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COMMITTEE ON FISHERIES

SUB-COMMITTEE ON AQUACULTURE

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DRAFT ACTION-ORIENTED GUIDANCE FOR TRANSFORMING AQUACULTURE FOR GREATER CONTRIBUTION TO ACHIEVE THE SDGS: KEY INTERCONNECTED ACTIONS TO GUIDE DECISION MAKERS AND PRACTITIONERS

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FOREWORD

This section will be completed as part of the final document.

ABBREVIATIONS AND ACRONYMS

AI	artificial intelligence
AqGR	aquatic genetic resources for food and agriculture
ASD	2030 Agenda for Sustainable Development
AVC	aquaculture value chain
BFT	biofloc technology
BT	Blue Transformation
CCRF	Code of Conduct for Responsible Fisheries
EAA	ecosystem approach to aquaculture
FAO	Food and Agriculture Organization of the United Nations
COFI	FAO Committee on Fisheries
GHG	greenhouse gas
GIS	geographic information system
GSA	Guidelines for Sustainable Aquaculture
ICT	information and communications technology
IoT	Internet of Things
IMTA	integrated multi-trophic aquaculture
NGO	non-governmental organization
NTM	non-tariff measure
PPA	Priority Programme Areas
PPP	public-private partnership
RAS	recirculating aquaculture system
SDG	Sustainable Development Goal
WTO	World Trade Organization

EXECUTIVE SUMMARY

This section will be completed as part of the final document.

PREFACE

During the last decades, aquaculture has expanded significantly taking advantage of scientific progress, technological innovations and investment, and a growing global demand for aquatic food. As a result, aquaculture has established its important role in global food security and poverty alleviation initiatives, accounting for over 48 percent of total fish production and 54 percent of fish used for human consumption in 2019, in addition to its significant contribution to livelihoods and employment and the production of 32.4 million tons of aquatic plants.

Looking at the future of feeding an ever-growing human population, expected to reach almost 10 billion people by 2050, aquaculture is projected to develop further through enhanced productivity, intensification and modernization and expansion into other regions and countries of the world, such as in Africa, Latin America or the Pacific. Future aquaculture developments should however be deeply rooted in the principles of sustainability, enshrined in the FAO Code of Conduct for Responsible Fisheries (CCRF) and related international instruments. These instruments should constitute the reference framework for national, regional, and international efforts to ensure sustainable production and harvesting of aquatic living resources in harmony with the environment and society.

In 2015, the United Nations Members adopted the 2030 Agenda for Sustainable Development (ASD), which features 17 Sustainable Development Goals (SDGs) covering a comprehensive set of issues on technical, institutional and policy changes needed to achieve sustainable development. Development of sustainable aquaculture has significant linkages and bearing for many SDG of the ASD. At the same time, relevant SDGs and associated targets offer significant opportunities for raising the profile of sustainable aquaculture development.

Food and nutrition security, poverty alleviation, and sustainable management and use of natural resources are at the very core of FAO's mandate, vision and work streams. They are highly featured across the ASD and its SDGs, making FAO a key player for their achievement.

In fact, the FAO 2022–2030 strategy prioritized supporting the ASD, through transformation to more efficient, inclusive, resilient and sustainable agri-food systems leaving no one behind. The FAO vision and strategy are built around FAO key Priority Programme Areas (PPAs) addressing the various food and agriculture sectors and representing important building blocks to support FAO work and the ASD. They include the Blue Transformation (BT) PPA for fisheries and aquaculture, built around three pillars for (i) transformed fisheries management; (ii) sustainable aquaculture expansion, and (iii) upgraded fisheries and aquaculture value chains.

Following a request by the 9th session of the Sub-Committee on Aquaculture of the FAO Committee on Fisheries (COFI-SCA), FAO has been working since 2017, through wide consultative processes, on the identification of successful initiatives in support of sustainable aquaculture and their documentation and compilation into Guidelines for Sustainable Aquaculture (GSA). This process has shared policy and scientific developments, technological innovations and the lessons learned in different regions, countries and contexts. In parallel, existing national and international guidelines were reviewed during expert and regional consultations, to identify the gaps that need to be filled, the updates to be undertaken, as well as the specific constraints, needs and expectations of Members. The aim of the GSA is to help countries improve implementation of the CCRF, while engaging and enabling their aquaculture sector to effectively participate in the implementation of the ASD and building collectively the future of sustainable aquaculture.

Furthermore, in order to meet the request of FAO Committee on Fisheries (COFI) Members to provide a practical guidance to support sustainable aquaculture development and building on the wealth of information and expert reports generated for the preparation of the GSA, the secretariat has prepared this Action-Oriented Guidance for Transforming Aquaculture for greater contribution to achieve the SDGs: Key interconnected actions to guide decision makers and practitioners (AOG). This is a practical

guidance intended for use by policy makers and aquaculture practitioners working throughout the aquaculture value chain (AVC) in pre-farming, grow out and post-harvest activities. It is intended as a live document to be adapted by each country to meet its specific needs and priorities. It should be updated regularly to reflect scientific developments, technological innovations and lessons learned.

