carp genetic improvement and breeding programs and potential commercialization for the associated technologies.

(b) *Patents and/or plant variety right applications*: An application was made for a patent in 2021 for genetics and TiLV resistance. The progress will be tracked and outcomes managed in 2022, with updates provided to One CGIAR as appropriate.

(c) *Critical issues and challenges in managing intellectual assets in the context of the CRP*: Genetics research is showing strong potential for commercialization and is raising increasing questions of commercialization of innovations and assets from work on tilapia and carp genetic improvement. A company experienced in commercial development of animal genetics has provided advice to WorldFish on commercial applications and opportunities with both tilapia and carp assets.

Initial consultations have been held with the Government of Malaysia on access and benefit sharing related to tilapia genetic assets held in the country. Further follow up is needed in 2022 to provide additional guidance, including commercialization of innovations emerging from FISH research within the genomics and genetics research cluster.

2.4 Monitoring, evaluation, learning and impact assessment

The focus during 2021 was to evaluate key interventions in aquaculture and fisheries implemented through strategic bilateral investments. Interventions in aquaculture were evaluated in Myanmar, India and Timor-Leste, while those for fisheries were evaluated in Bangladesh and Cambodia. Despite the difficulties in carrying out field activities because of the COVID-19 pandemic, progress was also made on different baseline and characterization studies that were completed in Bangladesh, Cambodia, India (Odisha), Myanmar and Nigeria. These studies were done with the scope to characterize the aquaculture systems in these geographies and, in some cases, assess the interests of farmers adopting new technologies, including improved strains of tilapia. This information is crucially important to identify areas of intervention to support sustainable development of aquaculture, and it serves as a good baseline against which future evaluations will be benchmarked.

Different studies were also implemented to evaluate impacts and adoption of key FISH innovations. Among others, the effort was to evaluate PeskaAS, a FISH digital system used to collect and analyze fisheries data in near real-time, in Timor-Leste. The main finding of this impact assessment was that the adoption of the PeskaAS fisheries monitoring system by the Timor-Leste government has generated near real-time data and analytics of small-scale fisheries for the first time. In turn, this has built ownership and collaboration between government agencies, and with communities, and has brought new investment into the fisheries sector. However, PeskaAS has had minimal impact on introducing or changing specific fisheries management policies and regulations as a result of fisheries catch statistics and trajectories. This assessment has generated important lessons about adopting a system approach while designing interventions that focus on digital solutions to inform policy and decision-makers. The lesson will be applied for the evolution of PeskaAS but also elsewhere in relation to other digital tools and their adoption in relevant countries.

A number of outcome impact case reports (OICRs) were completed using W1/W2 and bilateral project resources across the two flagships and crosscutting themes (Table 10).

During 2021, the MEL platform continued to facilitate the results-based management system that FISH adopted. To support the sustainability of the platform beyond the period of the CRPs, important developments were achieved in partnership with other centers, including the International Center for Agricultural Research in the Dry Areas (ICARDA), the International Potato Center, IITA, and the Roots, Tubers and Bananas (RTB) and Grain Legumes and Dryland Cereals (GLDC) CRPs.

Regular meetings of the MC and ISC were held during the year to monitor and assess performance. Tables 10 and 11 provide details.

2.5 Efficiency

The efficiency of FISH throughout the CRP was enhanced by not setting up new management structures and systems but relying on existing ones within WorldFish. As indicated in the FISH proposal, this support includes program management services to the CRP director, MC and ISC meetings, research support, finance, communications and administrative functions. This approach continued to be adopted in 2021. Remote and online working, a consequence of the COVID-19 pandemic, also resulted in some efficiencies, such as through reduced travel costs and shifts to virtual meetings. Efficiencies were also gained in several other areas:

- placements and co-funding PhD students with multiple partners, including the JCU, NRI, WUR, Lancaster University, Charles Darwin University and the French Agricultural Research Centre for International Development
- co-funding and co-location of research staff with partners, including the WUR, JCU, the Stockholm Resilience Centre and the NRI
- leveraging significant levels of co-funding FISH research activities by partners, including coastal fisheries research (JCU and WUR), genetics and genomics (Roslin and Earlham institutes), fish nutrition (Skretting and WUR) and fish in African Great Lakes food systems (NRI)
- co-funding research facilities with partners, including the fish nutrition laboratory in Abbassa (Egypt) with Skretting and also fish health research facilities and genetic programs with national public and private partners in Malawi, Zambia and Nigeria.

The MEL platform also helped the CRP establish a results-based management system. This contributed to management efficiencies through an adaptive decision-making process based on the performance and allocation of resources to areas of the program with greater outputs and outcomes.

2.6 Managing risks to your CRP

The FISH proposal provides a framework for the MC to monitor key risks and to recommend and assess mitigation strategies. As in 2020, a managing partner (NRI) took the lead in conducting a risk assessment of FISH during each MC meeting.

Key *external* risk factors in 2021 were similar to 2020: (i) funding and uncertainty over W1/W2 and W3/bilateral funding and the associated impacts on research operations and development outcomes, (ii) instability in focal/scaling countries, and (iii) communications.

Funding risk increased as a result of the COVID-19 pandemic. Remedial action included ensuring that risks be managed by continuing to gather early intelligence on budgets and W3/bilateral funding opportunities, adjusting workplans and prioritizing and managing expectations. A regular dialogue with the CGIAR System Management Office, a regular review of expenditure and funding risks, and proactive fundraising activities were also conducted. The impact of instability in focal/scaling countries could be significant, but this risk has been mitigated to date through intelligence gathering via partners

and in-country networks.³ Communication risks were reduced in 2021 through implementation of a communications plan for the year, as well as enhanced investment in external communications.

Key *internal* risk factors in 2021 were also similar to 2020, but with risks of continuation and scaling of key research products and outcomes highlighted. Retention of key staff was recognized as a continuing risk for FISH as the CRP moves into the transition into One CGIAR. Research quality is recognized to have improved, as indicated with the positive FISH evaluation, including through targeted investments in 2021 aligned with the CGIAR Independent Science for Development Council research quality guidelines, including ethical approval processes. Risks related to COVID-19 increased uncertainty during the year. However, these have been managed at both field and office level by implementing relevant health and safety measures, changes in management practices (e.g. virtual meetings) and reorienting priorities within W1/W2 and bilateral project planning and operations.

2.7 Use of W1/W2 funding

Investments by W1/W2 continued to make significant contributions to FISH's progress, contributing about 20% of FISH's overall funding. W1/W2 was invested as principal funding into selected priority activities within the two flagships, crosscutting themes and program management, as well as program synthesis.

In the Sustainable Aquaculture FP1, W1/W2 was invested in key areas of discovery research related to tilapia genomics, assessing on-farm performance of improved carps, developing improved feeds and health management practices for farmers, and assessing impacts of improved strains. Additional investments in 2021 were made to secure the core genetically improved carp populations in Bangladesh.

In the Sustaining Small-Scale Fisheries FP2, W1/W2 was invested in strategic assessments of co-management research and evaluation, synthesis of IHH research, and multiple products to influence various policy processes, from the UNFSS to national policy development activities. Investments in various tools, such as the enhanced FishBase nutrition tool, and rice-fish decision support tools, were also made to help put research into use.

Funds continued to be invested into crosscutting themes of strategic gender research, enhancing youths, COVID-19 assessments and policy guidance, and the emerging climate change agenda. W1/W2 funds were also used to support an expanded MEL function to strengthen performance-based management and impact assessments of FISH innovations, covering both aquaculture and small-scale fisheries, in order to strengthen selection of innovations and pathways for scaling and impact.

Further details are provided in Table 12.

3. Financial summary

The 2021 financial plan provided USD 5.91 million of W1/W2 funding, which combined with a 2020 carryover provided FISH with USD 6.08 million of W1/W2 funding for the year (Table 13). The expenditure of W1/W2 funds for 2021 was USD 6.08 million (100 percent), and the W3/bilateral expenditure was USD 20.4 million. The W1/W2 funds have been fully spent. The sourcing of bilateral funds increased during 2021 beyond that predicted in the FISH proposal, with a final budget of USD 27.0 million, of which about 76% 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 CRP.

Further details are provided in Table 13.

³ The MC, at its most recent meeting on March 2–3, 2021, noted that instability in Myanmar posed a significant risk to achievement of objectives in 2021 in that one focal country.

Part B: Tables

Evidence associated with these tables is provided directly in the tables, with further links in Part C.

Table 1. Evidence on progress toward SRF targets (sphere of interest).

SLO target (2022)	Summary of new evidence of CGIAR contribution	Geographical scope
SLO1: Reduce Poverty		
<p>1.1. ADOPTION: 100 million more farm households have adopted improved varieties, breeds, trees and/or management practices</p>	<p>424,855 households have adopted best aquaculture and fisheries management practices and technologies in Bangladesh, as per the cases presented.</p> <p><i>Case 1:</i> 261,201 households have applied improved pond management practices.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> – Feed the Future Bangladesh Aquaculture and Nutrition Activity (BANA). Annual Progress Report. October 2020–September 2021. – BANA. Project Brief. October 2020–September 2021. – MELOICR520 <p><i>Case 2:</i> 3654 fishing households have adopted better fisheries practices for more sustainable fisheries.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> – Enhanced Coastal Fisheries in Bangladesh II (ECOFISH II). Annual Report. December 1, 2020–December 31, 2021. – ECOFISH II. Project Brief. December 1, 2020–December 31, 2021. – MELOICR521 <p><i>Case 3:</i> 160,000 households have adopted better aquaculture practices and technologies practices such as improved rohu and tilapia strains, fish feeding practices and stocking management.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> – Aquaculture: Increasing Income, Diversifying Diets and Empowering Women in Bangladesh and Nigeria (IDEA). Annual Report. January–December 2021. 	<p>Bangladesh</p>

	<ul style="list-style-type: none"> - IDEA. Project Brief. January–December 31, 2021. - MELOICR523 	
<p>1.1. ADOPTION: 100 million more farm households have adopted improved varieties, breeds, trees and/or management practices</p>	<p>38,008 households in Eastern India, of which 83% are women-led, have adopted various aquaculture management best practices and technologies thanks to successful alliances with state governments.</p> <p><i>Case 1:</i> 35,211 households adopted BMPs in fish farming and various aquaculture technologies supported by government funding.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> - An assessment of aquaculture and fisheries collaboration in the State of Odisha: 2016–2021. - Fisheries and Animal Resources Development (F&ARD). (Program with Department of Fisheries, Odisha). Project Brief. April 2021–March 2022. - MELOICR516 <p><i>Case 2:</i> 2797 farmers are practicing rice-fish farming, <i>beel</i> farming and carp-mola polyculture with small indigenous species (SIS).</p> <p><i>References:</i></p> <ul style="list-style-type: none"> - Assam Agribusiness and Rural Transformation Project (APART): Fisheries Sub-Component. Six Month Report 6. October 2021–March 2022. - APART. Project Brief. October 2020–September 2021. 	India
<p>1.2. EXIT POVERTY: 30 million people, of whom 50% are women, assisted to exit poverty</p>	<p>151,407 people in Eastern India assisted to exit poverty through various aquaculture interventions through the collaboration between WorldFish and the Government of Odisha.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> - An assessment of aquaculture and fisheries collaboration in the State of Odisha: 2016–2021. - F&ARD. (Program with Department of Fisheries, Odisha). Project Brief. April 2021–March 2022. - MELOICR516 	India
<p>1.2. EXIT POVERTY: 30 million people, of whom 50%</p>	<p>51,254 people in Bangladesh were assisted to exit poverty through engagement in aquaculture activities and diversified livelihoods options, as evidenced in these cases.</p>	Bangladesh

<p>are women, assisted to exit poverty</p>	<p>Case 1: 4768 people assisted to exit poverty thanks to fish sales and aquaculture entrepreneurial activities. <i>References:</i></p> <ul style="list-style-type: none"> - BANA. Annual Progress Report. October 2020–September 2021. - BANA. Project Brief. October 2020–September 2021. - MELOICR520 <p>Case 2: 46,486 people received alternative income-generating activities. <i>References:</i></p> <ul style="list-style-type: none"> - ECOFISH II. Annual Report. December 1, 2020–December 31, 2021. - ECOFISH II. Project Brief. December 1, 2020–December 31, 2021. - MELOICR521 	
<p>1.2. EXIT POVERTY: 30 million people, of whom 50% are women, assisted to exit poverty</p>	<p>365,045 people (135,067 women) in Cambodia were assisted to exit poverty thanks to improved economic benefits derived from sustainable natural resource management and/or biodiversity conservation as a result of sustainable rice-field fisheries interventions. <i>References:</i></p> <ul style="list-style-type: none"> - RFF II. Final Report: October June 2016 - September 2021. - RFF II. Project Brief. October 2020–September 2021. - MELOICR519 	<p>Cambodia</p>
<p>1.2. EXIT POVERTY: 30 million people, of whom 50% are women, assisted to exit poverty</p>	<p>208,600 people across eight countries in sub-Saharan Africa were assisted to exit poverty thanks to the creation of new jobs in aquaculture and fisheries as a result of the implementation of the TAAT–Aquaculture compact project. <i>References:</i></p> <ul style="list-style-type: none"> - TAAT. Progress Report. October–December 2021. - TAAT. Project Brief. January–December 2021. - MELOICR522 	<p>Nigeria, Kenya, Zambia, Cameroon, Benin, Ghana, Burundi, DRC</p>
<p>SLO2: Improve Food and Nutrition Security for Health</p>		

<p>2.1. YIELD INCREASE: Improve the rate of yield increase for major food staples from the current <1% to 1.2%–1.5% per year</p>	<p>N/A for FISH</p>	
<p>2.2. MINIMUM DIETARY REQUIREMENTS: 30 million more people of whom 50% are women, meeting minimum dietary energy requirements</p>	<p>N/A for FISH</p>	
<p>2.3. MICRONUTRIENT DEFICIENCIES: 150 million more people of whom 50% are women, without deficiencies in one or more essential micronutrients</p>	<p>372,981 people in Bangladesh have improved their nutrition diversity through increased fish consumption, particularly SIS, as evidenced in various cases. <i>Case 1:</i> 22,981 people improved nutrition through input provision. <i>References:</i></p> <ul style="list-style-type: none"> – ECOFISH II. Annual Report. December 1, 2020–December 31, 2021. – ECOFISH II. Project Brief. December 1, 2020–December 31, 2021. MELOICR521 <p><i>Case 2:</i> 350,000 people are consuming more fish thanks to the adoption of better aquaculture practices and technologies that have contributed to increased fish productivity and availability. <i>References:</i></p> <ul style="list-style-type: none"> – IDEA. Annual Report. January–December 2021. – IDEA. Project Brief. January–December 31, 2021. – MELOICR519 	<p>Bangladesh</p>

