Digital solutions for sustainable fisheries and aquaculture

Integrating digital solutions to increase efficiency along the fish value chain

RELEVANCE

Food is a basic human right. Yet around three billion people cannot afford a healthy diet. While hunger and malnutrition affect the poorest and the most vulnerable in many parts of the world, others face obesity and micronutrient deficiencies. At the same time, our food systems account for more than one-third of greenhouse gas emissions, use up to 70 percent of the planet's freshwater, and are responsible for significant biodiversity loss. The urgent need to transform how we produce, process, and consume food to ensure healthier diets and a more sustainable future is obvious. Aquatic foods are among the most resource-efficient animal-source foods, providing high-quality protein and essential nutrients with a relatively low environmental footprint. To create a genuine transformation towards sustainability within this sector, digital solutions need to be integrated. Focusing on digital solutions will help the fishery and aquaculture sector to collect and process data, generate statistics and ensure evidence-based decisions, efficient management, and policy implementation. Digital innovations provide the technological backbone needed to make aquatic food systems more efficient and resilient.

To support this effort, the *Global Programme Sustainable Fisheries and Aquaculture* (GP Fish) has promoted digitalization within the fisheries and aquaculture sector in Cambodia, Madagascar, Malawi, Mauritania, Uganda, and Zambia. The programme is focused on setting up digital solutions along the value chain that are designed to become a lasting and widely adopted part of local communities.

The **Global Programme "Sustainable Fisheries and Aquaculture"** is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of the German Federal Ministry for Economic Cooperation and Development. The aim of the programme is an increase of fish supply from sustainable and resource-friendly fisheries and aquaculture to boost a healthy and diverse nutrition in Cambodia, India, Madagascar, Malawi, Mauritania, Uganda and Zambia. Sustainable production and processing techniques are promoted along the value chain in order to create jobs and income, with a special focus on youths and women. Local organisations are strengthened in their capacities to carry on programme interventions on a long-term basis. And policy advice is contributing to favourable framework conditions for a sustainable development of the fisheries and aquaculture sector in the implementing countries.

This knowledge product provides guidance on the critical steps for effectively integrating digital tools into the aquaculture and fisheries sector. It ensures that innovations are not only technically viable, but also locally relevant and scalable.

Lead fish farmer in Malawi with a tablet used for data collection

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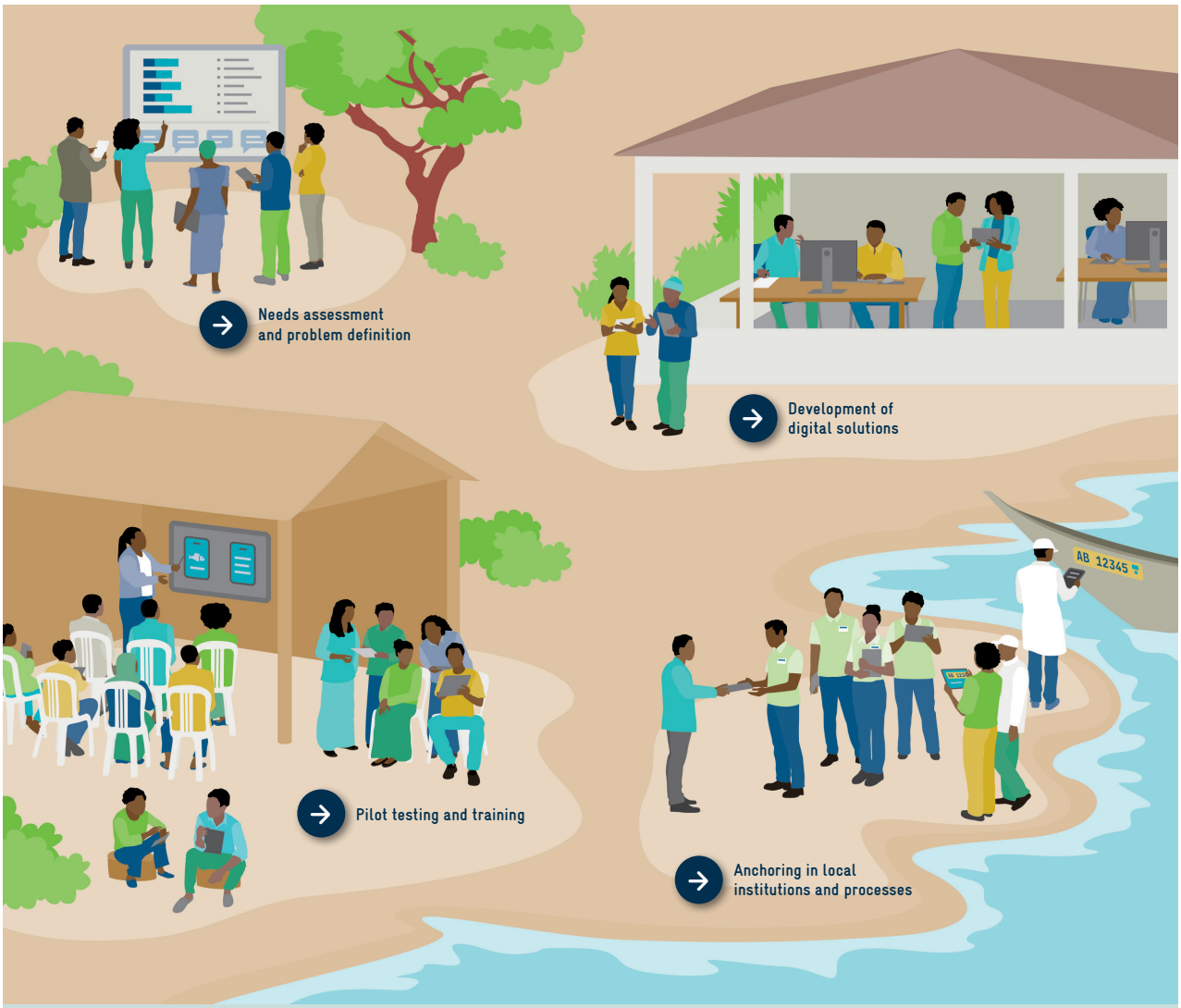
APPROACH