COMPONENT 1: ACTIONS FOR MAINSTREAMING SUSTAINABLE AQUACULTURE AND SUPPORTING ACHIEVEMENT OF THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

1. Mainstream expansion of aquaculture into global initiatives and align with the 2030 Agenda for Sustainable Development

1.1. Rationale

The world population is expected to reach almost 10 billion people by 2050, needing a significant increase in agricultural production, including fisheries and aquaculture, to provide adequate food and nutrition. Aquaculture production is projected to expand further through enhanced productivity, intensification and modernization. To be sustainable, aquaculture expansion requires sustainable development approaches that are economically profitable, but also protective of aquatic ecosystems health, biodiversity and social equity.

The ASD has identified SDGs and targets that: (i) focus on the elimination of hunger and reduction of poverty and inequality in all their forms; (ii) recognize the need for innovation and business development as well as social protection; (iii) commit to promoting and facilitating clean and efficient energy, and; (iv) seek to increase resilience to climate change, weather and natural disasters and market volatility.

The SDGs further seek to reduce the pressure of human economic activity on the natural environment by stressing the need for habitat and ecosystem protection, including by increased resource use efficiency, and sustainable production and consumption, spreading responsibility for delivering sustainability across all economic actors and beneficiaries.

Of high bearing to sustainable aquaculture development are SDGs 1 (end poverty in all its forms everywhere), 2 (end hunger, achieve food security and improved nutrition and promote sustainable agriculture), 5 (achieve gender equality and empower all women and girls), 8 (Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all), 12 (ensure sustainable consumption and production patterns), 13 (take urgent action to combat climate change and its impacts), 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development), 15 (Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss), 17 (Strengthen the means of implementation and revitalize the global partnership for sustainable development).

Other SDGs were reported to influence the work of FAO Members, Regional Economic Integration Organizations (REIOs) and other stakeholders in their efforts of promoting sustainable aquaculture. Nevertheless, it is recognized that emphasis at the national or local levels will change according to contexts, circumstances, conditions and Members' priorities. In addition, there will be in many cases specific SDG targets that will prevail most and weigh more than others in terms of importance and impact on sustainable aquaculture sector development.

To implement its vision of a world free from hunger and malnutrition where food and agriculture contribute to improving the living standards of all, especially the poorest, in an economically, socially and environmentally sustainable manner, the FAO 2022–2030 strategy prioritized supporting the ASD, through transformation to more efficient, inclusive, resilient and sustainable agri-food systems leaving no one behind for:

- Better Production: Ensure sustainable consumption and production patterns, through efficient and inclusive food and agriculture supply chains at local, regional and global level, ensuring resilient and sustainable agri-food systems in a changing climate and environment.

- Better Nutrition: End hunger, achieve food security and improved nutrition in all its forms, including promoting nutritious food and increasing access to healthy diets.
- Better Environment: Protect, restore and promote sustainable use of terrestrial and aquatic ecosystems and combat climate change (reduce, reuse, recycle, residual management) through more efficient, inclusive, resilient and sustainable agri-food systems.
- Better Life: Promote inclusive economic growth by reducing inequalities (urban/rural areas, rich/poor countries, men/women).

The FAO vision and strategy are built around FAO PPAs addressing the various food and agriculture sectors and representing important building blocks to support implementing FAO work and the ASD. They include the BT PPA for fisheries and aquaculture, comprising three pillars: (i) transformed fisheries management; (ii) sustainable aquaculture expansion, and; (iii) upgraded fisheries and aquaculture value chains. The three pilasters have significant linkages and bearing for most SDGs of the ASD.

Since its adoption in 1995, the CCRF has served as the reference framework for national, regional, and international efforts to ensure sustainable production and harvesting of aquatic living resources. Over the years, the CCRF has been enriched with several policy and technical guidelines to promote responsible aquaculture, best practices and responsible fish utilization and trade. Other international instruments of relevance to sustainable aquaculture include the Convention on Biological Diversity (CBD), its biodiversity conservation targets (Aichi Targets) and their Protocols: The Nagoya Protocol on Access and Benefit-sharing, The Cartagena Protocol on Biosafety and The Nagoya – Kuala Lumpur Supplementary Protocol on Liability and Redress to the Cartagena Protocol on Biosafety. Other key instruments and initiatives include the Paris Agreement concluded in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), the Addis Ababa Action Agenda on Financing for Development, the International Labour Organization (ILO) instruments on social responsibility, the World Trade Organization (WTO) agreements on tariffs and non-tariff measures such as the Sanitary and Phytosanitary Measures (SPS) and the Technical Barriers to Trade (TBT).

The relevance and importance of these international frameworks have been reiterated in 2021 into two high-level policy documents, the FAO COFI Declaration for Sustainable Fisheries and Aquaculture[1] and the Shanghai Declaration on Aquaculture for Food and Sustainable Development[2]: both Declarations stress this relevance into the universal context of the ASD and the many initiatives and programmes supporting its implementation at national and local levels.

1.2. Recommended actions

Policies and action to sustainably expand aquaculture and upgrade fisheries and aquaculture value chains should build on the wide range of instruments and initiatives that have proven useful during the last decades, drawing on lessons learned from their implementation to forge ahead the future of sustainable aquaculture in the 21st millennium. Of high relevance are the FAO CCRF, the GSA and their supporting FAO policy and technical guidelines to promote responsible aquaculture, best practices and responsible utilization and trade of fish and aquatic plants. Although voluntary, these instruments have been a key reference for national, regional and international policies and efforts to support sustainable production and harvesting of aquatic living resources in harmony with the environment.