<p>2.3. MICRONUTRIENT DEFICIENCIES: 150 million more people of whom 50% are women, without deficiencies in one or more essential micronutrients</p>	<p>213,138 people in Cambodia are consuming more fish at home (small indigenous fish) thanks to increased fish availability and social and behavior change communication activities.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> - RFF II. Final Report: October June 2016 - September 2021. - RFF II. Project Brief. October 2020–September 2021. - MELOICR519 	<p>Cambodia</p>
<p>2.3. MICRONUTRIENT DEFICIENCIES: 150 million more people of whom 50% are women, without deficiencies in one or more essential micronutrients</p>	<p>105,230 vulnerable women, men and children increase fish consumption by 30% thanks to the engagement of women in fish farming activities and various aquaculture related interventions supported by the Government of Odisha.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> - An assessment of aquaculture and fisheries collaboration in the State of Odisha: 2016–2021. - F&ARD. (Program with Department of Fisheries, Odisha). Project Brief. April 2021–March 2022. - MELOICR516 	<p>India</p>
<p>SLO3: Improve Natural Resources and Ecosystem Services</p>		
<p>3.1. WATER AND NUTRIENT EFFICIENCY: 5% increase in water and nutrient efficiency in agroecosystems</p>	<p>270,599 MT fish were produced by ponds under BMPs for carp and tilapia seed production at hatchery level and carp-mola polyculture. The adoption of various BMPs have shown to improve the efficiency of water and inputs in Bangladesh.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> - BANA. Annual Progress Report. October 2020–September 2021. - BANA. Project Brief. October 2020–September 2021. - MELOICR520 	<p>Bangladesh</p>

<p>3.1. WATER AND NUTRIENT EFFICIENCY: 5% increase in water and nutrient efficiency in agroecosystems</p>	<p>23,068 MT fish were produced across eight countries in sub-Saharan Africa by ponds under BMPs as a result of the implementation of the TAAT–Aquaculture compact project (an average of 66% increase of fish commodity productivity). <i>References:</i></p> <ul style="list-style-type: none"> – TAAT. Progress Report. October–December 2021. – TAAT. Project Brief. January–December 2021. – MELOICR522 	<p>Nigeria, Kenya, Zambia, Cameroon, Benin, Ghana, Burundi, DRC</p>
<p>3.1. WATER AND NUTRIENT EFFICIENCY: 5% increase in water and nutrient efficiency in agroecosystems</p>	<p>19,329 MT of fish were produced in Eastern India by farmers who have adopted and are practicing BMPs and best management technologies introduced by the FISH research program. <i>References:</i></p> <ul style="list-style-type: none"> – An assessment of aquaculture and fisheries collaboration in the State of Odisha. 2016–2021. – F&ARD. (Program with Department of Fisheries, Odisha). Project Brief. April 2021–March 2022. – MELOICR516 	<p>India</p>
<p>3.2. REDUCED GREENHOUSE GAS EMISSIONS: Reduction in “agricultural”-related GHG emissions by 5%</p>	<p>270,599 MT of fish in Bangladesh were produced through the adoption of the better aquaculture management practices and technologies, which reduced GHG emissions. As evidenced by Henriksson et al. (2018), improved aquaculture practices can significantly reduce GHG emissions and increase water and nutrient use efficiency. <i>References:</i></p> <ul style="list-style-type: none"> – BANA. Progress Report. October 2020–September 2021. – BANA. Project Brief. October 2020–September 2021. – MELOICR520 	<p>Bangladesh</p>

<p>3.2. REDUCED GREENHOUSE GAS EMISSIONS: Reduction in “agricultural”-related GHG emissions by 5%</p>	<p>19,329 MT of fish in India were produced using BMPs in aquaculture, which reduced GHG emissions. As observed by Henriksson et al. (2018), BMP interventions are key for significantly reducing GHG emissions and increasing water and nutrient use efficiency from aquaculture activities.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> - An assessment of aquaculture and fisheries collaboration in the State of Odisha: 2016–2021. - F&ARD. (Program with Department of Fisheries, Odisha). Project Brief. April 2021–March 2022. - MELOICR516 	<p>India</p>
<p>3.2. REDUCED GREENHOUSE GAS EMISSIONS: Reduction in “agricultural”-related GHG emissions by 5%</p>	<p>23,068 MT of fish were produced across eight countries in sub-Saharan Africa by ponds under BMPs as a result of the TAAT–Aquaculture compact project. As evidenced by Henriksson et al. (2018), improved aquaculture practices can significantly reduce GHG emissions and increase water and nutrient use efficiency.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> - TAAT. Progress Report. October–December 2021. - TAAT. Project Brief. January–December 2021. - MELOICR522 	<p>Nigeria, Kenya, Zambia, Cameroon, Benin, Ghana, Burundi, DRC</p>
<p>3.3. ECOSYSTEM RESTORED: 55 million ha of degraded land area restored</p>	<p>344,781 ha under improved natural resource management as a result of the adoption of aquaculture BMPs and of co-management of fisheries in Bangladesh, as evidenced in two cases.</p> <p><i>Case 1:</i> 80,368 ha of pond area in Bangladesh restored as a result of the application of BMPs in aquaculture.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> - BANA. Annual Progress Report. October 2020–September 2021. - BANA. Project Brief. October 2020–September 2021. - MELOICR520 <p><i>Case 2:</i> 264,413 ha of biologically significant areas under improved natural resource management.</p> <p><i>References:</i></p> <ul style="list-style-type: none"> - ECOFISH II. Annual Report. December 1, 2020–December 31, 2021. - ECOFISH II. Project Brief. December 1, 2020–December 31, 2021. 	<p>Bangladesh</p>

	<ul style="list-style-type: none"> - MELOICR521 	
<p>3.3. ECOSYSTEM RESTORED: 55 million ha degraded land area restored</p>	<p>5729 ha of pond area under improved BMPs, such as rice-fish integrated systems and carp-mola polyculture, are documented in three cases from India. <i>Case 1:</i> 4960 ha of area under fish farming using BMPs. <i>References:</i></p> <ul style="list-style-type: none"> - An assessment of aquaculture and fisheries collaboration in the State of Odisha: 2016–2021. - F&ARD (Program with Department of Fisheries, Odisha). Project Brief. April 2021–March 2022. - MELOICR516 <p><i>Case 2:</i> 769 ha of area under improved BMPs (<i>beel</i>, rice-fish integrated systems and carp-mola polyculture) <i>References:</i></p> <ul style="list-style-type: none"> - Assam Agribusiness and Rural Transformation Project (APART): Fisheries Sub-Component. Six Month Report 6. October 2021–March 2022. - APART. Project Brief. October 2020–September 2021. 	India
<p>3.4. PREVENTION OF DEFORESTATION: 2.5 million ha of forest saved from deforestation</p>	N/A for FISH	

Table 2. Condensed list of policy contributions in this reporting year (sphere of influence).

The following table provides key FISH policy contributions during 2021.

Title of policy, legal instrument, investment or curriculum to which CGIAR contributed	Description of policy, legal instrument, investment or curriculum to which CGIAR contributed	Level of maturity: 1,2 or 3	Link to sub-IDOs	CGIAR crosscutting marker score				Link to OICR
				gender	youth	capdev	climate change	
The Nijhum Dwip Management Plan led by WorldFish now approved by the Ministry of Fisheries and Livestock (MoFL), Bangladesh MELPOL528	Approved in 2021 and currently being rolled out, the policy will help to provide a sustainable, practical and accountable framework for protecting marine biodiversity, sustaining productive fisheries and improving livelihoods	Level 2 - Policy/Law etc. Enacted	3.1.2 - Enhanced conservation of habitats and resources. 3.2.1 - More productive and equitable management of natural resources	0	0	1	0	MELOICR521

WorldFish key partner in the revision of Bangladesh's National Fisheries Policy (1998) MELPOL508	FISH experts provided critical input to the revision of the National Fisheries Policy (1998), to help accelerate the expansion of aquatic food production through sustainable aquaculture and resilient small-scale fisheries.	Level 1 - Research taken up by next user (decision maker or intermediary)	3.2.1 - More productive and equitable management of natural resources D.1.1 - Enhanced institutional capacity of partner research organizations	0	0	1	0	
The Government of Egypt issues law 146/2021 on Protection and Development of Lakes and Fisheries following FISH research findings and recommendations MELPOL469	The new law, which replaces the previous 124/1983 law, allows integrated Aquaculture-Agriculture in new lands and it has established the Lakes and Fisheries Protection and Development Agency (LFPDA).	Level 2 - Policy/Law etc. Enacted	1.3.2 - Increased livelihood opportunities 3.2.1 - More productive and equitable management of natural resources	0	0	1	1	MELOICR518
National Strategy on Aquatic Animal Health (NSAAH) Management within the Progressive Management Pathway to improve aquaculture biosecurity in Egypt MELPOL506	The NSAAH seeks to create improvements in the Egyptian aquaculture and fisheries sectors. Activities will enhance capacity to improve the health of fish and the livelihoods of fish dependent families.	Level 1- Research taken up by next user (decision maker or intermediary)	1.3.2 - Increased livelihood opportunities 1.4.2 - Closed yield gaps through improved agronomic and animal husbandry practices	0	0	1	0	MELOICR518
The Government Policy Corrigendum on Grant of Long-term lease of Gram Panchayat Tanks for <i>Pisciculture</i> promulgated in 2018 delivers significant outcomes in Odisha, India MELPOL525	The application of the policy over three years demonstrated excellent results in improving the livelihoods of over 60,000 Women Self-Help Groups and their families.	Level 3 - Evidence of impact on people and/or natural environment of the changed policy or investment	1.3.2 - Increased livelihood opportunities	2	0	1	0	MELOICR516
The genetically improved farmed tilapia (GIFT) promoted by the	The GIFT Multiplication center and hatchery at government fish farm demonstrated farmers' interest in	Level 2 - Policy/Law etc. Enacted	3.1.3 - Increased genetic diversity of agricultural	0	0	2	0	MELOICR516

Government of Odisha (India) in collaboration with Worldfish now being adopted by farmers MELPOL515	adopting GIFT. In 2021, a new scheme was prepared to expand the uptake to private sector.		and associated landscapes C.1.2 - Increased capacity of partner organizations , as evidenced by rates of investment in agricultural research					
Fish Cage Culture in Reservoirs promoted by the Government of Odisha (India) following the technical guidance of WorldFish now taken up by private sector actors MELPOL514	The policy for leasing water area in reservoirs for undertaking cage culture fisheries launched last year records an increased interest and uptake of cage fish culture in Odisha, India.	Level 2 - Policy/Law etc. Enacted	1.3.2 - Increased livelihood opportunities C.1.3 - Conducive agricultural policy environment	0	1	1	0	MELOICR516
The success of the pilot program on the inclusion of fish in supplementary nutrition in the State Nutrition Strategy promises positive nutrition scenarios in Odisha (India) MELPOL532	The feedback and acceptance received from the community on the inclusion of dried fish-based products in supplementary nutrition, confirmed the potential for its adoption and scalding to improve nutrition outcomes.	Level 2 - Policy/Law etc. Enacted	2.1.2 - Increased access to diverse nutrient-rich foods	2	1	1	0	MELOICR516
The FISH technical support to the conservation efforts of the Government of Odisha (India) contributes to the fishing ban around olive ridley turtles' nesting sites MELPOL342	WorldFish scientists assisted the Government of Odisha to prepare a status report on Olive Ridley Turtle conservation compliance measures along coastal Odisha, which was submitted to the Honourable Orissa High Court.	Level 1- Research taken up by next user (decision maker or intermediary)	3.1.2 - Enhanced conservation of habitats and resources.	0	0	0	0	

WorldFish and national partners contribute to high level policy discussions towards a more favourable environment for the dissemination of Genetically Improved Farmed Tilapia (GIFT) across India MELPOL443	WorldFish, MPEDA-RGCA, State Governments, private hatchery operators, and farmers provided positive feedback and justification for scaling tilapia in India to the Government of India resulting in favourable policy changes.	Level 2 - Policy/Law etc. Enacted	1.3.2 - Increased livelihood opportunities 1.4.3 - Enhanced genetic gain	0	0	1	0	MELOICR517
WorldFish researchers contribute to the development of the 2020-2030 strategy for the dissemination and scaling for the genetically improved farmed tilapia (GIFT) in India MELPOL513	To support the dissemination and impact at scale of genetically improved farmed tilapia (GIFT) in India, WorldFish researchers prepared and submitted a detailed national dissemination and scaling strategy.	Level 1- Research taken up by next user (decision maker or intermediary)	1.3.2 - Increased livelihood opportunities 1.4.3 - Enhanced genetic gain	0	0	1	0	MELOICR517
IWMI-WorldFish research on youth to be part of the newly released report by the United Nations Committee on World Food Security's (CFS) High-Level Panel of Experts on Food Security and Nutrition MELPOL526	Research on Youth conducted by WorldFish and IWMI was included in "Promoting youth engagement and employment in agriculture and food system" under Food Security and Nutrition (HLPE) initiative.	Level 1- Research taken up by next user (decision maker or intermediary)	C.1.3 - Conducive agricultural policy environment D.1.1 - Enhanced institutional capacity of partner research organizations	0	2	0	0	
WorldFish scientists contribute to the United Nations Nutrition Paper on the Role of Aquatic Foods in Sustainable Healthy Diets MELPOL527	The United Nations paper on aquatic food will inform the UN Food Systems Summit and national policy development dialogues.	Level 1- Research taken up by next user (decision maker or intermediary)	2.1.2 - Increased access to diverse nutrient-rich foods	0	0	1	0	

WorldFish legal agreement with private sector opens the path to investments and future growth of Genetically Improved Farmed Tilapia (GIFT) based aquaculture industry in Nigeria MELPOL531	WorldFish has signed an agreement with Premium Aquaculture Limited to transfer genetically improved farmed tilapia (GIFT) fry to Nigeria.	Level 1- Research taken up by next user (decision maker or intermediary)	1.4.3 - Enhanced genetic gain C.1.1 - Increased capacity of beneficiaries to adopt research outputs	0	0	1	0	
WorldFish facilitates the launching of Nigeria's Fish Futures to nourish a nation MELPOL529	WorldFish gathered research leaders, Nigerian government officials and key investors to launch the much anticipated book, which identifies opportunities and constraints to building the sector's capacity.	Level 1- Research taken up by next user (decision maker or intermediary)	1.3.2 - Increased livelihood opportunities	0	0	1	0	
Timor-Leste opens the second public-private-partnership genetically improved (GIFT) tilapia hatchery MELPOL533	The Ministry of Aquaculture and Fisheries continues to co-invest in the Public Private Partnership (PPP) model hatchery developed by FISH research and established in Timor-Leste to improve access to GIFT.	Level 1- Research taken up by next user (decision maker or intermediary)	1.4.3 - Enhanced genetic gain C.1.1 - Increased capacity of beneficiaries to adopt research outputs	0	0	2	0	

Table 3. List of outcome/impact case reports from this reporting year (sphere of influence).

The following table lists the OICRs generated in 2021. The report covers both new outcome/impact cases and those that have either progressed to a new level of maturity or have been updated at the same level of maturity.