Needs assessment and problem definition on the ground

Different methods can be applied to better understand local conditions, challenges, and opportunities for introducing and using digital tools and solutions. Market studies assess demands, trends and pricing of digital tools. Feasibility studies determine whether innovations can be implemented. And gap analysis map existing shortfalls in digital infrastructure including connectivity and IT skills. In addition, training needs assessments help to ensure that farmers gain the necessary digital skills, and producer group analyses make it possible to tailor solutions to their priorities. Finally, qualitative methods such as interviews and focus group discussions offer valuable insights into user experiences, acceptance, and socio-cultural factors influencing the adoption of digital tools.

In several intervention areas of the GP Fish, needs assessments revealed limitations in digital access and literacy, highlighting the importance of tailoring solutions to local realities. In such cases, efforts must focus on strengthening digital capacities from the outset rather than assuming access or skills. This is especially relevant for small-scale aquaculture farmers in rural or remote areas where internet connectivity and digital literacy are often limited. For these groups, standard digital solutions often fail without offline options and prior capacity building.

Moreover, the COVID-19 pandemic underscored the need to respond to global changes with flexible delivery methods. Digital solutions are proving their usefulness for information exchange in times when in-person interaction is not possible. In 2020, for example, maritime ports and fishing vessels continued operations under COVID-19 restrictions, that prevented inspectors from travelling and monitoring



ports. Without at-sea observers, it was difficult to verify the use of authorized fishing gear, bycatch reduction devices, adherence of catch requirements, and other regulations. To address this inspection gap, the African Non-Governmental Organization (NGO) *Stop Illegal Fishing* (SIF) together with GP Fish piloted the use of **body-worn cameras** for inspectors, combined with live-streaming and real-time online expert support. The pilot was first implemented in the ports of Tema and Takoradi in Ghana and later scaled up to ports in Mozambique and Madagascar. Initial inspections covered fishing gear, catch, logbooks, vessel registration, safety documents and vessel identity verification. This solution delivered cost savings, increased flexibility and improved inspector safety while providing documented evidence of violations.

Development of digital solutions

When moving from needs assessment to the development of digital solutions, two aspects are relevant. First, digital tools must fit both, the day-to-day routines and resources of the users. Second, involving fishers, aquaculture operators, community leaders, researchers and government officers from the outset helps identify their needs and build trust. Co-developing and embedding digital innovations in locally grounded processes, designed in cooperation with the ultimate users, ensures usability, acceptance, and long-term sustainability. Therefore, we have to differentiate between developing and programming new solutions or building on existing ones, which can then be further adapted to local contexts and additional user groups. Building on existing tools helps to reduce costs and accelerate deployment.

Information being registered on a tablet for the first sale certificate in Mauritania

In Madagascar, for example, a **mobile phone-based system** was developed in collaboration with mobile network operators and the national weather service to support fish farmers in managing climate risks. The system provides timely weather updates via a hotline, allowing farmers to adjust production and harvesting practices and cycles in response to extreme weather events such as floods.

In Uganda, we built on an existing digital solution and further developed and adapted it. In partnership with the *Federation of Fisheries Organizations Uganda* (FFOU) an existing app was adapted to the local fisheries context, which resulted in the **ABAVUBI App.** The app allows fishers and small businesses to record transactions, manage accounts, access an online marketplace, make mobile payments, and track catch volumes, income, and expenses. User training and roll-out were led by IT administrators from FFOU member associations.