To align policies and strategies of sustainable aquaculture sector development to the SDGs and relevant targets of the ASD, countries may need to decide trade-offs across development sectors and within the aquaculture sector. In doing so, Members should ensure:

- Creating an enabling environment for sustainable aquaculture sector development.

[1] FAO. 2021. *2021 COFI Declaration for Sustainable Fisheries and Aquaculture*. Rome. https://doi.org/10.4060/cb3767en
[2] https://aquaculture2020.org/declaration/

- Equitable access to natural resources and use rights.
- Environmental sustainability and efficiency of resource use.
- Conservation, access and benefit-sharing of aquatic genetic resources for food and agriculture and their wild relatives.
- Equitable access to services and infrastructure.
- Adoption of climate smart aquaculture practices to mitigate the impact of climate change.

Mainstreaming sustainable aquaculture into national development strategies and action plans to support achieving the ASD requires setting up a process and a functioning institutional structure. The United Nations Development Group (UNDG) Reference Guide on Mainstreaming the ASD, which offers a common platform for SDG work at country level, recommends a process in three steps:

- Building political momentum: mobilize key players, engage sustainable aquaculture sector within the national agriculture policy and broader SDGs processes, and raise awareness of the SDGs and their implications and connection with sustainable aquaculture.
- Building a joint vision and action plan: consult broadly to remove contentious issues and build consensus, engage stakeholders in cross-sectoral and multidisciplinary dialogue on SDGs, develop an action plan towards sustainable aquaculture, develop a joint vision on sustainable aquaculture within the framework of the broader vision for food and agriculture.
- Translating the vision into action to accelerate change: Mobilize private sector and civil society and enhance partnerships; integrate SDGs in policies, programmes and action plans; strengthen statistical capacity on data related to SDGs and sustainable fisheries and aquaculture; amend budget and mobilize funding for implementation; build capacity and take action at all levels.

2. Address trade-offs between Sustainable Development Goals through spatial and time scales

2.1. Rationale

Despite the achievements of aquaculture during the last decades in establishing its crucial role in global food security and poverty alleviation initiatives, development has been uneven between regions and countries and did not always take into consideration its environmental or societal impacts. Aligning to the ASD framework and working towards its relevant SDGs and targets can prove useful to bring coherence and promote synergy across administrations, initiatives, conflicting interests, institutions and communities.

While aquaculture brings opportunities to contribute to most of the SDGs, there are many factors influencing what the outcomes for SDGs can be from different aquaculture systems under different situations. Regarding the environment, several aquaculture systems can reduce the environmental footprint and even provide environmental restorative functions. But as with all food systems, different trade-offs will be resulting, for example environmental performance versus societal benefits. Faced with uncertainty and needing to decide priorities and allocation of resources, countries struggle with what type of aquaculture systems (new or existing one) and operation (small or large scale) to invest in and where to make most impact.

2.2. Recommended actions

Countries and aquaculture stakeholders need to address challenges on how to deal with trade-offs between different SDGs and bring coherence between various sustainability instruments and requirements. these trade-offs entail the need for (i) integrating aquaculture priorities in relation to the priorities of other sectors such as agriculture, fisheries, forestry, water, energy, environment or tourism, and (ii) prioritizing among different aquaculture systems, based on a good balance between economic profitability, social responsibility and environmental protection.

In the first case, key considerations relate to licensing or prioritizing access to land, water and use of infrastructure, services and aquatic resources, especially around lakes, rivers, freshwater and marine basins. Integrated coastal zone management (ICZM) is an approach promoted to coordinate the various users of coastal areas. At the national or local level, these considerations can relate to decisions about national or local level policy promoting and/or incentivizing investments in aquaculture, fisheries, agriculture or other sectors such as coastal tourism. At the regional and international level, the trade-offs relate to decisions about regional integration priorities, transboundary waters, incentives to promote export (fiscal incentives, infrastructure and technical support services, insurances schemes and so on), trade-agreements defining specific tariffs and market access requirements.

In the second case, understanding trade-offs across SDGs for different aquaculture types poses a great challenge because of the need for highly detailed information about a system's general performance, but also because of the need for local knowledge and capacity, support services, infrastructure, technical experience, perspectives and markets. This enables a better understanding of how they may constitute barriers to up-scaling or innovations for expansion to support achieving SDGs. For aquaculture this becomes even more challenging due to its explicit absence of visibility in the SDG targets and indicators. This is why consideration of different aquaculture systems and policies is highly important, both horizontally and vertically in governance, management and policy frameworks.

Understanding the wide diversity of both the species and the aquaculture systems is crucial for development of the sector's present and future contributions to the different SDGs. Having a broader aquaculture value-chain (AVC) perspective is imperative for gaining deeper insights about its overall contribution and for outcomes from investments and transformation efforts. An understanding of "farming conditions" and the role of "contexts" in which sustainable aquaculture development will be embedded, is also needed to realize how aquaculture can deliver on the SDGs.

A critical precondition for ensuring that sustainable aquaculture development aligns with and contributes to the SDGs, and addresses the challenges noted above, is an "enabling environment for sustainable aquaculture in support of the ASD". It includes proper policy/regulation and planning processes, effective and efficient legal and institutional frameworks, support infrastructure and services, including financial services.