Title of OICR	Link to full OICR	Maturity level: 1, 2, 3
The adoption of local ingredients in nutritious fish feed increases the productivity and profitability of the fish farm showing great potential for impact to climate mitigation, food and nutrition security	MELOICR478	Level 1
WorldFish's and partners' efforts contribute to favourable policy shifts in Egypt providing a way forward for the fisheries and aquaculture sector across the country	MELOICR518	Level 1
The technical collaboration between WorldFish and the Government of Odisha (India) reaches nutrition and income goals for over 151,407 people	MELOICR516	Level 2
The Genetically Improved Farmed Tilapia (GIFT) gains further government support opening the path to a favourable environment of scaling for impact for tilapia farmers in India	MELOICR517	Level 2
More than 261,201 fish producers in Bangladesh adopt improved pond management practices	MELOICR520	Level 2
Research and application of co-management strategies enhance biodiversity conservation while providing socioeconomic resilience for over 46,486 fishers in Bangladesh	MELOICR521	Level 2
The adoption of improved aquaculture management practices and technologies contributes to improved nutrition for over 350,000 fish and non-fish farming households in the northwest of Bangladesh	MELOICR523	Level 2
Sustainable rice-fish management in Cambodia contributes to significant improvement in nutrition and livelihoods for over 365,045 people	MELOICR519	Level 2
The adoption of improved aquaculture management practices and technologies boosts fish production generating income through employment for over 200,000 people across eight countries in sub-Saharan Africa	MELOICR522	Level 2

Table 4. Condensed list of innovations by stage for this reporting year.

The following table provides a list of FISH innovations from 2021.

Title of innovation with link	Innovation type	Stage of innovation	Geographic scope (with location)
Contextualized better management practices (BMPs) for African catfish (<i>Clarias gariepinus</i>) spawning and fingerling production in the Democratic Republic of Congo (DRC) MELINN603	Production systems and Management practices	Stage 3: available/ ready for uptake	National (Congo DRC)
Niches for women's entrepreneurship: A methods package MELINN614	Social Science	Stage 2: successful piloting	Global
Exploring women's empowerment in fisheries: A methods pack for a collaborative study on women's empowerment in small-scale fisheries MELINN621	Social Science	Stage 2: successful piloting	Global

<p>Methodological innovation for 'Illuminating Hidden Harvest' of small-scale fisheries</p> <p>MELINN819</p>	<p>Research and Communication Methodologies and Tools</p>	<p>Stage 3: available/ ready for uptake</p>	<p>Global</p>
<p>Climate Information Services for Aquaculture in Bangladesh: A Decision Framework for Managing Temperature and Rainfall Variability-Induced Risks</p> <p>MELINN827</p>	<p>Other</p>	<p>Stage 1: discovery/proof of concept</p>	<p>National (Bangladesh)</p>
<p>ComFA+Fish: Dried fish powder sachet in Zambia</p> <p>MELINN831</p>	<p>Other</p>	<p>Stage 2: successful piloting</p>	<p>National (Zambia)</p>
<p>Contextualized better management practices (BMPs) for smallholders farming tilapia in pond-based systems in Malawi</p> <p>MELINN832</p>	<p>Production systems and Management practices</p>	<p>Stage 3: available/ ready for uptake</p>	<p>National (Malawi)</p>

Better management practices for fish handling in the Egyptian market, focusing on farmed fish (Arabic) MELINN833	Production systems and Management practices	Stage 3: available/ ready for uptake	National (Egypt)
Integrating nutrition and gender into Community Fish Refuge-Rice Field Fisheries system management: A practitioner's guide for interventions in Cambodia MELINN834	Production systems and Management practices	Stage 3: available/ ready for uptake	National (Cambodia)
FishNutrients : Fish nutrient data platform tools up the fight against malnutrition MELINN835	Other	Stage 3: available/ ready for uptake	Global
Generation 18 GIFT Nile tilapia strain MELINN838	Genetic (variety and breeds)	Stage 1: discovery/proof of concept	Global
Generation 16 of the Abbassa Nile Tilapia strain	Genetic (variety and breeds)	Stage 1: discovery/proof of concept	Global

MELINN839			
<p>Generation 1 of improved strain of catla (<i>Catla catla</i>) produced in Bangladesh</p> <p>MELINN840</p>	Genetic (variety and breeds)	Stage 1: discovery/proof of concept	Global
<p>Generation 3 of improved strain of Rohu Carp (<i>Labeo rohita</i>) produced in Bangladesh</p> <p>MELINN848</p>	Genetic (variety and breeds)	Stage 3: available/ ready for uptake	Global
<p>Generation 8 of genetically improved farmed tilapia (GIFT) has been produced in India</p> <p>MELINN851</p>	Genetic (variety and breeds)	Stage 4: uptake by next user	National (India)
<p>Rapid pathogen sequencing (Rappseq): a cloud platform for identifying aquaculture bacterial pathogens from long-read DNA sequence data</p> <p>MELINN854</p>	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept	Global

<p>Model resilient fishing village: an approach of livelihood transformation of fishery communities in Bangladesh</p> <p>MELINN856</p>	<p>Production systems and Management practices</p>	<p>Stage 4: uptake by next user</p>	<p>National (Bangladesh)</p>
<p>Stimulation of natural foods production in ponds by use of low protein feeds with fibre (NSP) rich carbohydrates in Tilapia culture</p> <p>MELINN861</p>	<p>Production systems and Management practices</p>	<p>Stage 3: available/ ready for uptake</p>	<p>Global</p>
<p>Database of the nutrient composition of ingredients locally available for low-cost feed formulation in Africa and Asia</p> <p>MELINN862</p>	<p>Other</p>	<p>Stage 4: uptake by next user</p>	<p>Global</p>
<p>FishScores: Aquaculture's environmental impact calculator</p> <p>MELINN867</p>	<p>Research and Communication Methodologies and Tools</p>	<p>Stage 1: discovery/proof of concept</p>	<p>Global</p>
<p>Safe, hygienic, inclusive and gender sensitive production technology</p>	<p>Production systems and Management practices</p>	<p>Stage 4: uptake by next user</p>	<p>National (Bangladesh)</p>

<p>developed to dry small pelagic fish in Bangladesh</p> <p>MELINN868</p>			
<p>Seaweed (sea vegetable) farming in Bangladesh</p> <p>MELINN869</p>	<p>Production systems and Management practices</p>	<p>Stage 2: successful piloting</p>	<p>National (Bangladesh)</p>
<p>Composite fish powder developed in Bangladesh from three important pelagic small fish to supplement the children's diet with essential nutrients</p> <p>MELINN870</p>	<p>Other</p>	<p>Stage 1: discovery/proof of concept</p>	<p>National (Bangladesh)</p>
<p>Better management practices for tilapia hatcheries in Egypt</p> <p>MELINN871</p>	<p>Production systems and Management practices</p>	<p>Stage 3: available/ ready for uptake</p>	<p>National (Egypt)</p>
<p>Promote digital feed supply chain management system for efficient fish feed delivery in Bangladesh</p> <p>MELINN872</p>	<p>Production systems and Management practices</p>	<p>Stage 1: discovery/proof of concept</p>	<p>National (Bangladesh)</p>

<p>'Macher Gari' an innovative way to increase availability and accessibility of aquaculture inputs to farmers in Bangladesh</p> <p>MELINN873</p>	Other	Stage 2: successful piloting	National (Bangladesh)
<p>A formal financial package facilitated by Digital Financial Service (DFS) channels to improve access to credit for small aquaculture farmers and small and medium enterprises in Bangladesh.</p> <p>MELINN374</p>	Social Science	Stage 2: successful piloting	National (Bangladesh)
<p>KIU Bookkeeping App: a digital lending mechanism to promote easy access to cash flow finance</p> <p>MELINN874</p>	Other	Stage 1: discovery/proof of concept	National (Bangladesh)
<p>Cold chain: mitigating post-harvest fish losses through a modern transport system and cold chain in Bangladesh</p> <p>MELINN875</p>	Production systems and Management practices	Stage 3: available/ ready for uptake	National (Bangladesh)

<p>Last mile: unleashing women entrepreneurship in aquaculture in Bangladesh</p> <p>MELINN876</p>	Social Science	Stage 2: successful piloting	National (Bangladesh)
<p>The Right Haat: promoting a digital advisory platform for aquaculture stakeholders in Bangladesh</p> <p>MELINN877</p>	Other	Stage 1: discovery/proof of concept	National (Bangladesh)
<p>Model of a blockchain based traceability system within the a High Yield Variety (HYV) Carp roll-out in Bangladesh</p> <p>MELINN878</p>	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept	National (Bangladesh)
<p>Methodologies and training techniques defined to support the delivery of the extension to farmers for the production and management of monosex tilapia</p> <p>MELINN879</p>	Production systems and Management practices	Stage 3: available/ ready for uptake	National (Benin, Burundi, Cameroon, Cote d'Ivoire, Democratic Republic of Congo, Ghana, Kenya, Malawi, Nigeria, Tanzania, Togo and Zambia)

<p>A framework and methodology to assess inclusion in community-based natural resource management (CBNRM)</p> <p>MELINN880</p>	<p>Social Science</p>	<p>Stage 3: available/ ready for uptake</p>	<p>Global</p>
<p>Improved small-scale smoking technology for rohu fish smoking in Myanmar</p> <p>MELINN881</p>	<p>Production systems and Management practices</p>	<p>Stage 3: available/ ready for uptake</p>	<p>National (Myanmar)</p>
<p>New knowledge and practices for managing the risks of introductions and transfers of Genetically Improved Farmed Tilapia (GIFT) in different countries and territories</p> <p>MELINN882</p>	<p>Production systems and Management practices</p>	<p>Stage 3: available/ ready for uptake</p>	<p>Global</p>
<p>Genetically Improved Farmed Tilapia (GIFT) introduction in Odisha State (India)</p> <p>MELINN594</p>	<p>Production systems and Management practices</p>	<p>Stage 4: uptake by next user</p>	<p>National (India)</p>

Standard Operating Procedure (SOP) for the inclusion of dried small fish in the Supplementary Nutrition Program (SNP) in Odisha, India MELINN596	Production systems and Management practices	Stage 2: successful piloting	National (India)
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Table 5. Summary of status of planned outcomes and milestones (sphere of influence-control).

The following table provides the status of planned outcomes and milestones for 2021.

Flagship (FP)	FP outcomes 2022	Sub-IDs	Summary narrative on progress against each FP outcome in 2021	Milestone	Milestones status: complete, partially completed, cancelled or changed	Brief explanation (Evidence)	Links to evidence
FP1	Outcome 1.1: 1.5 million households have access to and are using our selectively improved, faster growing and more resilient strains of tilapia and carp seed	1.4.3: Enhanced genetic gain	FISH has extended previous genetics research to create a strong and larger platform to extend tilapia breeding programs to other geographies and this will deliver more resilient tilapia to farmers over the next decade. This has established a stronger and more responsive foundation of the tilapia genetic program upon which more secure and sustainable livelihoods for farmers in FISH focal and scaling country can be build.	New multi-year public and/or private investment programs have extended improved tilapia breeding programs to four FISH scaling countries with high potential for impact (Nigeria, Malawi, Solomon Islands, Timor-Leste, India)	Partially completed	The successful establishment of multi-year investment programs support the structuring of tilapia breeding programs in four FISH focal countries (Nigeria, Malawi, Timor-Leste, India). The delay in catalyzing investments in Solomon Islands has been a consequence of the COVID-19 pandemic.	<p>Benzie JAH, Beveridge MCM and Marwaha N. 2021. Fish breeding and genetics for improved productivity, profitability and sustainability of small-scale farms. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Program Brief: FISH-2021-20.</p> <p>Press Release: Timor-Leste's 2nd public-private-partnership tilapia hatchery opens in Lautem. WorldFish, October 6. 2021.</p> <p>Gaikwad A, Padiyar A, Datta S, Shikuku KM, Mohan CV, Trong T, Benzie J and Phillips M. 2021. Dissemination and scaling strategy for genetically improved</p>

							<p>farmed tilapia (GIFT) in India, 2020–2030. Penang, Malaysia: WorldFish. Strategy: 2021-09.</p> <p>WorldFish Blog. Boosting Malawi's aquaculture production for food security. Meriam Phiri May 18, 2021.</p> <p>Press Release: WorldFish signs agreement with Premium Aquaculture Limited to transfer GIFT to Nigeria. WorldFish, March 26, 2022.</p>
			<p>Spawning and production of the first selected generation of silver carp and catla were completed.</p> <p>Experiments on key resilience traits in GIFT were completed and genomic data obtained was included in the production of novel improved strains of global importance.</p>	<p>Production of the first selected generation of <i>Catla</i> and silver carp (in Bangladesh) and the production of genomic data on specific traits designed to increase resilience in tilapia (global)</p>	Completed	<p>Silver carp production was completed in 2020.</p> <p>Catla was delayed because of challenges related to maturity of broodstock (2019) and COVID-19 (2020), but it was completed in 2021 and is continuing in 2022.</p> <p>Genomics data on resilience in tilapia was completed.</p>	<p>Hamilton, Matthew G., 2020, "Worldfish Silver Carp Genetic Improvement Program G1 families", Harvard Dataverse, V1</p> <p>Hamilton, Matthew G.; Yeasin, Mohammed; Akhter, Md; Barman, Benoy; Roy, Aashish Kumar; Hossain, Jamal; Kamruzzaman, Md.; Rahman, Md. Mustafizur; Hossain, Md.; Kundu, Ramprosad; Shanta,</p>

							<p>Sirajum Monira; Sarkar, Uzzal Kumar, 2021, "2021 catla families produced", Harvard Dataverse, V2</p> <p>MELINN840</p> <p>Barria, A. et al. (2020). Genetic parameters for resistance to Tilapia Lake Virus (TiLV) in Nile tilapia (<i>Oreochromis niloticus</i>). <i>Aquaculture</i>, 522: 735126.</p> <p>Genetic resistance to lethal virus found in key farmed fish species</p> <p>Rodde, C. et al. (2020). Can individual feed conversion ratio at commercial size be predicted from juvenile performance in individually reared Nile tilapia <i>Oreochromis niloticus</i>. <i>Aquaculture Reports</i>, 17: 100349.</p> <p>Mengistu, S. B., Mulder, H. A., Benzie, J. A. H. et</p>
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			<p>The strategies for incorporating selected resilience traits—oxygen resilience, feed efficiency and disease resistance—(especially TiLV)—into tilapia breeding programs have been identified to maximize genetic gain within tilapia generations.</p>	<p>Strategies for the incorporation of the new resilience traits into tilapia breeding programs developed to support private sector in Africa and Asia</p>	<p>Completed</p>	<p>The strategy for incorporating the new resilience traits into tilapia breeding programs was completed.</p>	<p>Agustin Barria, Ross Houston. (24/12/2021). A report on the optimal strategy for use of genomic selection for new traits. WorldFish Report.</p>