Pilot testing and training

Successful integration of digital tools needs a well-designed pilot phase before roll-out. Introducing digital solutions should go hand in hand with appropriate training and user support. This ensures that users not only gain access to new technologies but also acquire the skills and knowledge to apply them effectively. The pilot phase collects feedback from the target group to refine the tools and related training. It also tests feasibility, identifies potential problems, and builds user acceptance before wider implementation.

In Malawi, the project embedded a new **digital monitoring and evaluation system** within the *Department of Fisheries* (DoF). To ensure effective implementation, trainers – including lead fish farmers, district fisheries officers, agriculture extension officers, and NGO representatives – participated in dedicated trainings. They received tablets and learned how to use them for programming and data transmission. The tablet-based system transmits real-time field data to an online server. It records information on production, income, employment, and training outcomes, along details of trainings, coaching sessions, and follow-up activities (e.g. participant numbers, share of women, number of sessions). As these activities often take place simultaneously across districts with various field advisors, digital data collection ensures consistent monitoring, feedback, and oversight. This information was used to adapt the evolving monitoring and evaluation system of the DoF, while real-time data analysis supported project management, reporting, and strategic decision-making. For the first

time, the DoF established its own monitoring and evaluation system for aquaculture, strengthening supervision and governance of the sector.

In Zambia, the GP Fish piloted another **tablet-based monitoring and evaluation system** with dam committees, which are responsible for the sustainable fishery management in small dams. Dam committee members and local fishers were trained in tablet-based data collection of catches and the application of training content. The data collection was guided by a programmed questionnaire. Three versions of the questionnaire were tested to gradually arrive at a tool that is user-friendly and practical under local conditions. With this tool, the dam committees were able to collect structured datasets for the first time, laying the groundwork for more systematic management of fisheries resources at community level.

Anchoring in local institutions and processes

Finally, once tools and approaches prove to be successful in the pilot phase, ownership should be transferred to a designated local partner to ensure continued use, up-dates and potential scaling. This allows innovations to be systematically integrated into existing administrative structures, institutional mandates, and national priorities.

This approach has been effectively applied in Mauritania, demonstrating how digital tools can strengthen national systems. In sustainable fisheries management, the number of registered and licensed boats should be based on the maximum sustainable yield. This refers to the largest number of fish that can be taken out each year without risking overfishing. To address this, the project in Mauritania, together with the *Ministry of Fisheries and Maritime Economy,* introduced an **electronic registration and licensing system.** The aim is to increase transparency on boat numbers, catch composition, and the implementation of the ministry's management plan for small pelagic fish. Data is integrated into the IT-based national catch permit control system. This expands the number of registered and licensed boats, ensuring that a greater share of wild catches enters official registration and reporting systems. Rather than replacing the existing procedures, the system was enhanced by digitalizing the registration and licenses and embedding mobile licensing processes directly into the administrative workflows.

STEPS TO DEVELOP AND INTRODUCE DIGITAL TOOLS

WHAT?	HOW?	WHY?
Needs assessment and problem definition	• Market and feasibility studies • Focus group discussions • Interviews	Understanding the user demands, existing IT skills and framework conditions
Development of digital solutions	• Analysis and selection of existing tools and adaptation to local context and user group demands • Collaborative development with the involvement of local stakeholders	Ensures demand-orientation, acceptance, feasibility and usability of the developed tools
Pilot testing and training	• Demonstration and training in the practical use of tools • Collection of feedback on functionalities, user challenges and user friendliness during trainings or via questionnaires	Embedding user perspective in the development process to validate relevance and practicality before broader roll-out
Anchoring in local institutions and processes	• Embedding into existing IT infrastructure and day-to-day routines • Building capacities of local institutions on use and maintenance	Guarantee long-term use, maintenance and regular updates

IMPACTS

- At the **systemic level,** digital registration, monitoring and licensing systems have strengthened governance and transparency. Real-time data collection and analysis provide a robust evidence base for policy-making and management decisions. Trainings on the use of digital devices enhance institutional capacities.

- At the **user and community level,** digital trainings built capacities to use tools such as apps, tablets, and monitoring devices. This has enabled local actors to collect and process data more effectively and to take greater responsibility in fisheries resource management.

- Regarding **sustainability and the environment,** digital solutions enable evidence-based quotas, traceability and improved monitoring of resources. They support the fight against illegal practices, promote more sustainable use of fish stocks and contribute to the conservation of aquatic ecosystems, while reducing paper consumption and related costs.

- On the **economic and market level,** digital platforms strengthen networking, transparency and efficiency along the fisheries and aquaculture value chains. They improve access to markets, enhance income security, and provide tools for digital payments, accounting and business transactions, thereby supporting small-scale fisheries and aquaculture enterprises.