3. Promote the role, visibility and integration of aquaculture in agri-food systems

3.1. Rationale

Although aquaculture is a millennia-old activity, its development into a structured agri-food system and commercial activity in several regions and countries is recent. More often, aquaculture governance and management are often under the responsibility of other sectors such fisheries, agriculture, water and forestry, trade or environment, guided by fragmented policy and regulations and reporting to multiple institutional actors.

Fish farming conditions encompass political (including governance), economic, legal, social, environmental factors acting on decisions by concerned stakeholders (governments, companies, investors, service providers, non-governmental organizations (NGOs), donors, individuals). Benefits from and costs of doing aquaculture have to be weighed against those from other viable options, for example terrestrial food production or coastal/lakeshore tourism. Contexts involve how aquaculture production and its value chains will generate benefits and costs, framed by both the local characteristics and regional/global connections of a society and the environment, i.e. its relationship to distant resource systems (for example feed ingredients) and markets and consumers overseas.

Achieving the ASD has proven very challenging, requiring partnership, innovation, and coordination of actions at multiple scales. Aquaculture is well-positioned to be part of the solutions, but progress towards its contribution to achieving the SDGs is dependent on its integration at various levels (local, national,

regional and international) and its recognition as an integral part of the agri-food systems with intrinsic linkages to capture fisheries and terrestrial agriculture.

3.2. Recommended actions

It is important to recognize the role of aquaculture and promote its importance within national agri-food systems, with a focus on its specificities and the complexities of the life cycles of aquatic organisms (animals, seaweeds and aquatic plants), the diversity of aquaculture systems, sites, practices and ecosystem services.

Promoting a holistic agri-food systems perspective, integrating the development of sustainable aquaculture can transcend the narrow focus of fragmented production issues, value chains and sectoral policies and contribute to achieving sustainable development. It will enable strengthening aquaculture amidst numerous other activities and users of land and water (including in both rural, urban and peri-urban areas) to develop joint objectives and strengthen guidance in key cross-cutting areas; and promote more integrated actions in aquaculture and across agriculture, forestry, fisheries and other economic sectors, that balance the different dimensions of sustainability, as well as marine spatial planning, integrated coastal zone management and integrated watershed management.

It will be important to promote an aquaculture that is interconnected within the agri-food system, including through the use of sustainable aquaculture feed ingredients, the use of sustainable aquaculture products (including by-products and co-products) as animal feed ingredients and other inputs for agriculture, and supporting a diversity of production systems to prevent supply chain bottlenecks. Identify common issues/concerns among food producing sectors and stakeholders as starting points for dialogue and coordinated/coherent action on aquaculture development. Create inclusive dialogue platforms that lead to shared understanding and negotiated solutions across sectors and across the dimensions of sustainability and tools to transform these solutions into changes in practices to be developed. Positioning aquaculture within existing policy platforms can also enhance its legitimacy.

COMPONENT 2: CREATING AN ENABLING ENVIRONMENT FOR SUSTAINABLE AQUACULTURE IN SUPPORT OF THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

4. Reform and strengthen governance and planning for sustainable aquaculture

4.1. Rationale

Aquaculture governance sets the processes by which a jurisdiction manages its resources, how its stakeholders participate in making and implementing decisions, how decision-makers are held accountable to stakeholders and how the rule of law is applied and enforced. Establishment of a national aquaculture governance framework can bring coherence among the various policy, legal and institutional arrangements often scattered across various institutions and will provide a predictable and transparent environment for investment in aquaculture.

The integrated and transformative nature of the ASD requires policies that systematically consider intersectoral linkages and support cross-sectoral communications and collaboration. Aquaculture systems interact with other agri-food systems, for example through the feed inputs and competition for water, energy, infrastructure, services, markets, investment finance, credit, creating risk for economic disruptions and requiring an agri-food systems approach to maintaining resilience and sustainability. Policy decisions taken in each of the sub-sectors can have significant impacts on others, and tensions may arise among stakeholders from real or perceived trade-offs between various objectives.

Good aquaculture governance, planning and visibility within national agri-food systems requires integrated, coordinated, multisectoral and ecosystem-based management, and innovative solutions throughout the value chains. It also requires strong and effective leadership and accountability and involves broad stakeholder engagement from across various disciplines and sectors for coherent, transparent, inclusive and effective governance mechanisms.

The ecosystem approach to aquaculture (EAA) represents a suitable stepwise process through which aquaculture can be spatially planned and managed and integrated into the local ecological and social context and economy. It provides a planning and management framework to effectively integrate aquaculture into local planning and offers solutions for engaging with producers, other relevant stakeholders and the government for the effective sustainable management of aquaculture operations by taking into account local and national social, economic, environmental and governance objectives.

Partnership is particularly relevant across the aquaculture value chains, where producers, government agencies and private actors can work together towards effective and practical sustainable solutions. The diversity of service providers, the knowledge and skills they bring are crucial for enabling producers to improve productivity, manage resources sustainably, operate their farms profitably, and access and respond to broader markets. Multistakeholder platforms can create a common space to voice solutions towards shared objectives, helping to mobilize capacities, technologies, financial requirements and access to productive resources.

4.2. Recommended actions to reform and strengthen governance and planning of sustainable aquaculture

4.2.1. Actions to promote coherent and coordinated governance across agri-food systems

Adequate governance of agri-food systems calls for a national policy dialogue, coherence and coordination, where aquaculture is duly recognized and integrated. How sectoral policies interact with the targets and larger objectives of the SDGs should be analysed and prioritized in national or subnational planning.