			WorldFish G3 rohu (<i>Labeo rohita</i> or <i>ru</i>) were made available to hatcheries to be grown into breeding parents (i.e. broodstock), and now the first generation is being distributed to farmers for a first on-farm performance trial. WorldFish G3 rohu is expected to grow 30% more rapidly than river-sourced fish.	Improved rohu carp strains released to farmers in Bangladesh	Completed	Reports, datasets, journal articles and blogs document the performance and dissemination of WorldFish G3 rohu in Bangladesh in 2021.	<p>Benzie JAH, Beveridge MCM and Marwaha N. 2021. Fish breeding and genetics for improved productivity, profitability and sustainability of small-scale farms. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Program Brief: FISH-2021-20.</p> <p>MELINN848</p> <p>Hamilton, Matthew G.; Akhter, Md; Barman, Benoy Kumar; Yeasin, Mohammed; Roy, Aashish Kumar; Hossain, Jamal; Kamruzzaman, Md.; Rahman, Md. Mustafizur; Hossain, Md.; Kundu, Ramprosad; Shanta, Sirajum Monira; Sarkar, Uzzal Kumar, 2021, "2021 WorldFish Rohu Genetic Improvement Program families", Harvard Dataverse, V1</p>

							<p>AGRILINKS, December 3, 2021. Genetically Improved Rohu Carp is Now in the Hands of Bangladeshi Farmers.</p> <p>Hamilton, M. Yeasin, M. 2021. Genetically improved rohu carp is now in the hands of Bangaldeshi farmers. Fish Innovation Lab, pp. 2.</p> <p>M. G. Hamilton, W. Mekkawy, Md. Badrul Alam, John A. H. Benzie, Early selection to enhance genetic gain in a rohu (Labeo rohita) genetic improvement program, Aquaculture, 553, 2022, 738058</p>
	<p>Outcome 1.2: 2.5 million households have adopted disease detection and control strategies, cost-effective and sustainable aquafeeds and/or</p>	<p>1.4.2: Closed yield gaps through improved agronomic and animal husbandry practices</p> <p>2.4.2: Reduced livestock and fish disease risks</p>	<p>Policy actions and investments are in place to support the scaling of fish health, feed and management practices by local stakeholders in Bangladesh, Egypt, India, Timor-Leste, Myanmar and Nigeria with the effect of increasing sustainability of aquaculture management practices in Africa and Asia</p>	<p>Public sector and/or private sector policies/investment s supporting scaling of fish health, feed and management practices documented in focal and scaling countries in Africa and Asia (Bangladesh, Egypt, India, Timor-</p>	Completed	<p>Policy and outcome cases document efforts and multiple pathways to scale fish health, feed and management practices in Africa and Asia (Bangladesh, Egypt, India, Timor- Leste, Myanmar, Nigeria)</p>	<p>WorldFish key partner in revision of Bangladesh’s National Fisheries Policy (1998) MELPOL508</p> <p>MELINN691</p> <p>National Strategy on Aquatic Animal Health (NSAAH) Management within the Progressive Management Pathway to improve aquaculture</p>

	improved aquaculture management practices	associated with intensification and climate change		Leste, Myanmar, Nigeria)			<p>biosecurity in Egypt MELPOL506</p> <p>WorldFish Facilitates Transfer of GIFT Tilapia to Nigeria MELPOL531</p> <p>The technical collaboration between WorldFish and the Government of Odisha reaches nutrition and income goals for over 151,407 people. MELOICR516</p> <p>Megi Cullhaj, Andressa Gutierrez. (2021). Improving the production, nutrition and market values of small-scale aquaculture in Myanmar's Shan State and Sagaing Region (INLAND MYSAP) - Project brief (October 2019—September 2020).</p> <p>MELINN651</p> <p>Timor-Leste opens the second public-private-partnership genetically improved (GIFT) tilapia hatchery MELPOL533</p>
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	<p>Outcome 1.3: 4.8 million metric tons of annual farmed fish production with reduced environmental impact and increased resource-use efficiency (measured by 20% reduction in GHG emissions and 10% increase in water and nutrient-use efficiency)</p>	<p>1.3.4: More efficient use of inputs 3.3.3: Reduced net greenhouse gas (GHG) emissions from agriculture, forests and other forms of land use.</p>	<p>FISH research uncovers the environmental relevance related to future aquaculture improvements and development. This helps formulate recommendations and guidance to inform policy makers and decision makers on ways to promote sustainable intensification of aquaculture in the future.</p>	<p>Environmental improvement plans prepared from FISH research to be adopted by public and/or private sector partners in three countries: one in Africa (Egypt) and two in Asia (Bangladesh, Indonesia).</p> <p><u>Revised Milestone:</u> Environmental and climate change recommendations prepared by FISH research are to be adopted by the public and/or private sector.</p>	<p>Completed</p>	<p>A set of publications and guidance products has been prepared to support the integration of environmental sustainability and climate resilience into aquaculture development plans, at global and selected country levels.</p> <p>The milestone was modified to reflect this approach, intended to support wider adoption of environment and climate related aquaculture recommendations.</p>	<p>Zhang, W., Belton, B., Edwards, P., Henriksson, P.J., Little, D.C., Newton, R. and Troell, M., 2022. Aquaculture will continue to depend more on land than sea. Nature, 603(7900), pp.E2-E4.</p> <p>Henriksson, P.J.G., Troell, M., Banks, L.K., Belton, B., Beveridge, M.C.M., Klinger, D.H., Pelletier, N., Phillips, M.J. and Tran, N., 2021. Interventions for improving the productivity and environmental performance of global aquaculture for future food security. One Earth, 4(9), pp.1220-1232.</p> <p>Gephart, J.A., Henriksson, P.J., Parker, R.W., Shepon, A., Gorospe, K.D., Bergman, K., Eshel, G., Golden, C.D., Halpern, B.S., Hornborg, S. and Jonell, M., 2021. Environmental performance of blue foods. Nature, 597(7876), pp.360-365.</p>
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			<p>Policy actions and investments are in place to support the uptake of FISH aquaculture research by local stakeholders in Egypt, Zambia, Nigeria, Malawi, Kenya, India, Myanmar, Bangladesh and Timor-Leste, with the effect of reducing poverty and malnutrition among poor men, women and youths in Africa and Asia.</p>	<p>National institutions and public private sector investments strategies and policies support scaling of FISH integrated sustainable aquaculture technologies to support poor men, women and youth in 10 scaling and focal countries in Africa and Asia</p>	<p>Partially completed</p>	<p>The adoption of sustainable aquaculture technologies and management practices is documented by policy and outcome cases in Egypt, Zambia, Nigeria, Malawi, Kenya, India, Myanmar, Bangladesh and Timor-Leste.</p> <p>Work in Solomon Islands has been delayed because of logistical constraints following the COVID-19 pandemic.</p>	<p>National Strategy on Aquatic Animal Health (NSAAH) Management within the Progressive Management Pathway to improve aquaculture biosecurity in Egypt MELPOL506, MELOICR518</p> <p>More universities are adopting the upgraded fisheries and aquaculture curriculum</p>

				(Egypt, Zambia, Nigeria, Malawi, Kenya, India, Myanmar, Bangladesh, Solomon Islands, Timor-Leste)			<p>in Zambia and across borders MELPOL377</p> <p>WorldFish Facilitates Transfer of GIFT Tilapia to Nigeria MELPOL531</p> <p>The adoption improved aquaculture management practices and technologies boosts fish production generating income through employment for over 200,000 people across eight countries in sub-Saharan Africa MELOICR522</p> <p>MELINN832 MELINN862</p> <p>The Genetically Improved Farmed Tilapia (GIFT) gains further government support opening the path to a favourable environment of scaling for impact MELOICR517</p> <p>MELINN851</p> <p>The adoption of innovative aquaculture technologies and sustainable practices is</p>
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							<p>improving nutrition and livelihoods for over 1,000 poor families in Myanmar MELOICR434</p> <p>Supporting small-scale aquaculture farmers to improve nutrition and income for nearly 800 households in Myanmar's vulnerable communities MELOICR442</p> <p>More than 261,201 fish producers in Bangladesh adopt improved pond management practices MELOICR520</p> <p>The adoption improved aquaculture management practices and technologies contributes to improved nutrition for over 350,000 people in Bangladesh MELOICR523</p> <p>Timor-Leste opens the second public-private-partnership genetically improved (GIFT) tilapia hatchery MELPOL533</p>
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	<p>Outcome 1.4: 2.3 million poor men, women and youth access improved livelihood opportunities resulting from increased aquaculture production and associated value chains and enterprise development (of which 50% are women).</p>		<p>Better management practice (BMPs) for improving fish farming management have been published at global level and contextualized in multiple countries through national BMP guidelines and bilaterally funded projects. Policy actions and new investments are in place in Egypt, Nigeria, India, Myanmar and Bangladesh to guide the adoption of the improved management practices and boost environmentally sustainable aquaculture farming in Africa and Asia.</p>	<p>National institutions and public private sector investments strategies and policies support scaling of FISH integrated sustainable aquaculture technologies to improve environmental performance in 5 scaling and focal countries in Africa and Asia (Egypt, Nigeria, India, Myanmar, Bangladesh)</p>	<p>Completed</p>	<p>BMP adoption has been documented through policy and outcome cases in Egypt, Nigeria, India, Myanmar and Bangladesh.</p>	<p>Egypt: National Strategy on Aquatic Animal Health (NSAAH) Management within the Progressive Management Pathway to improve aquaculture biosecurity in Egypt MELPOL506 and MELOICR518</p> <p>The Genetically Improved Farmed Tilapia (GIFT) continues to be disseminated to more farmers across India while gaining further government support MELOICR454</p> <p>MELINN851</p> <p>The adoption of innovative aquaculture technologies and sustainable practices is improving nutrition and livelihoods for over 1,000 poor families in Myanmar MELOICR434</p> <p>Supporting small-scale aquaculture farmers to improve nutrition and</p>
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							<p>income for nearly 800 households in Myanmar's vulnerable communities MELOICR442</p> <p>More than 261,201 fish producers in Bangladesh adopt improved pond management practices MELOICR520</p> <p>The adoption improved aquaculture management practices and technologies contributes to improved nutrition for over 350,000 people in Bangladesh MELOICR523</p> <p>WorldFish Facilitates Transfer of GIFT Tilapia to Nigeria MELPOL531</p>
FP2	Outcome 2.1: 1 million fishery dependent households have reduced poverty as a result of adopting improved fisheries	1.3.1: Diversified enterprise opportunities 1.3.2.: Increased livelihood opportunities 2.1.2: Increased access to	A wide range of products was prepared to support the nutrition sensitive approach, from global to national scale. This includes national experiences in India, Solomon Islands, Cambodia and Myanmar, and global experiences collated to inform policy, investments and research	Nutrition sensitive approaches to fisheries articulated, evidenced and prepared for scaling	Completed	The ICAR webinar was to understand and manage the status of opportunities of small-scale fisheries in inland open waters and about the suite of approaches, practices and research needed to support nutrition-sensitive fisheries futures in India.	<p>Nutrition-sensitive approaches to fisheries futures of India, hosted by ICAR</p> <p>Nutrition status, and role of fish analysed and published for Solomon Islands coastal communities.</p>

	management	nutrient rich foods	<p>on the nutritional role of fish and, more in general, aquatic foods in society.</p> <p>In addition, FISH related wide-spread global fishery innovations become nutrition sensitive and integrate specific nutrition modules.</p>			<p>Key experiences reported in Solomon Islands and Malawi about the contribution small-scale fisheries to healthy and sustainable diet and food systems, and in sub-Saharan Africa on the role of inland fisheries for the diet of young children.</p> <p>A discussion paper by United Nations Nutrition focuses on the role of aquatic foods in sustainable healthy diets presenting the breadth of evidence available from national and regional case study.</p> <p>Key nutrition-sensitive fishery innovations informed by FISH research are documented.</p> <p>Key synthesis documents illustrate the nutrition-sensitive approach related to small-scale fisheries and incorporated into FISH research.</p>	<p>Simmanca FA, Kanyumba L, Cohen PJ, Njaya F, Nankwenya B, Gondwe E, Manyungwa C, Chimatiro S, Byrd K, O'Meara L et al. 2021. Sustaining and improving the contribution small-scale fisheries make to healthy and sustainable food systems in Malawi. Penang, Malaysia: WorldFish. Program Brief: 2021-27.</p> <p>O'Meara, L. Cohen, P. J. Simmanca, F. et al. (2021). Inland fisheries critical for the diet quality of young children in sub-Saharan Africa. Global Food Security, 28: 100483.</p> <p>United Nations Nutrition Paper on the Role of Aquatic Foods in Sustainable Healthy Diets</p> <p>WorldFish scientists contribute to the United Nations Nutrition Paper on the Role of Aquatic Foods in Sustainable Healthy Diets MELPOL527</p>
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			FISH research produces key recommendations and ensures that both	Achieving a status where global and regional food,	Completed	At global level an influential policy paper on the role of fish and aquatic foods in	Cohen PJ, Simmance F, Thilsted SH, Atkins M, Barman B, Bunting S,

			<p>global and regional policy actions and investments focus on the food and nutritional values of fish and aquatic foods</p>	<p>fisheries, and marine focused policies and investments are accounting for food and nutrition values of fish and aquatic foods</p>	<p>sustainable healthy diets was published by UN Nutrition, together with a review paper on fish in food systems</p> <p>At regional level, various initiatives were taken to guide policy and investment, including the Great-lake region of Africa. FISH researchers also uncovers the critical role that inland fisheries and aquatic foods play for the diet of children in sub-Saharan Africa.</p> <p>Key innovations related to SSF are supported by FISH research to adopt nutrition-sensitive approaches.</p>	<p>Byrd K, Chimatiro S, de Bruyn J, Dubois M et al. 2021. Advancing research and development outcomes with fish in regional food systems. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Program Brief: FISH-2021-18.</p> <p>United Nations Nutrition Paper on the Role of Aquatic Foods in Sustainable Healthy Diets</p> <p>O'Meara, L. Cohen, P. J. Simmance, F. et al. (2021). Inland fisheries critical for the diet quality of young children in sub-Saharan Africa. Global Food Security, 28: 100483.</p> <p>WorldFish scientists contribute to the United Nations Nutrition Paper on the Role of Aquatic Foods in Sustainable Healthy Diets MELPOL527</p> <p>Chimatiro S, Simmance FA, Wesana J, Cohen</p>
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	<p>Outcome 2.2: 1.2 million people, of which 50% are women, assisted to exit poverty through livelihood improvements</p>	<p>1.3.1: Diversified enterprise opportunities 1.3.2: Increased livelihood opportunities 2.1.2: Increased access to nutrient rich foods</p>	<p>Fisheries research has focused on investments in water management and irrigation development to share information on why fish-friendly irrigation is critical in transforming food systems to improve food security, improve nutrition and minimize the environmental impact in both Asia and Africa.</p>	<p>Achieving a status when National and regional water management, infrastructure and land-use policies accounted for SSF use, rights and access</p>	<p>Completed</p>	<p>A growing body of evidence shows that the integration of fisheries in irrigation systems can benefit both fishers and farmers, as well as the natural environment.</p> <p>To promote this integration, a practical guide was prepared by IWMI, FAO and WorldFish to support those involved in water resources planning and management.</p> <p>Promotion and advocacy to explore the potential for incorporating fisheries into</p>	<p>FAO, WorldFish and IWMI. 2020. Increasing the benefits and sustainability of irrigation through the integration of fisheries - A guide for water planners, managers and engineers. Colombo.</p> <p>World Water Week: Fish friendly irrigation: Enhancing production, livelihoods and health. A World Water Week session exploring the challenges and</p>