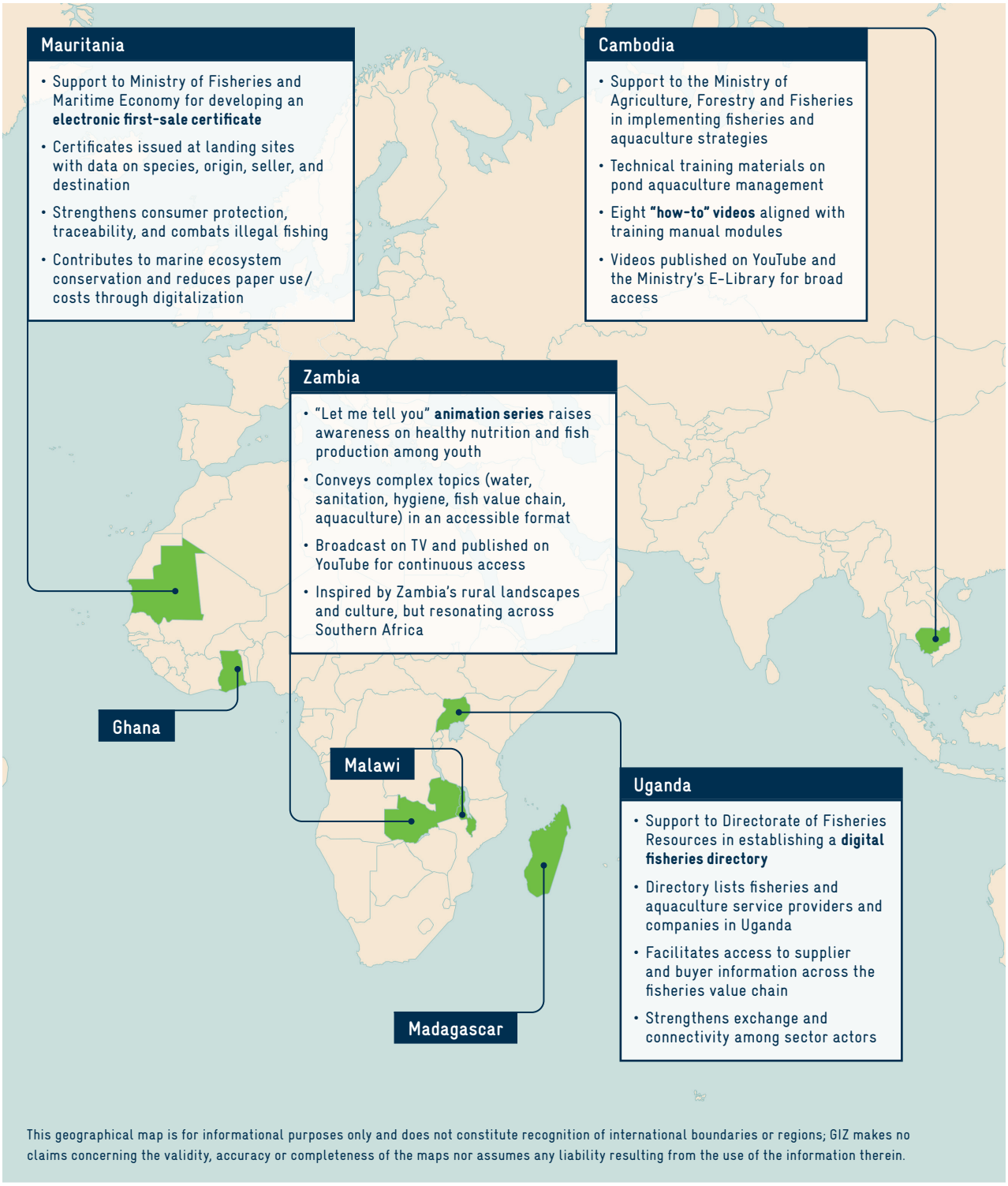
- Finally, in **awareness raising and education,** digital tools have proven highly effective in reaching broader audiences. Online platforms, videos and e-libraries facilitate low-threshold knowledge transfer and ensure wide accessibility across regions and beyond national borders.

SUCCESS FACTORS FOR DIGITAL INNOVATIONS

- [ ] Good comprehension of local demands and IT skills
- [ ] Sound understanding of framework conditions, challenges, and opportunities
- [ ] Co-development of IT-tools to ensure relevance, acceptance and usability
- [ ] Demand-oriented strengthening of IT capacities for user groups
- [ ] Systematic integration into existing structures and processes to ensure regular maintenance and updating
- [ ] Cost savings by using existing or further developing proven IT-tools and structures

Training for tablet based data collection in Cambodia

CASE STUDIES & IMPLEMENTING COUNTRIES



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