Agri-food systems must take an integrated approach to sustainability that includes taking stock of the relevant sectoral policies, mapping and analysing synergies and trade-offs between the economic, social and environmental spheres, assessing the state of the sustainability of these systems and identifying key issues, their causes and drivers. Also, efforts are needed to integrate or adjust aquaculture development to conservation objectives.

Strategic Partnerships that work within established governance frameworks should be promoted to strengthen the capacity to coordinate state and non-state actors in order to mobilize resources and capacity. This requires institutional structures that allow exchange of information and opinion, division of roles and responsibilities, and mechanisms for tracking results.

To enhance policy dialogue, the government’s leadership and convening power is important to mobilize key stakeholders, create decision opportunities and consultations for public investment. This includes facilitating innovative and flexible approaches to service provision and allowing for non-public spaces for private bargaining among stakeholders.

4.2.2. Actions to promote sustainable aquaculture governance

Effective aquaculture governance mechanisms should promote public policies and legal frameworks, risk management approaches, planning and adequate monitoring mechanisms. They require strengthened capacities and cooperation of public and private sector institutions and other relevant stakeholders at all levels, through realistic and implementable public-private partnerships (PPPs).

Aquaculture governance should aspire for democratization, decentralization, territorial development approaches and public sector management reforms, as well as inclusive and incremental institutional development to foster a long-term approach with sustainable impact. Inclusiveness requires recognition of key actors' interests and conflicts, while creating mechanisms through which various actors can articulate perspectives and demands.

Policy dialogue should create a space to engage with entrepreneurs and tap into the potential of the private sector, including farmer organizations, cooperatives, small and medium-sized enterprises, in addition to large, export-oriented enterprises. The diversity of actors from the private sector, producer organizations and civil society requires a changing role of the state from sole provider of services to that of regulator, coordinator and facilitator.

The voice and representability of producers, especially small ones, should be heard. Producer organizations can help small producers access an array of services, including improved market information, extension and collective bargaining power. They are also an effective means to empower small producers, in particular women and youth, Indigenous People and vulnerable groups.

4.2.3. Actions to promote aquaculture planning and management

Spatial planning and management to allocate suitable farming areas and farm sites and management frameworks should:

- Secure access to land and water while preventing conflicts with other users (fisheries, agriculture, forestry, tourism, conservation and so on) of inland and coastal zone resources.
- Provide access to infrastructure (roads, electricity, post-harvest and marketing infrastructures).
- Meet the specific biological needs of the aquatic species groups.
- Enable economic profitability.
- Minimize stress and disease.
- Recognize carrying capacity of the ecosystem for production (spatial integration will be important)
- Support resilience to climatic variability, climate change and other external threats and disasters.
- Improve public perception about potential social and environmental impacts of aquaculture through transparent and efficient information sharing.

5. Invest in basic infrastructure and efficient support services

5.1. Rationale

Improving aquaculture productivity is key to transforming the sector and promoting its expansion and the resulting income and livelihoods of the million people and actors that depend on it. Yet many farming areas and aquafarmers, in particular smallholder family farmers, continue to lack access to basic infrastructure, resources and services. Without adequate infrastructure, fish farmers are hindered from fully participating in the local economy and pursuing entrepreneurial activity to improve their income.

Basic infrastructure is a pre-requisite for providing greater access to land, resources, services, finance, markets, technologies and modern tools to increase productivity, reduce losses and waste and generate wealth and value. Increasing public investment in basic infrastructure provides an incentive for service providers and investors, including farmers to invest more in their production. Beyond improving farmers' incomes, this generates on- and off-farm employment and contributes to strengthening local economies and communities.

Feed represents the single largest operating cost item (between 40 and 60 percent) for most fed fish and crustacean farming operations. As such, feed plays a pivotal role in determining the sustainability and

economic profitability or not of any farming operation. In addition, the quality of the feed will influence greatly the quality and safety of the farmed fish.

Two other important areas of aquaculture production requiring investment and support services are access to high quality seed and brood stock and the provision of disease prevention services during pre-farming and grow out. Finally, aquatic organism farming requires laboratory services to monitor the quality and safety of water, seed, feed and aquaculture products, and to support national environmental monitoring programs for micro-organisms, chemical residues and biotoxins in the case of bivalve molluscs.

5.2. Recommended actions

Creating the conditions for inclusive transformation and expansion of aquaculture requires investing in basic infrastructure: roads, electricity, markets, land and water transportation, hatcheries, feed and food, processing facilities, quality control and food safety laboratories, telecommunications, ice production facilities and storage capacity, waste collection and disposal among others.

Integrating the expansion of aquaculture into public policies for agri-food systems development enables better access to and the use of public funds for investment in basic infrastructure. This enables better planning of public investment across sectors to promote economy of scale that minimizes investment and running costs, optimizes multi users' services and facilitates efficient maintenance. This is the case for example for extension services, aquatic organism health support services, food markets, feed and food quality and safety control laboratories. In these and other areas, integrated facilities can service different agri-food systems efficiently and at minimum costs, both for infrastructure investment, operations and maintenance.

Sustainable use of feed in aquaculture should be considered though the whole feed production chain, from the choice and sourcing of individual feed ingredients, the formulation and manufacture of the aquaculture feeds, the handling and management of aquaculture feeds on the farm by the farmer, to the nutritional wholesomeness and safety of the aquatic products.