					<p>water management and irrigation continued with webinar sessions involving international experts reporting on key experiences in Cambodia and Myanmar and in the Mekong region.</p> <p>A key synthesis document illustrate how FISH research has contributed to the fishery and irrigation integration to support sustainability, including its social dimension (Duncan et al., 2021)</p> <p>Finally, a recent case study in Cambodia shows significant benefits for people when integrating fisheries into irrigation systems is achieved.</p>	<p>opportunities for better integrating fisheries in irrigation for improved food and nutrition security and environmental health, 24 August, 2021.</p> <p>2021 APFIC: Inland fisheries connectivity, irrigation and water management. A webinar series to explore the potential for incorporating fisheries and aquaculture into water management and irrigation.</p> <p>Duncan N, de Silva S, Conallin J, Freed S, Akester M, Baumgartner L, McCartney M, Dubois M and Sellamuttu SS. 2021. Fish for whom?: Integrating the management of social complexities into technical investments for inclusive, multi-functional irrigation. World Development Perspectives 22: 100318.</p> <p>Senaratna Sellamuttu S, McCartney M, de Silva S, Duncan N, Dubois M,</p>
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							<p>Beveridge MCM and Marwaha N. Enhancing productivity and resilience of water systems by integrating fisheries. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Program Brief: FISH-2021-08.</p> <p>Sustainable rice-fish management in Cambodia contributes to significant improvement in nutrition and livelihoods for over 365,045 people MELOICR519</p>
	<p>Outcome 2.3: 2.1 million hectares of inland aquatic and coastal marine habitat restored and under more productive and equitable management</p>	<p>3.2.1: More productive and equitable management of natural resources</p> <p>3.3.1: Increased resilience of agroecosystems and communities, especially those including smallholders</p>	<p>Significant progress made during 2021, though further investments and policy change will be required following the foundation provided by FISH</p>	<p>Investment in effective (evidence based) scaling strategies to spread innovations in focal and scaling countries and supporting nutrition-sensitive fisheries management model</p>	<p>Completed</p>	<p>Multiple activities were undertaken in 2021 to scale small-scale fisheries innovations to and with partners, providing a strong foundation for greater impact beyond FISH.</p> <p>Key studies were produced to investigate scaling approaches for key innovations such as the digital monitoring system for small-scale fisheries implemented in Timor-Leste. In addition, mechanisms to support scaling of rice-fish</p>	<p>Dam Lam R, Dos Reis Lopes J, Lozano D, Freitas Da Costa D, De Fátima Belo M, Da Silva J, Da Cruz G, Tilley A. 2022. Digital monitoring of small-scale fisheries in Timor-Leste: An impact assessment. Penang, Malaysia: WorldFish.</p> <p>Mark Dubois (Producer, Director), Bethany Smith (Producer, Director). (25/8/2021). Scaling Rice Fish Systems:</p>

					<p>systems and water management integration were also investigated to enhance technical participation and social inclusion of stakeholders.</p> <p>A systematic review of fisheries, aquaculture and aquatic food literature (2017–2019) was also conducted to determine the food systems components and interrelations with nutrition, justice, sustainability and climate change that must be considered in research and scaling.</p>	<p>Decision Support Tools (DST) for tailoring and targeting investments. Bayan Lepas, Malaysia: WorldFish (WF) (Executive Producer).</p> <p>Duncan N, de Silva S, Conallin J, Freed S, McCartney M, Akester MJ and Dubois M. 2021. Fish for whom? Integrating the management of social complexities into technical investments for inclusive, multifunctional irrigation. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Policy Brief: FISH-2021-09.</p> <p>Dubois M, Akester M, Ou P, Freed S, Leemans K, Mam K, De Silva S, Smith B, Teoh SJ, Aung HM et al. 2021. Integrated rice and fish systems. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Program Brief: FISH-2021-14.</p>
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							<p>Nicolette Duncan, Sanjiv de Silva, John Conallin, Sarah Freed, Michael Akester, Lee Baumgartner, Matthew McCartney, Mark Dubois, Sonali Senaratna Sellamuttu.</p> <p>Fish for whom: Integrating the management of social complexities into technical investments for inclusive, multi-functional irrigation. World Development Perspectives, 22, 2021, 100318</p> <p>Simmance, F. A. Cohen, P. J. Huchery, C. Sutcliffe, S. Suri, S. K. Tezzo, X. Thilsted, S. H. Oosterveer, P. McDougall, C. Ahern, M. Freed, S. Byrd, K. A. Wesana, J. Cowx, I. G. Mills, D. J. Akester, M. Chan, C. Y. Nagoli, J. Wate, J. T. & Phillips, M. J. (2022). Nudging fisheries and aquaculture research towards food systems. Fish and Fisheries, 23, 34– 53.</p>
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			<p>The evidence gathered shows the adoption of co-management models in various contexts in Asia (i.e. Bangladesh, Cambodia, Philippines and Sri Lanka) and the benefits that this can bring to fishers, people and communities.</p>	<p>Adoption of improved co-management models in focal and scaling countries at wider-scale, and policy recognition and support for complementary livelihood and governance models</p>	<p>Completed</p>	<p>A major push and progress made in 2021 to disseminated and popularise the co-management models developed during FISH, with the production of a report highlighting the diversity of co-management models in practical case studies. The report documents adoption of co-management models in a range of Asian contexts and focuses on understanding common patterns, diversity and efficacy in their applications.</p> <p>FISH policy actions documented in Bangladesh, Egypt and Cambodia. FISH research also influence global policy actions by contributing to the 2021 United Nations Nutrition Paper on the Role of Aquatic Foods in Sustainable Healthy Diets, which collates current evidence about nutritional benefits.</p> <p>Outcome cases in Bangladesh and Cambodia document the benefits of adopting co-management models for people and fishers.</p> <p>The gender responsive approach was also given</p>	<p>Cohen, P. J. Roscher, M. Wathsala Fernando, A. Freed, S. Garces, L. Jayakody, S. Khan, F. Mam, K. Nahiduzzaman, M. Ramirez, P. Ullah, M. H. van Brakel, M. Patrick Smallhorn-West, P. and DeYoung, C. 2021. Characteristics and performance of fisheries co-management in Asia - Synthesis of knowledge and case studies: Bangladesh, Cambodia, Philippines and Sri Lanka. Bangkok. FAO.</p> <p>Hilsa Fisheries Management Action Plan (HFMAP) for 2020 - 2030 now being implemented MELPOL528</p> <p>The Government of Egypt issues law 146/2021 on Protection and Development of Lakes and Fisheries following FISH research findings and recommendations MELPOL469</p> <p>Research and application of co-</p>
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						<p>special attention in the Pacific.</p>	<p>management strategies enhance the biodiversity conservation while providing socio-economic resilience for over 46,486 fishers in Bangladesh MELOICR521</p> <p>Sustainable rice-fish management in Cambodia contributes to significant improvement in nutrition and livelihoods for over 365,045 people MELOICR519</p> <p>Lau, J. and Ruano-Chamorro, C. (June 2021). Gender Equality in Coral Reef Socio-ecological Systems - Literature Review.</p>
			<p>Significant progress made during 2021, but the milestone is only partially completed awaiting analysis of data sets from the IHH country case studies. These data will enable a new level of precision in national and regional foresight research.</p>	<p>Completion of foresight analysis (accounting for environmental, demand, production trends) of small-scale fisheries performance.</p>	<p>Partially Completed</p>	<p>Partially completed as part of the cooperation with FAO and Duke University on the “Illuminating Hidden Harvest” and related initiatives. By publishing important research papers, FISH explored synergies and trade-offs between food production, food demand and the environment in different geographical areas such as Tanzania and Malawi - on a</p>	<p>De Bruyn, J. Wesana, J. Bunting, S. W. Thilsted, S. H. Cohen, P. J. Fish Acquisition and Consumption in the African Great Lakes Region through a Food Environment Lens: A Scoping Review. <i>Nutrients</i> 2021, 13, 2408. https://doi.org/10.3390/n13072408</p>

					<p>national scale, and in the Great Lakes area and in Africa - on a regional scale.</p>	<p>Wang, P. Tran, N. Enahoro, D. Chan, C. Y. Shikuku, K. M. Rich, K. M. Byrd, K. & Thilsted, S. H. (2021). Spatial and temporal patterns of consumption of animal-source foods in Tanzania. <i>Agribusiness</i>, 1– 21. https://doi.org/10.1002/agr.21729</p> <p>Chan CY, Tran N, Cheong KC, Sulser TB, Cohen PJ, Wiebe K, et al. (2021) The future of fish in Africa: Employment and investment opportunities. <i>PLoS ONE</i> 16(12): e0261615. https://doi.org/10.1371/journal.pone.0261615</p> <p>Peart J, Tran N, Chan CY, Maskaveva A, Shoko AP, Kimirei IA and Madalla NA. 2021. A review of fish supply–demand in Tanzania. Penang, Malaysia: WorldFish. Program Report: 2021-32.</p> <p>Simmance FA, Kanyumba L, Cohen PJ,</p>
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								Njaya F, Nankwenya B, Gondwe E, Manyungwa C, Chimatiro S, Byrd K, O'Meara L et al. 2021. Sustaining and improving the contribution small-scale fisheries make to healthy and sustainable food systems in Malawi. Penang, Malaysia: WorldFish. Program Brief: 2021-27.
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Table 6. Number of peer-reviewed publications from current reporting period (sphere of control).

The following table provides overall numbers of peer-reviewed publications, with a link to the full list indicated in Part C.

	Number	Percentage
Peer-reviewed publications	71	100%
Open access	57	80%
ISI	68	96%

Table 7. Direct participants in CGIAR training/knowledge sharing activities.

The following table summarizes the participants in capacity development activities during 2021, subdivided according to CGIAR performance indicators, in short- and long-term programs.

Trainees	Female	Male
In short-term programs facilitated by FISH	80,492	38,442
In long-term programs facilitated by FISH (including 16 female and 10 male researchers in PhD programs)	21	19

Table 8. Key external partnerships.

The following table lists key partnerships in 2021 for each flagship. A full list of current partners is provided as supporting evidence (Evidence F: Full list of current external partnerships).

Lead Flagship (FP) & Cluster (C)	Brief description of partnership aims	List of key partners in partnership	Main area of partnership: Research, delivery, policy, capacity development, other please specify
FP1 C1	Research is on genomics and genetics of advanced disease resistance and resilience traits in tilapias and carps.	<ul style="list-style-type: none"> a) French Agricultural Research Centre for International Development (Montpellier, France) b) Earlham Institute (Norwich, UK) c) Roslin Institute (University of Edinburgh, UK) d) Swedish University of Agricultural Sciences (Uppsala, Sweden) e) Wageningen University and Research (Wageningen, Netherlands) f) Mississippi State University, Feed the Future Innovation Lab for Fish 	Research (a, b, c, d, e, f) Capacity development (a, b, c, e)
FP1 C2	Research and delivery of epidemiological, diagnostic and management tools is intended to reduce disease risks in tilapia and carp aquaculture. During 2021, more emphasis was placed on engaging with national partners in testing and scaling tilapia and/or carp diagnostics, epidemiology and health tools and their application to decision-making.	<ul style="list-style-type: none"> a) Bangladesh Agricultural University b) Bangladesh Fisheries Research Institute c) Center of Excellence for Shrimp Molecular Biological and Biotechnology, Faculty of Science, Mahidol University (Bangkok, Thailand) d) Centre for Environment, Fisheries and Aquaculture Science (Lowestoft, UK) e) Chulalongkorn University (Bangkok, Thailand) f) Department of Fisheries (Bangladesh) g) Food and Agriculture Organization h) Khulna University (Bangladesh) i) Norwegian Veterinary Institute (Oslo, Norway) j) University of Exeter k) University of Queensland l) Wilderlab NZ Ltd (Wellington, New Zealand) m) World Organisation for Animal Health 	Research (a, b, c, d, e, h, l, j, k, l) Delivery (f) Policy (f, g, m) Capacity development (a, g, m)
FP1 C2	Research on AMR agents and One Health approaches applied to aquaculture.	<ul style="list-style-type: none"> a) Centre for Environment, Fisheries and Aquaculture Science b) Dutch Science Foundation c) Ending Pandemics (San Francisco, US) 	Research (a, f, g, h, l, j) Delivery (d) Capacity development (b, c, e, j)

		<ul style="list-style-type: none"> d) Fleming Fund (London, UK) e) Fish Inspection and Quality Control (Khulna, Bangladesh) f) Food and Agriculture Organization g) Khulna University (Bangladesh) h) Royal Veterinary College (London, UK) i) Stockholm Resilience Centre (Sweden) j) University of Exeter k) University of Waterloo (Toronto, Canada) l) World Organisation for Animal Health 	Policy (k)
FP1 C3	Research is being done for the implementation of a baseline study in Bangladesh and Nigeria.	<ul style="list-style-type: none"> a) Tokyo University (Japan) 	Research (a)
FP1 C3	Research is being done on the development of tools for life cycle assessment (LCA) and environmental and climate performance of different aquaculture systems. In 2021 there was a specific focus on India and Myanmar.	<ul style="list-style-type: none"> a) Stockholm Resilience Center (Sweden) b) Washington State University (US) 	Research (a, b)
FP2 C1	Research and scaling are being done for improvements in equitable nearshore fisheries management and capacity building, with coastal communities and agencies in Solomon Islands, Vanuatu and Kiribati (Pacific regional scaling focus via the SPC) as well as Bangladesh. FISH partnered with the Minderoo Foundation and Schmidt Family Foundation in support of digital tools for small-scale fisheries management.	<ul style="list-style-type: none"> a) Department of Fisheries (Bangladesh) b) The Pacific Community (Nouméa, New Caledonia) c) Ministry of Fisheries and Marine Resources (Solomon Islands) d) Timor-Leste Ministry of Agriculture and Fisheries (Dili, Timor-Leste) e) University of Wollongong (Australia) f) Charles Darwin University g) Minderoo Foundation and Schmidt Family Foundation h) Royal Norwegian Embassy (Jakarta, Indonesia) i) Food and Agriculture Organization 	<ul style="list-style-type: none"> Research (a, d, f) Capacity development (d, f) Delivery (a, g) Policy (a, b, c, g)

FP2 C1	Co-development is being done for a participatory MEL process, system and indicators to support the transparent implementation of the SSF Guidelines (FAO 2015) by governments, initiatives and organizations.	<ul style="list-style-type: none"> a) Food and Agriculture Organization b) International Center for Agricultural Research in the Dry Areas 	<ul style="list-style-type: none"> Research (a, b) Delivery (a, b) Policy (a, b) Capacity development (a, b)
FP2 C3	<p>Rational and healthy use of small fish is being incorporated into the feed and food systems of small-scale agriculture.</p> <p>A partnership was formed with the Stockholm Resilience Center and the Stanford Center for Ocean Solutions in a Blue Food Assessment, a component of the EAT-Lancet initiative on transforming food systems.</p>	<ul style="list-style-type: none"> a) Lancaster University b) Africa Centre of Excellence: Malawi Aquaculture and Fisheries with Lilongwe University of Agriculture and Natural Resources c) Stockholm Resilience Center and Stanford Center for Ocean Solutions d) Food and Agriculture Organization (Rome, Italy) e) FishBase f) University of Tasmania, Centre for Marine Socioecology, Australia 	<ul style="list-style-type: none"> Research (a, f) Capacity development (b, d, e) Policy (c, e)
FP1 & FP2	Research is being conducted around impacts of FISH innovations and policies, including the development and rollout of a project benefits methodology to assess future benefits of innovation packages in relation to the five One CGIAR impact areas.	<ul style="list-style-type: none"> a) University of Pisa, Department of Agriculture, Food and Environment (Italy) b) University of Ferrara, Department of Chemical, Pharmaceutical and Agricultural Sciences (Italy) 	<ul style="list-style-type: none"> Research (a, b) Policy (b)
FP1 & FP2	COVID-19 research and policy development	<ul style="list-style-type: none"> a) Multiple partners, but notably FAO and national public partners and a special collaboration with AWFISHNET on the impacts of COVID-19 on fish value chains in Sub-Saharan Africa 	<ul style="list-style-type: none"> Research (a) Policy (a)
FP1 & FP2	Vocational training	Collaboration with 17 institutions to develop packages of FISH materials to support capacity building on demand (implemented in partnership with www.thinkaqua.org).	<ul style="list-style-type: none"> Capacity development (a) Policy (a)

Table 9. Internal cross-CGIAR collaborations.