It requires support services and partnerships involving public institutions, the fishing industry, aquaculture farmers, the feed industry and other key agri-food system stakeholders to apply the principles of sustainability in the responsible use of wild fish in aquaculture feeds, including promoting the replacement of juvenile and low-value fish as feed with compound feed, at the same time specifically avoiding the undermining of food security of local populations or other negative social or environmental impacts. It also calls for coaching fish farmers on best practices for feed utilization in order to avoid waste and improve efficiency and profitability.

Key services to fish farmers, in particular small-scale farmers, require the strengthening of broodstock, seed production and distribution systems for the conservation and sustainable use of improved aquatic genetic resources and enhancing the extension and application of select farmed types and their wild relatives. Promotion of decentralized and reliable supply of healthy seed to farmers, particularly small-scale farmers has proven beneficial.

Key actions to prevent and mitigate health risks to aquatic organism require:

- Promoting aquatic biosecurity protocols and management agreements, including prevention of disease and integrated disease and pest management, and encourage measures to improve organism health and welfare.
- Promoting control, prevention and management of transboundary aquatic organism diseases of relevance for aquaculture.
- Harmonizing aquatic animal and seaweed/plant health management approaches and measures and effective cooperation at national, regional and inter-regional levels in order to maximize the effectiveness of limited resources.

- Depending on the national legal context or ratification status, adhering to relevant international instruments related to the responsible use of antimicrobials, chemicals and veterinary drugs, including the FAO Action Plan on Antimicrobial Resistance (AMR) and principles of One Health, as appropriate.
- Addressing the risks of antimicrobial resistance and the impact of veterinary medicines and other chemicals in the environment associated with aquaculture.

While the quality and safety of feed and seed can be assessed by private laboratories, including laboratories attached to large aquaculture farms, environmental monitoring programs and food safety assurance are the responsibility of aquatic organism health and food safety authorities. PPPs should be explored as they have proven useful in many countries where they provided reliable and cost-effective laboratory services to aquaculture.

6. Promote financial services and incentives

6.1. Rationale

Expansion of aquaculture requires investment capital and financial services to build or expand and operate efficiently feed mills, hatcheries, aquafarms, processing facilities and related activities and services. The level and types of investment and financing depend on the farmed species, the farming system, the production volumes and the technology used.

Aquaculture is often in competition with other sectors (agriculture, fisheries, agro-industry, tourism and so on) for limited investment and finances where return on investment and the associated risks strictly guide investment and financing decisions. Investors, financial institutions and insurance companies in many countries are often discouraged from funding and investing in aquaculture because of insufficient visibility and limited knowledge of the aquaculture sector. They are generally cautious in extending loans to aquaculture actors because of the inherent risks associated with disease outbreaks and extreme climatic events. In some cases, the long production cycle of fish farming makes timely loan repayment difficult. Lack of adequate collaterals to cover risks and the lack of down payment are other discouraging factors. Even when financial institutions provide loans, interest rates are generally prohibitive, which is a disincentive for farmers to borrow, especially small and medium-scale farmers.

In several countries, valuing eco-system services and internalizing their costs and benefits have proven useful for setting up trading credits for Nutrients (carbon, nitrogen, phosphorus), adopting fiscal incentives to promote clean technologies such as integrated multi-trophic aquaculture (IMTA)/integrated systems.

6.2. Recommended actions

Building support for policies that promote expansion of aquaculture requires making the case for how investment in aquaculture can materially contribute to broader national objectives. This requires the development of an investment strategy to attract and incentivize investors and financial institutions. The strategy should be focused, comprehensive and at sufficient scale. It should target infrastructure, new technologies, research, development and innovation to unlock the full potential of sustainable aquaculture, including increased production and economic profitability while addressing other issues such as poverty reduction, nutrition, employment, gender equality, inclusion, preserving ecosystems and biodiversity, adaptation to and mitigation of the impacts of climate change and aquatic organism health impacts.

Aquaculture value chain performance should be better facilitated, aligned, prioritized and targeted towards measurable improvements and with a long-term perspective through Private and public investment. Countries with well-functioning, predictable and transparent financial markets can derive

significant benefits from investment, including from foreign sources, in terms of better access to capital, technology and skills, market access, generation of employment and productivity increases.

This requires an enabling environment, competent authorities, strengthened partnerships and multistakeholder innovation platforms. Development assistance and financial institutions should pay particular attention to policy advice, human and institutional capacity development and monitoring and evaluation of progress, ensuring a level playing field between smallholders and larger investors is important for both equity and economic efficiency reasons. Investment in aquaculture expansion, including from foreign sources, should recognize the rights of access to land, water and natural resources, whether statutory or customary, owned by individuals or communities.

Building on successful experiences in other areas such as agriculture or fisheries, the strategy should explore and exploit new opportunities for inclusive aquaculture and rural finance to ease liquidity constraints faced by farmers. Different innovative approaches to rural finance and forms of investment have proven successful in different countries. They include agricultural investment funds, investment promotion, guarantee funds and information and communications technology (ICT), blended financing and philanthropies crowding, to increase the level of financing while lowering the risks to investors. Interventions to improve access to credit should also promote financial literacy and management skills, in addition to producer organisations or community-based savings and loan groups, which allow for better risk management and improved access to finance from the formal banking sector. Different incentives can be used at various stages to address short- and long-term changes. Positive incentives include training, direct payments and compensation for land/ponds set aside or improved market access.

7. Strengthen information, research and innovations

7.1. Rationale

Research and innovation are considered a key enabler of most – if not all – SDGs, and a main driver of agricultural and rural transformations. Innovation refers not only to technologies and practices, such as improved breeds, aquaculture systems and practices, biotechnologies, and financial instruments, but also to business management, organizational forms such as PPPs and aquaculture farmers' cooperatives.

Heavy investment and highly publicized innovations in aquaculture include large-scale, intensive, land-based recirculating aquaculture system (RAS), IMTA, aquaponics, highly automated net pen systems, increasing robotics and remote command-and-control, and novel financing tools for larger companies or small start-ups. The most impactful innovations in the industry are, however, often of a far lower profile and deal with improved selective breeding for better growth, feed conversion efficiency, improvements on aquaculture of extractive species, and environmental stressor and disease tolerance (resistance). Other innovations include refinements in feed formulations to reduce the reliance on forage-fish resources for fishmeal and fish oil in aquaculture diets, expanded use of vaccines to improve animal health, and better extension, outreach and training for farmers.

In aquaculture, key innovations that have enabled expansion of aquaculture in a wide range of areas include genetics and breeding, feed formulation and feeding techniques, biosecurity, health management and monitoring (including development of vaccines, disease detection techniques). The others include water use and waste management, energy consumption and saving, post-harvest processing and value addition technologies and quality control, automation and the use of ICT and artificial intelligence in on-farm management, business management of aquaculture value chains, marketing and distribution logistics.

Many innovations have benefitted from developments in more mature areas of agriculture, fisheries and agri-food systems, in particular aquatic organism production, biosecurity and health management, food industry and feed formulation. Others were the result of specific research in aquaculture, such as integrated multi-trophic aquaculture, water and waste treatment and marine aquaculture technology.

Dissemination, technology transfer and adoption of successful innovations have used several approaches combining public interventions through extension and advisory services, private interventions through producers' organizations, cooperatives and other self-help group arrangements or PPP around research and development, in particular in countries where aquaculture is important. Increased globalization and easy access to information have accelerated the transfer of technologies and the flexibility/adaptability of the sectors. Adoption of innovations and technology transfer has often been hindered by obsolete regulations, lack of skills, capacity to deal with repair/maintenance and access to spare parts.

Successful demand-led research and innovations were stimulated by establishing and managing centers of excellence on aquaculture through partnership between the private sector, academia, state and non-state actors, using PPP investment mechanisms.

The compilation of accurate, relevant and timely data facilitates monitoring, comparisons and analyses of status and trends that are essential for aquaculture expansion, sustainable utilization of the resources it requires and investment. Accurate assessments of the status and progress of aquaculture support governments and relevant stakeholders in formulating better informed policies, strategies and plans and in the monitoring and reporting of aquaculture's contributions to economic development, food security and poverty alleviation and related SDGs.

7.2. Recommended actions

Sound public and private investment in research and development (R&D) and advisory services should be inclusive, encourage innovation that benefits smallholders and address issues like improving sustainability and resilience, raising incomes and reducing risks, including creating new market opportunities and encouraging diversification, and reducing natural resource depletion and degradation.

It should go hand in hand with investment in capacity development and better provision of information to smallholder family farmers about innovations, both in the form of improved technological products and processes, and social practices and organization to promote simple, practical solutions, and make services and products available that might otherwise be unaffordable to small-scale farmers. This kind of innovation can take advantage of new technologies such as the use of mobile phones and social networks to aid extension and create new markets in areas where there is a lack of infrastructure and services or a lack of experience in logistics and distribution.

An important area for investment in global research and development is on the utilization of cultured seaweeds and aquatic plants for direct human consumption and as feed ingredients for aquaculture and terrestrial livestock and, to reduce the pressure on fish stocks and agricultural land, reduce enteric methane emission from livestock, and exploit a new source of food and feed.

This requires improvement of data collection and information systems paying attention not only to production but also to social indicators (consumption, employment), environmental performance indicators and economic indicators through the aquaculture value chain, making use of internationally accepted indicators of social, economic and environmental impacts. The global reporting system can benefit greatly by strengthening transparency and outreach of the biannual Code survey and progress reporting on sustainable aquaculture in FAO's Committee on Fisheries, and its Sub-Committees on Aquaculture and Fish Trade.

8. Promote the contribution of aquaculture to provide healthy, nutritious and sustainable aquatic food

8.1. Rationale

Aquaculture is expected to provide around 60 percent of fish for human consumption by 2030. It already provides more than 97 percent of seaweeds for human consumption. This reinforces the key role aquaculture can play in the transformation of current agri-food systems by providing nutritious and healthy aquatic foods, a key component of diversified and healthy diets. Fish and other aquatic foods will be important sources of high-quality proteins, essential fatty acids and micronutrients, especially for the poor and vulnerable. Being one of the most traded and diversified (over 460 farmed species) food commodities, expansion of aquaculture trade is projected to make available low, medium and high value nutritious farmed aquatic food, some produced in one country, processed in another and yet exported and consumed in a third different country.