The following table provides key collaboration among CRPs, platforms and centers during 2021, where these are not already managing partners of FISH.

FP	Brief description of the collaboration	Collaborating CRPs, platforms or centers	Optional: value added, in a few words e.g. scientific or efficiency benefits
FP1	WorldFish, the International Livestock Research Institute, International Food Policy Research Institute (IFPRI) and the IWMI shared research from post-doc and collaborative initiatives on modeling AMR in water systems and assessing and reducing AMR use in aquaculture.	CGIAR Antimicrobial Resistance Hub	Collaborative research on AMR and One Health
FP1	This partnership connected FISH research through participation in CGIAR's COVID-19 working groups and research, including working groups on value chain fractures and One Health and in supporting country responses.	CGIAR COVID-19 Hub	Collaborative research on COVID-19
FP1	Collaborations included a CGIAR foresight report with all CGIAR centers, foresight research in Nigeria and development of a fish module for the IMPACT model. Several co-investments were also made in aquaculture value chains and COVID-19 research in Ghana, Nigeria and India.	PIM	Collaborative research was done to understand fish futures and development of foresight modeling tools.
FP1 & FP2	Collaboration with the CCAFS was strengthened across FISH in several areas: (i) CCAFS Flagship 4 (Climate Services and Safety Nets) on increasing access of climate information services to aquaculture farmers and fishers in Bangladesh and Odisha, India, (ii) development of a "fish" component in Mali and Zambia within the new World Bank-funded AICCRA project, and (iii) development of the 2DI, mainly through two "challenges," the first addressing climate change in Asian mega-deltas (with the IRRI and IWMI) and the second a Blue Challenge covering the Pacific, South Asia and the African Great Lakes (with IWMI and regional partners).	CCAFS	The integration of aquaculture and small-scale fisheries within climate change initiatives has been accelerated.
FP1	A food system integration story was published that captures synergies between fish and roots, tubers and bananas in food systems, focusing	RTB	Collaborative research was developed to integrate scientific approaches and policy work around food systems.

	on Nigeria and Bangladesh. The cooperation was also extended to new research in African Great Lakes region.		
FP2	A framework was developed to guide research engagement in the policy process, with application to small-scale fisheries.	IFPRI, WorldFish	An analytical framework was developed to understand the impact of research on policy processes.
FP2	A partnership with the WLE combined complementary research interests, including refinements to ecosystem-based approaches to fisheries management and associated innovations and relations between landscapes and diets in Myanmar.	WLE, particularly the flagship on Managing Resources, Risks and Competing Uses for Resilience	Joint funding was successfully pursued as were design and delivery of scientific research. The likelihood of policy influence has been increased.
FP2	Collaboration with IWMI for the establishment of the Inland Fisheries Alliance (IFA) which promotes sustainable inland fisheries and has contributed to increased awareness of inland fisheries at UNFSS and elsewhere.	WorldFish, IRRI, IWMI, Center for International Forestry Research	Interdisciplinary research and potential for policy and practice influence to increase sustainability of inland fisheries.
FP2	WorldFish and the IWMI partnered on a WLE-led project investigating gender in the highly vulnerable wetlands in transition to the Ramsar conservation areas in the Gulf of Mottama, Myanmar. WorldFish is playing the role of senior gender advisor to the project, partnering with the IWMI gender leader.	WLE, particularly the flagship on Managing Resources, Risks and Competing Uses for Resilience	Lessons were applied from FISH regarding methodologies to assess inclusion-exclusion in governance, drawing on earlier CGIAR GENNOVATE methodologies, as well as applying Aquatic Aquaculture Systems (AAS) and FISH insights regarding GTAs.
FP2	Collaborative research and co-investment was made into global synthesis research on policy impacts and COVID-19 research.	IFPRI, PIM	Scientific, policy influence, institutional strengthening.
FP1	Active participation to develop the CGIAR Seed Systems Strategy . A case study on tilapia seed system in Bangladesh was compiled in collaboration with other CGIAR colleagues.	PIM, IFPRI, ILRI, IRRI, IWMI, RTB, CIP, IITA, WLE	Coproduction of One CGIAR ToC and seed system programs - Synthesis report

MELIA	A close cooperation with other key centers and CRPs has continued since 2018 to refine and develop the MEL platform. Communication material and training tools have been jointly developed and training provided to all FISH researchers. Webinars to support the development of the 2021 POWB as well as refresher demos to augment online planning exercises via the MEL platform were collaboratively conducted by three CRPs.	ICARDA, CIP, IITA and the RTB and GLDC CRPs	Efficiency and effectiveness of FISH has increased through MEL and cross center/CRP cooperation and support for capacity development.
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Table 10. Monitoring, evaluation, learning and impact assessment (MELIA).

The following table provides the status of evaluations, impact assessments and other learning exercises planned in the POWB.

Studies/learning exercises planned for this year (from POWB 2021)	Status completed, partially completed, cancelled, changed	Type of study or activity	Description of activity / study (max 150 words)	Links to MELIA publications
Baseline study for small-scale aquaculture systems in Myanmar	Completed	Ex-ante, baseline and/or foresight study	The Fish for Livelihoods (formerly SAIL) project was funded by USAID and implemented by WorldFish in Myanmar. The study provided important insights about the current status of aquaculture in Myanmar. It helped identify areas of urgent intervention in addressing constraints to aquaculture production, and serves as a good baseline against which future evaluations will be benchmarked.	Ali, Syed Aman, 2022, " Fish for Livelihoods (F4) Baseline Database ", Harvard Dataverse Report
Baseline study for the assessment of current aquaculture systems in Rajshahi and Rangpur divisions, Bangladesh	Completed	Ex-ante, baseline and/or foresight study	This study was planned in two phases. The first was based on a participatory consultation to identify hot spots and cold spots for aquaculture production and related prevalence of different aquaculture systems in Bangladesh. The scope of this was to inform sampling for the rollout of the second phase of data gathering. The study completed the first phase but had to delay the second because of the COVID-19 pandemic. Data collection was completed in 2021 and a report and two articles are under development. The results of the study will be very helpful to characterize the aquaculture systems in Bangladesh. This will help identify areas of intervention to support sustainable development of aquaculture and will serve as a good baseline against which future evaluations will be benchmarked.	Rossignoli, Cristiano; Dam Lam, Rodolfo, 2021, " Rangpur-Bangladesh Hotspot-Coldspot Characterization Study ", Harvard Dataverse

<p>Impact assessment of hilsa co-management system on the resilience of local fishing communities affected by recurrent crises in Bangladesh: the case of ECOFISH intervention</p>	<p>Completed</p>	<p>Program/project evaluation or review</p>	<p>The study aims to measure the impact of the ECOFISH project, the objective of which was to strengthen the resilience of local fishing communities affected by recurrent crises in Bangladesh. The evaluation was based on a difference-in-difference (DiD) framework. The DiD analysis indicates that households who benefited from ECOFISH have a higher propensity to adopt positive responses than non-beneficiaries when hit by a shock. Those beneficiaries also report a statistically higher recovery rate (resilience). The analysis indicates however that the project did not manage to reduce the propensity of households to engage in detrimental coping strategies and that the long-term food and nutritional security of the beneficiaries has not yet visibly improved compared to the control group.</p>	<p>Béné, C. and Haque, M.A., 2022. Strengthening the resilience of vulnerable communities: Results from a quasi-experimental impact evaluation in coastal Bangladesh. The European Journal of Development Research, 34(2), pp.843-868.</p>
<p>Foresight modeling on aquatic foods in global food systems: Africa employment and investment opportunities</p>	<p>Completed</p>	<p>Ex-ante, baseline and/or foresight study</p>	<p>The study applied the International Model for Policy Analysis of Agriculture Commodities and Trade (IMPACT) to explore two Pan-African scenarios for fish sector growth: a business-as-usual (<i>BAU</i>) scenario and a high-growth scenario for capture fisheries and aquaculture with accompanying strong gross domestic product growth (<i>HIGH</i>). Post-model analysis was used to estimate employment and aquaculture investment requirements for the sector in Africa. Africa's fish sector is estimated to support 20.7 million jobs in 2030, and 21.6 million by 2050 under the <i>BAU</i>. Approximately 2.6 people will be employed indirectly along fisheries and aquaculture value chains for every person directly employed in the fish production stage. Under the <i>HIGH</i> scenario, total employment in Africa's fish food system will reach 58.0 million jobs, representing 2.4% of total projected population in Africa by 2050. Aquaculture production value is estimated to achieve US\$ 3.3 billion and US\$ 20.4 billion per year</p>	<p>Chan CY, Tran N, Cheong KC, Sulser TB, Cohen PJ, Wiebe K, et al. (2021) The future of fish in Africa: Employment and investment opportunities. <i>PLoS ONE</i> 16(12): e0261615.</p>

			<p>under the <i>BAU</i> and <i>HIGH</i> scenarios by 2050, respectively. Farm-gate investment costs for the three key inputs (fish feeds, farm labor, and fish seed) to achieve the aquaculture volumes projected by 2050 are estimated at US\$ 1.8 billion per year under the <i>BAU</i> and US\$ 11.6 billion per year under the <i>HIGH</i> scenario. Sustained investments are critical to sustain capture fisheries and support aquaculture growth for food system transformation towards healthier diets.</p>	
Fish foresight modeling study in Tanzania	Completed	Ex-ante, baseline and/or foresight study	<p>Two studies have been conducted:</p> <p>The first study focused on a preliminary review of the data and existing literature was done to help further develop a fish sector model for Tanzania. We highlight factors influencing fish supply and demand, and the need for further research, investment and sustainable management of aquatic food systems in the country.</p> <p>The second assessed spatial and temporal patterns of the consumption of animal-source foods (ASF) consumption in Tanzania using data from a nationally representative household survey. Results showed a 30% increase in weekly household expenditure on ASF from USD 3.02 in 2008 to USD 3.94 in 2014. The likelihood of a household purchasing ASF was 4.5 percentage points higher in urban than rural areas. With the exception of dried fish, the expenditure elasticity of ASF demand was positive and statistically significant. Expenditure and own-price elasticities were largest for chicken and lowest for dried fish.</p>	<p>Wang, P. Tran, N. Enahoro, D. Chan, C. Y. Shikuku, K. M. Rich, K. M. Byrd, K. & Thilsted, S. H. (2021). Spatial and temporal patterns of consumption of animal-source foods in Tanzania. <i>Agribusiness</i>, 1– 21.</p> <p>Peart J, Tran N, Chan CY, Maskaeva A, Shoko AP, Kimirei IA and Madalla NA. 2021. A review of fish supply–demand in Tanzania. Penang, Malaysia: WorldFish. Program Report: 2021-32.</p>

Assessing the impacts of GIFT on livelihoods, nutrition and food security, and gender empowerment	Cancelled	Program/project adoption or impact assessment	Data collection was delayed because of the COVID-19 pandemic.	
Project evaluation: Improving the Production, Nutrition and Market Values of Small-Scale Aquaculture in Myanmar's Shan State and Sagaing Region (INLAND MYSAP)	Completed	Program/project adoption or impact assessment	INLAND MYSAP supports the sustainable intensification of the small-scale freshwater aquaculture sector, improving the availability and access to nutritious, affordable food and increasing incomes for poor and vulnerable households in four fish-deficient townships in Shan State and Sagaing Region. The assessment assessed the progress of the project, and it highlights the impacts of improved small-scale freshwater aquaculture practices on poverty reduction and nutrition and food security in the area of implementation.	Nway, Hsu Myat, 2022, " MYSAP Inland baseline survey ", Harvard Dataverse
Socio-economic and nutritional impact of carp-mola polyculture in Odisha	Completed	Correlates of adoption /impact study	This study was included in the report "Baseline study for the assessment of current aquaculture systems in Odisha, India" Dataset collected and report produced. A specific paper is under elaboration.	Dam Lam, Rodolfo, 2021, " Baseline study for the assessment of current aquaculture systems in India - 2021 Odisha impact assessment ", Harvard Dataverse Rodolfo Dam Lam, Denise Lozano, Neetha Shenoy, Cristiano Rossignoli, Vishnumurthy Mohan Chadag, Arun Panemangalore. (25/10/2021). An assessment of Aquaculture and Fisheries Collaboration in the State of Odisha, 2016-2021.

Ex-ante impact evaluation of genetically improved rohu carp in Bangladesh	Cancelled	Ex-ante, baseline and/or foresight study	Data collection was delayed because of the covid-19 pandemic.	
Baseline study for the assessment of current aquaculture systems in Cambodia	Completed	Ex-ante, baseline and/or foresight study	<p>This is the first comprehensive survey of Cambodia's aquaculture value chain. The study combines qualitative (46 key informant interviews) and quantitative surveys (1204 farmers and 191 other aquaculture value chain actors) to investigate the potential for aquaculture in Cambodia to grow, support livelihoods and contribute to food security.</p> <p>We found the following:</p> <ul style="list-style-type: none"> • The fish farm sector in Cambodia is comprised mainly of small family farms raising carnivorous fish species or pangasius, using direct inputs of “trash fish” harvested from the wild. • Most fish seed and pelleted feed is imported, and domestic producers of these inputs struggle to compete. • Fish farmed in Cambodia are mostly sold live, and farm fish are more expensive than the main species harvested from inland capture fisheries and struggle to compete with imported farmed fish. • Capture fisheries employ many times more people than aquaculture. • Space for aquaculture is limited because few locations have both perennial access to water and protection from flooding. 	<p>Joffre, O.M., Freed, S., Bernhardt, J., Teoh, S.J., Sambath, S. and Belton, B., 2021. Assessing the Potential for Sustainable Aquaculture Development in Cambodia. <i>Frontiers in Sustainable Food Systems</i>, p.379.</p>

			These findings raise questions about the potential of Cambodia's aquaculture sector, as currently organized, to contribute significantly to employment, food and nutrition security, and rural economic development.	
Baseline study for the assessment of current aquaculture systems in Odisha, India	Completed	Program/project adoption or impact assessment	<p>The collaboration between F&ARD and WorldFish has contributed to an extensive dissemination of better aquaculture management practices, improved feed and feeding practices and has increased the access to quality fish fingerlings in Odisha. This study has two aims. First, characterize aquaculture systems in India, which will help identify areas of intervention to support sustainable development of aquaculture and will serve as a good baseline against which future evaluations will be benchmarked. Second, evaluate the intervention implemented by WorldFish since 2018. These interventions have contributed to higher fish productivity and poverty alleviation and have strengthened the overall household resilience to external shocks. On average, beneficiaries doubled their fish production compared to control groups and increased their income from aquaculture activities by up to 48%.</p> <p>Three articles and a report are under development and will be published in 2022</p>	<p>Henriksson JG, Patrik; Chandra D, Pratap; Chadag, Vishnumurthy Mohan, 2022, "Closing the 'performance gap' of India's aquaculture sector", Harvard Dataverse</p> <p>Dam Lam, Rodolfo, 2021, "Baseline study for the assessment of current aquaculture systems in India - 2021 Odisha impact assessment", Harvard Dataverse</p> <p>Rodolfo Dam Lam, Denise Lozano, Neetha Shenoy, Cristiano Rossignoli, Vishnumurthy Mohan Chadag, Arun Panemangalore, (2021). An assessment of Aquaculture and Fisheries Collaboration in the State of Odisha, 2016-2021.</p>

Baseline study for the assessment of current aquaculture systems in Nigeria	Completed	Ex-ante, baseline and/or foresight study	This study was planned with the scope to characterize aquaculture systems in Nigeria and assess the interests of farmers in tilapia. This will help identify areas of intervention to support sustainable development of tilapia aquaculture and will serve as a good baseline against which future evaluations will be benchmarked.	Shikuku, Kelvin; Lozano, Denise, 2021, " A baseline characterization of aquaculture systems and livelihoods in Delta and Ogun states, Nigeria ", Harvard Dataverse
Impact assessment of co-management systems on productivity, nutrition and food security, and environment	Changed - Completed	Synthesis (secondary study)	<p>The objective of this synthesis was to determine, from current evidence and experiences from the region, a view of co-management application and performance. The priority objective was to understand the diversity of co-management as it is implemented and applied in practice, and to understand if common themes, in terms of strengths or challenges, emerged.</p> <p>Ultimately this improved understanding of how co-management could guide fisheries management agencies working in Asia toward enabling better social, ecological and environmental outcomes from co-management and from fisheries systems. The findings of the study can be used to formulate recommendations to improve policies, programs, projects and management practices.</p>	Cohen, P. J. Roscher, M. Wathsala Fernando, A. Freed, S. Garces, L. Jayakody, S. Khan, F. Mam, K. Nahiduzzaman, M. Ramirez, P. Ullah, M. H. van Brakel, M. Patrick Smallhorn-West, P. and DeYoung, C. 2021. Characteristics and performance of fisheries co-management in Asia - Synthesis of knowledge and case studies: Bangladesh, Cambodia, Philippines and Sri Lanka . Bangkok. FAO.
Project evaluation: Feed the Future Cambodia Rice Field Fisheries Phase II	Completed	Program/project adoption or impact assessment	The project had the goal to increase the productivity and the sustainability of the rice field fishery system. Interventions and public awareness took place in one hundred forty community fish refuges (CFR) around the Tonle Sap Lake and among the communities living nearby those CFR. To evaluate the impact of the actions undertaken, biological surveys were conducted and households living nearby were	Freed, Sarah; Sean, Vichet; Ou, Phichong, 2021, " Feed the Future Cambodia - Rice field fisheries Phase 2 project database ", Harvard Dataverse

			interviewed on a regularly base about their livelihood. A report will be published in 2022.	
Baseline study – livelihood, food security and nutrition baseline in Timor-Leste	Completed	Program/project evaluation or review	This study documents the process, outcomes and lessons identified from a 4-year coastal livelihoods enhancement project in Timor-Leste using a participatory approach with two groups of people (40 participants in total) from two rural coastal communities. We find that there are opportunities to harness the economic and nutritional value of coastal aquatic foods in Timor-Leste. People in coastal communities are willing and interested to test out their ideas for enhancing their fish-based and coastal livelihoods. However, ideas can be limited to those in neighboring communities, and people may not be accustomed to working collectively. Facilitating access to training and building capacity to bridge the rural-urban divide are important components of making such initiatives a success.	Hunnam K, Duarte A, de Sousa A, Barreto CC, Tilley A, Dos Reis Lopes J, Pereira M, Ride A and Eriksson H. 2021. Participatory planning and implementation of fish-based livelihood innovations in Timor-Leste . Penang, Malaysia: WorldFish. Program Report: 2021-21.
Socioeconomic and environmental impact of PeskaAS: National fisheries monitoring system of Timor-Leste	Completed	Program/project adoption or impact assessment	Digital tools and technologies are transforming the way we monitor and manage food systems and natural resources, but to date there is scant credible collection and analysis of evidence of their impacts on well-being, environmental sustainability, and broader goods and services. The development of ICTs has a crucial role to play in the timely provision of information to guide management and investment decisions by small-scale fisheries stakeholders, from coastal fishers to government officials. The implementation of PeskaAS in Timor-Leste is one such attempt. We sought to co-design and roll out a system to collect and analyze fisheries data in near real-time with the aim to (i) strengthen sustainable fisheries resource management in Timor-Leste, (ii) promote improved collaboration and communication between fisheries	Dam Lam R, Dos Reis Lopes J, Lozano D, Freitas Da Costa D, De Fátima Belo M, Da Silva J, Da Cruz G, Tilley A. 2022. Digital monitoring of small-scale fisheries in Timor-Leste: An impact assessment . Penang, Malaysia: WorldFish.

			<p>stakeholders, and (iii) identify new opportunities to enhance fish-based livelihoods and food systems transformation in Timor-Leste. This study aimed to assess the progress made toward these goals since 2016, through different pathways since the establishment and iterative development of PeskAAS. Using targeted interviews, we undertook a survey of respondents in key stakeholder groups: fishers, community enumerators, the private sector, nongovernmental organizations (NGOs), external agencies, municipal fisheries officers and national government.</p>	
<p>The impact of sustainable aquaculture technologies on the welfare of small-scale fish farming households in Myanmar</p>	<p>Completed</p>	<p>Program/project adoption or impact assessment</p>	<p>This study analyzed the determinants and potential impacts of the adoption of sustainable aquaculture technologies on the welfare of small-scale aquaculture households in Myanmar using an endogenous switching regression model. Welfare is measured by fish productivity and fish income per cycle and the Household Dietary Diversity Score. Our analysis revealed that distance to the sale-point, membership in farmers organizations, awareness of pond maintenance benefits, access to information through private extension services, and location were the main drivers behind adopting sustainable aquaculture technologies. Results showed that adopting these technologies increases welfare outcomes of small-scale aquaculture households; however, the non-adopters stand to benefit the most in terms of an increase in welfare outcomes if they adopt the technologies. Our research findings suggest that policies targeted at raising the income and dietary diversity of small-scale aquaculture households can be realized through interventions to raise farmers' awareness, adoption and technical know-how about the sustainable aquaculture technologies.</p>	<p>Aung, Y.M., Khor, L.Y., Tran, N., Akester, M. and Zeller, M., 2021. The impact of sustainable aquaculture technologies on the welfare of small-scale fish farming households in Myanmar. Aquaculture Economics & Management, pp.1-30.</p>

<p>Impacts of COVID-19 and options to build resilience and recovery in fish value chains in Myanmar</p>	<p>Completed</p>	<p>Synthesis (secondary study)</p>	<p>This report focuses on assessing the impacts of COVID-19 and options to build resilience and recovery in fish value chains in Myanmar. A mixed-methods approach, comprising a quantitative survey and qualitative interviews and in-depth discussions, was used to implement the study.</p> <p>The overall findings are as follows:</p> <p>Impacts of COVID-19 on fish value chains were more severe in 2021 than 2020 because of the prolonged pandemic and stricter measures implemented to contain the spread of the virus as well as the political instability in Myanmar since the beginning of 2021. Sales of farmed fish dropped significantly in 2021 from 2020. Most notably, the total cost bought by the surveyed farms outweighed the total sales earned in March 2021. The quantity of processed fish sold was significantly higher in 2021 than 2020. Diverse fish products, especially high value fish species, were traded with higher prices in 2020 than 2021. Surveyed respondents have adopted different coping mechanisms to build recovery and resilience during this ongoing crisis. Among the most common practices are borrowing, using savings and buying inputs on credit.</p>	<p>Hoong Y, Tran N, Akester MJ, Khin MS, Belton B, Shamwela S, Naw L, Noot S, Myint KT, Oo KM et al. 2021. Impacts of COVID-19 and options to build resilience and recovery in fish value chains in Myanmar. Penang, Malaysia: WorldFish. Program Report: 2021-31.</p>
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Table 11. Update on actions taken in response to relevant evaluations.

The following table provides an update (since 2019 reporting) on the response of FISH to recommendations made from the Independent Evaluation Arrangement of previous CRPs (AAS and the Livestock and Fish CRP), the [2020 independent review of the FISH CRP](#) and other relevant crosscutting evaluations.

Name of the evaluation	Rec. #	Text of recommendation	Status of response to this rec.	Concrete actions taken for this recommendation	By whom	When	Comments
FISH Independent Review	4.1.1	<p><u>Quality of science</u></p> <p>1. Attempts to unify and reduce reporting efforts should continue.</p> <p>2. The interaction of small- and large-scale fisheries should be given slightly more consideration in the future.</p> <p>3. Slightly more emphasis on reproduction has the potential to enhance quality of science and effectiveness in both aquaculture and small-scale fisheries as outlined in this review.</p>	Completed	<p>For Recommendation 1, the use of the MEL system was reinforced further in order to enhance the overall efficiency of reporting.</p> <p>For Recommendation 2, the interactions between small- and large-scale fisheries are being included in the synthesis products of FP2 produced in 2021. Substantive research on this topic will need to be integrated within the new One CGIAR research portfolio.</p> <p>For Recommendation 3, reproduction of tilapia and carp were a key element of the research in 2021. This is a key aspect of research that will have to be integrated in the new One CGIAR research portfolio.</p>	<p>R1. Director and MEL team</p> <p>R2. FP2 Flagship leader</p> <p>R3. FP1 Flagship leader</p>	By end of 2021	Recommendations also to be considered in the development of the new One CGIAR portfolio
	4.1.2	<p><u>Effectiveness</u></p> <p>1. More funding needs to be devoted to research on impact assessment.</p> <p>2. The value of various traits differs among countries. To increase impact, different lines will likely need to be developed for different countries.</p>	Completed	<p>For Recommendation 1, additional W1/W2 investments were made into impact assessment research in 2021. In addition, bilateral projects have been encouraged to invest sufficient budget into impact assessment research. Cooperation with CGIAR's Standing Panel on Impact Assessment and other strategic partners, such as the University of Tokyo, have been reinforced to look to</p>	<p>R1. Director and MEL team</p> <p>R2. FP1 Flagship leader</p> <p>R3. FP1 Flagship leader</p>	By end of 2021	Recommendations also to be considered in the development of the new One CGIAR portfolio

		<p>3. The development of genetically enhanced tilapia is at a critical juncture. To make a quantum leap forward, either multiple trait selection or the simultaneous use of multiple genetic enhancement programs is needed.</p> <p>4. The poor are not always in a position to adopt some of the most effective new technologies. Increased involvement of medium and large private businesses may help with technology transfer to the poor and may open employment for the poor. This would shift the paradigm toward more exporting of foods and fish and less importing, improving the nutrition and quality of life of the poor.</p> <p>5. An increased number of manuals and grey outputs should be produced in the native tongue of the target countries.</p>		<p>enlarge the scope of the impact assessments in aquaculture and fisheries.</p> <p>For Recommendation 2, a response is being incorporated into a working paper on the future of CGIAR fish genetics being prepared during 2021.</p> <p>For Recommendation 3, a response is also being included in the working paper referred to above, for consideration in the new One CGIAR portfolio 2022–2030.</p> <p>For Recommendation 4, impact assessment research will be used after the conclusion of the CRP to further explore this recommendation and recommended actions for the new One CGIAR portfolio 2022–2030.</p> <p>For Recommendation 5, the CRP in 2021 focused on producing more manuals and grey outputs in local languages.</p>	<p>R4. FP1 Flagship leader and impact assessment lead</p> <p>R5. Director, FP1 and FP2 flagship and bilateral project leaders</p>		
	4.1.3	<p><u>Future orientation</u></p> <p>1. Shortcomings in resources and inputs were overcome by partnering and leveraging with high-quality scientists from universities, research institutions, NGOs and other CRPs, creating a large web or network. The legacy, reputation and vast network of WorldFish have allowed it to</p>	Completed	<p>For Recommendation 1, FISH used this strategy of partnership and leveraging in 2021, and has supported the new One CGIAR portfolio 2022–2030.</p> <p>For Recommendation 2, FISH's partnership strategy continued in 2021 as per the recommendation.</p>	<p>R1. Director and MEL team</p> <p>R2. FP1 flagship leader</p> <p>R3. FP1 flagship leader</p> <p>R4. FP1 flagship leader and impact</p>	By end of 2021	Recommendations also to be considered in the development of the new One CGIAR portfolio

	<p>leverage the investment in FISH into a high-quality and effective CRP, and this strategy should continue.</p> <p>2. Partners stated that WorldFish’s reputation and network have allowed them to obtain significant bilateral funding and partnerships with universities, research institutions, the private sector and governments that bring resources and funds into the CRP; thus “the spider has spun an enormous, highly effective, and high-quality web.” Respondents describe the strategy as “to work with the best”—an approach and result recognized and highly admired by all partners interviewed, including all managing partners, several private companies, end users, and country partners. This should continue.</p> <p>3. Harnessing Global Fisheries to Tackle Micronutrient Deficiencies was extremely impactful research. Perhaps small-scale fisheries, aquaculture systems, and genetics should diversify even more in the future and gravitate more toward increasing micronutrients and protein, not just protein. This paper focuses upon marine fish, and it would be</p>		<p>For Recommendation 3, work was initiated in 2020 and continued in 2021 on a micronutrient model for inland fisheries.</p> <p>For Recommendation 4, mechanisms for enhancing internal communications were explored in 2021 – a weekly team meeting was established to enhance communication among research leaders.</p> <p>For Recommendation 5, the priorities highlighted have been integrated into the 2021 POWB. In addition, these recommendations are being brought to the attention of teams involved in preparation of the new One CGIAR research portfolio 2022–2030.</p>	<p>assessment lead</p> <p>R5. Director, FP1 and FP2 flagship and bilateral project leaders</p>		
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		<p>impactful to repeat this analysis with freshwater fish.</p> <p>4. Although this CRP is high quality and effective, small improvements in communication would be beneficial for improving the remaining life of FISH. Perhaps a small number of team-building exercises could be considered to improve communication, trust, empathy, and respect between administration and research, which would likely impact quality and effectiveness.</p> <p>5. Most of the flagships, clusters and crosscutting themes are highly impactful and should be continued in One CGIAR to derive full benefit from the strong foundation that has been laid. Genetics, feed stuffs, diseases (the most important problem in aquaculture), nutritious ponds, micronutrients, small-scale fisheries in general, rice refuges, policy enhancement, small community self-management as a continuum, and gender stand out in particular. More impact assessment research should be instituted. Youths and climate change are difficult topics, and increased collaboration with other centers in One CGIAR may be beneficial.</p>				
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	4.2	<p><u>CGIAR System Level Recommendations</u></p> <p>1. The quality of science and effectiveness would benefit in the future if delays in funding and early termination of CRPs could be avoided.</p> <p>2. The main objectives of the unfunded FP3 (enhancing the contribution of fish for the nutrition and health of the poor) were integrated into FP1 and FP2. This has been one of the most successful and impactful areas of research and should receive increased support in the future.</p> <p>3. The FISH CRP, which had a relatively small budget, has done an excellent job of leveraging resources (USD 4 per every dollar invested), and increased support would likely result in a good return on investment.</p> <p>4. More funding needs to be devoted to research on impact assessment.</p> <p>5. More funding needs to be devoted to the highly impactful work on small-scale fisheries.</p>	Completed	<p>For Recommendation 1, action was required at the One CGIAR system level. The CRPs were terminated at the end of 2021.</p> <p>For Recommendation 2, a line of research on fish and nutrition should be incorporated into the new portfolio development. In 2021 FISH continued to gather evidence of nutrition-related outcomes –see milestones- and raise the profile of fish and aquatic foods for achieving One CGIAR’s nutrition goals in the new portfolio 2022–2030</p> <p>For Recommendation 4, additional W1/W2 funds have been included in 2021 POWB, but this recommendation requires further uptake by One CGIAR in planning the new portfolio 2022–2030.</p> <p>For Recommendation 5, the 2021 FISH priorities were used to leverage investments in small-scale fisheries in the future.</p>	<p>R1. One CGIAR</p> <p>R2. Impact assessment research lead One CGIAR</p> <p>R3. One CGIAR, MEL teams</p> <p>R4. FP1 flagship leader and impact assessment lead</p> <p>R5. Director, FP2 flagship and MEL lead</p>	By end of 2021	Recommendations also to be considered in the development of the new One CGIAR portfolio
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AAS	R2	Strengthening research capacity: AAS management should rethink its approach to staffing and the allocation of human resources.	Completed	<p>High quality in the recruiting process in FISH was assured in order to guarantee the program with the right mix of human resources needed to develop science capacity across the program.</p> <p>Additional recruitments were made in 2019, 2020 and 2021 to strengthen research capabilities in FP1 and FP2.</p> <p>Cross-CRP and partnership development was also used to strengthen research capacity within FISH.</p>	MC, CRP director, flagship/crosscutting leadership	End of 2021	This process was completed with the closure of the CRP. Research capacity and quality will continue to be strengthened in the new One CGIAR research program.
	R4	Increase alignment of AAS activities: The decision to associate bilateral projects with the AAS should be based primarily on their potential to further the AAS research agenda.	Completed	<p>All new bilateral projects are discussed and designed to further strengthen the FISH research agenda.</p> <p>By doing this, FISH pursues the greatest efficiency and effectiveness of its research by strengthening the synergies of research funded by W1/W2.</p> <p>A formal alignment process is applied for W3/bilateral projects, which is undergoing further refinement with the development of the MEL system. The process has been assessed through the performance management standards.</p>	MC, CRP director, flagship/crosscutting leadership	End of 2021	
	R9	Management information: A functional research management information system should be established.	Completed	The adoption of the MEL system was formally approved by the MC in June 2018 and has been progressively introduced into FISH.	M&E lead, program/project leads	End of 2021	

	R10	CGIAR should justify further investment in aquatic agricultural systems more on the grounds of comparative advantage, and to do this the focus needs to be much more on fish.	Completed	<p>FISH brings together and mutually integrates CGIAR's existing competences around fish—aquaculture and small-scale fisheries—and the generation of new knowledge and methodological innovations.</p> <p>A food systems agenda has been strengthened through cooperation with the Agriculture for Nutrition and Health CRP under certain FISH research clusters (FP2, C3).</p>	MC, CRP director, flagship/crosscutting leadership	End of 2021	
Livestock	R2	Increase synergies between livestock and aquaculture.	Completed	The collaboration with the Livestock CRP continues to develop. Recently, it has focused around AMR and some interaction with the CRP in relation to research on health and feeds.	Flagship/cluster leads within FP1	End of 2021	It will continue in the new One CGIAR research programs.
	R5	Establish an M&E system based on the theory of change.	Completed	<p>The MEL system is now in place to serve both performance monitoring and outcome evaluation on the basis of the theory of change, impact pathways and outcome targets.</p> <p>A set of theories of change at the focal country level were further improved in 2019 to strengthen the capacity of the MEL system and to capture the results and performance in a more relevant, efficient and effective way. These were used and revised in 2020 and 2021.</p>	CRP director, FISH M&E lead, FISH MEL community of practice	By mid-2019	The learning from the experience will benefit the development of the new One CGIAR research program.

	R6	Build private sector partnerships for technology delivery.	Completed	Since its design, FISH has looked to identify potential private partners with shared objectives in order to find win-win solutions both for research and commercial interests. There was a significant increase in private sector partnerships in 2020 and 2021.	Flagship/cluster leads within FP1	End of 2021	
Gender in CGIAR Research and Workplace— Evaluation Report— CGIAR Gender in Research (Vol I)	R5	CRPs should refresh and refocus their gender strategies and/or future workplans as relevant to ensure alignment with priorities on Gender in the CGIAR Research Policy.	Completed	The FISH gender strategy was completed in 2018, and various supporting actions were introduced to integrate gender into FISH research and workplace activities. Ongoing activities strengthen gender integration.	CRP director, FISH gender lead	FISH gender strategy published in July 2018	The learning from the experience will benefit the development of the new One CGIAR research program.

Table 12. Examples of W1/W2 use in this reporting period (2021).

Specific examples	Broad area of use of W1/W2
<p>FP1, Cluster 1.1 Genetics and genomics research in GIFT and carps: W1/W2 funds contributed partial funding to the following:</p> <ul style="list-style-type: none"> (i) production of next generations of GIFT strains (Malaysia), Abbassa strain (Egypt) and tilapia genomics and genetic architecture research (ii) tilapia gamete cryopreservation research (iii) GIFT genetic mapping (iv) rohu carp selection and feed-related research (v) commercialization strategies for GIFT and carps (vi) early growth assessments of rohu carp (vii) tilapia resilient traits analysis and paper writing, including TiLV (viii) mola genetic data analysis (ix) research into trait preferences in Bangladesh and India 	<ul style="list-style-type: none"> ● Genetics and genomics research ● New tilapia and carp strains ● Investments in key research partners ● Aquatic genetic resources policy development ● User preference research
<p>FP1, Cluster 1.2 Tilapia disease: W1/W2 funds contributed partial funding to the following:</p> <ul style="list-style-type: none"> (i) TiLV diagnostics, management and biosecurity in tilapia core genetic programs, hatcheries and farms (ii) tilapia epidemiology and health economics research in Bangladesh, Egypt and Zambia (iii) development of rapid genomic methods for disease detection (iv) lab-in-a-backpack prototype design for small-scale farmer diagnostics 	<ul style="list-style-type: none"> ● Field diagnostic tools for fish diseases ● Biosecurity policy and practice development ● Epidemiology and economic assessment tools
<p>FP1, Cluster 1.2 Sustainable fish feed ingredients: W1/W2 funds contributed partial funding to the following:</p> <ul style="list-style-type: none"> (i) research into novel fish feed ingredients (ii) development and testing of tools for fish feed formulation using low-cost ingredients (iii) nutritious pond research and support for proof of concept and scaling of the concept (iv) energy and feed management analysis of Bangladesh carp systems (v) BMP guidelines and other extension products in support of scaling feed and health management measures 	<ul style="list-style-type: none"> ● Research partnerships ● Novel feeds research ● Nutritious pond scaling ● Digital tools for feed formulation

<p>FP1, Cluster 1.3 Aquaculture systems: W1/W2 funds contributed partial funding to the following:</p> <ul style="list-style-type: none"> (i) report on integrated aquaculture system performance assessment in FISH focal and scaling countries (ii) GIFT performance assessment in India and Timor-Leste (iii) research on inclusive business models (iv) digital solutions and tools for aquaculture performance assessment (v) development of seed dissemination models (vi) a simplified LCA estimator produced and connected to the electronic farm-data surveys tool (on-farm performance) 	<ul style="list-style-type: none"> ● Performance assessment of genetically improved tilapia and carps ● Baselines characterizing aquaculture systems ● Research on scaling and innovation systems ● Development of digital tools for performance assessment
<p>FP2, Cluster 2.1 Resilient coastal fisheries: W1/W2 funds contributed partial funding to the following:</p> <ul style="list-style-type: none"> (i) JCU partnership for assessment of inclusive co-management and gender-related research (ii) tools and methods for co-management application (iii) gender integration in co-management (iv) livelihood alternatives in coastal fisheries (v) digital tools for small-scale fisheries management (PeskaAS) (vi) assessment and synthesis of coastal fisheries innovations 	<ul style="list-style-type: none"> ● Co-management model assessments ● Gender integration in small-scale fisheries management and governance ● Integration of climate resilience into coastal fisheries management
<p>FP2, Cluster 2.2 Fish in multifunctional landscapes: W1/W2 funds contributed partial funding to the following:</p> <ul style="list-style-type: none"> (i) policy research and scaling of rice-fish systems and multifunctional landscapes in Myanmar (ii) innovations for enhancing fisheries outcomes in rice-based landscapes, farming systems and water management in Cambodia and Myanmar (iii) youths, fisheries and aquaculture in Myanmar and Nigeria (iv) rice-fish assessments in Cambodia (v) gender integration in fisheries and aquaculture innovations in multifunctional landscapes (vi) rice-fish systems decision support tool (vii) targeted awareness raising campaign implemented at different scales—international, regional and national (Southeast Asia focus)—to promote water and fisheries guidelines 	<ul style="list-style-type: none"> ● Putting research and innovations into practice in rice-based landscapes and farming systems ● Policy influence related to fish friendly irrigation and water management ● Youths and small-scale fisheries ● Decision-support tool for rice-fish system interventions
<p>FP2, Cluster 2.3 Fish in food systems: W1/W2 funds contributed partial funding to the following:</p> <ul style="list-style-type: none"> (i) IHH research synthesis with FAO and Duke University 	<ul style="list-style-type: none"> ● Small-scale fisheries in food systems and policy influence ● COVID-19 research on African fish traders

<p>(ii) partner funds and capacity development/co-funding of PhD researchers in the African Great Lakes region and development of policy guidance</p> <p>(iii) food system assessments and contributions to UNFSS</p> <p>(iv) COVID-19 impacts, responses and lessons in African fish trading networks</p>	<ul style="list-style-type: none"> ● UN Food Systems Summit synthesis
<p>Gender: W1/W2 funds contributed funding to the following:</p> <p>(i) strategic gender research, including development and testing of a GTA and WEFI</p> <p>(ii) capacity building and coaching initiatives for gender integration within FISH</p>	<ul style="list-style-type: none"> ● Gender research and integration into FISH ● Research and policy partnerships
<p>Youth: W1/W2 funds contributed funding to the following:</p> <p>(i) synthesis of youth research</p> <p>(ii) youth policy guidelines in Myanmar and Nigeria</p>	<ul style="list-style-type: none"> ● Youth research and preparation of policy guidance
<p>Capacity development: W1/W2 funds contributed funding to the following:</p> <p>(i) young scientists research</p> <p>(ii) special collaboration with vocational training institutes to put FISH research into vocational training</p>	<ul style="list-style-type: none"> ● Capacity development supported to put research into use ● Relevant indicators captured
<p>Monitoring and evaluation: W1/W2 funds contributed funding to the following:⁴</p> <p>(i) M&E activities across FISH, including partial funding of selected outcome/impact assessments</p> <p>(ii) continued strengthening of the MEL platform</p>	<ul style="list-style-type: none"> ● Impact assessments ● MEL platform development
<p>Program management: W1/W2 funds contributed funding to the following:</p> <p>(i) investments in core program management activities, including partial funding of key Project Management Unit (PMU) leaders and management staff, operations and learning meetings, including MC and ISC meetings</p>	<ul style="list-style-type: none"> ● Governance and management of FISH

⁴ Tables 2, 3, 5 and 10 provide further information on the activities implemented.

Table 13. CRP financial report.

The following table provides the status of FISH W1/W2 financials for 2021 (all figures in USD).

	2021 expenditure (W1/2)	2021 budget (W1/2)	Comments on major changes
Personnel	2,617,975	2,198,418	
Consultancy	652,318	194,083	
Travel	18,250	24,424	
Operational expenses	1,576,155	2,554,094	
Collaborators and partnerships	954,092	889,108	
Capital and equipment	0	0	
Closeout cost	261,676	220,339	A new item for 2021, reflecting the estimated costs of reporting and other related items for CRP closeout. It also consists of USD 60,000 accrual for 2022.
CRP total <u>budget (W1/W2)</u>	6,080,466	6,080,466	

Part C: Additional evidence to be submitted through management information systems or as indicated

The following evidence is submitted separately and will be available via the MEL platform:

Evidence A: Full list of policy contributions in reporting year (Common Reporting Indicator I1): in MEL

Evidence B: List of CRP innovations in reporting year (Common Reporting Indicator C1): in MEL

Evidence C: Outcomes and milestones: in MEL

Evidence D: Full list of publications published in reporting period: in MEL

Evidence E: Altmetrics (Common Reporting Indicator I2): in MEL

Evidence F: Full list of current external partners: in MEL

Evidence G: Participants in capacity development activities in the current reporting period (Common Reporting Indicator C3): in MEL



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