8.2. Recommended actions

The unique nutritional role of aquaculture should be promoted recognizing the importance aquatic food can play in building sustainable agri-food systems, and in addressing hunger, and the triple burden of malnutrition, in addition to its role to mitigate global climate change and reduce its impacts.

National strategies for promoting nutrition and health should recognize that aquatic food is a key dietary component in many countries, poor or wealthy, with a special focus on Africa and Small Island Developing States. Recognition should be given to the strong potential of aquaculture to sustain future demand for aquatic food, addressing the current imbalance of aquaculture production with Asia generating over 88 percent of the total in 2019.

Nutrition-sensitive approaches should consider and promote the nutrient content of farmed aquatic foods, with a particular focus on its potential and role in combatting all forms of malnutrition, especially for pregnant women and children. Such approaches can include promoting safe aquatic foods in national food-based dietary guidelines, school feeding programmes, and other food and nutrition strategies. This will require transforming/adapting supply chains, production, processing, trade and consumption of aquaculture food products as part of agri-food systems to make them more sustainable, resilient, ethical and inclusive, using e-commerce and internet distribution platforms. Promoting healthy diets in school food programmes may benefit from adapting public procurement protocols.

9. Promote networking, exchange and dissemination of innovations and know-how

9.1. Rationale

Being one of the most globalized agri-food systems, aquaculture require continuous technology transfer and innovations to align production systems and practices with retailing and distribution requirements and expectations of consumers. While aquaculture production occurs mostly in developing countries, mainly in Asia, fish and seafood consumers are all around the world, including in the most lucrative markets of the developed countries, demanding nutritious, sustainability sourced and convenience food.

The future advancement of aquaculture development in support of achieving the SDG depends on local, national, and global actors, that could be supported through networks, partnerships and alliances to increase aquaculture production that generates equitable benefits to stakeholders while preserving the environment and contributing to social stability. The establishment of networks and platforms for the exchange of experiences and information and to facilitate broader involvement in policy- and decision-making processes could be very relevant to aquaculture development.

9.2. Recommended actions

At the local, national and regional levels, the development of multistakeholder platforms should be encouraged and promoted to accelerate collaborative actions among industry, research, academic and other stakeholders to develop strategic research and innovation agendas for sustainable aquaculture development.

Bolstering private sector at all scales should be pursued through inter alia the use of PPPs as a way to create shared value and to facilitate market entry and rights for small producers. It will also create an environment to better understand and share the interests of civil society, businesses and government priorities to leverage resources and knowledge and promote proper inclusive business models.

Partnerships should be strengthened to benefit from the reinvigoration of global cooperation and networking for aquaculture development among existing and planned centers of excellence, supported by financial, technological and capacity-building assistance through strategic North-South and South-South cooperation. Inclusive dialogue platforms, creating and improving information systems and data collection, and facilitating flows of information enable better understanding of aquaculture's contribution to sustainable development, including through the monitoring and evaluation of the sector. Modernizing traditional aquaculture with innovative approaches, digital technologies, capacity development programmes, and education and extension activities will unlock employment opportunities.

10. Promote socially responsible aquaculture

10.1. Rationale

The positive contributions of aquaculture to sustainable development are relatively well recognized, although not yet visible at the level the sector deserves. On the other hand, equitable access to the economic, social, environmental and cultural benefits of aquaculture development has been consistently questioned. This accessibility can be possible for all, when and where not driven only by the pursuit of production goals and economic efficiency and profitability. This has been the case of operations where aquaculture is poorly regulated, managed or planned, exacerbating historical inequalities and bringing about negative impacts. These inequalities can result from discriminatory access to resources and services (for example, land, seed and feed supply, water and marine space, support services, credit and finance), undermining the development of decent livelihoods based on aquaculture. Having no or less access to ownership of assets such as farming sites, production, processing and marketing assets, credit, insurance, technology and capacity building, women, youth, vulnerable and indigenous people, and small-scale farmers are most likely to be left out even though aquaculture scales up and expands.

Social protection plays a key role in reducing rural poverty and hunger. Measures such as cash and asset transfers provide liquidity and financial security to poor people, giving them the means to invest in their future. By providing a basic income, these measures help to relax insurance and credit constraints, allowing poor people to give the chance to start their own businesses, engage in profitable activities, and ultimately to break out of the cycle of multigenerational poverty. Aqua food producers, in particular smallholders and family farmers in developing countries, are highly vulnerable to risks and shocks, including illness, drought, disease, conflict and the negative impacts of climate change.

As aquaculture production world-wide is undergoing a transformation from labor-intensive farming methods to greater mechanization and digitalization, automated systems are being developed and adopted on aquaculture farms that further change the nature of the demand for labor in aquaculture.

10.2. Recommended actions

Aquaculture farmers and workers are important contributors to the world's agri-food systems and the management of natural resources, in particular land, water and living resources. Attributing a fair value to their work as part of a sustainable food system is central to addressing inequality and attaining multiple objectives of the ASD. This requires removing structural constraints and providing smallholder and family farmers with the tools and capacities to build resilient livelihoods.

Improving social responsibility and decent livelihoods work conditions in the aquaculture sector requires: (i) supporting, the aquaculture value chain and at all scales, the formation, engagement and involvement with aquaculture organizations, including those representing the interests of women, youth, vulnerable and indigenous people, (ii) protecting and improving rural livelihoods via the design and access to effective social protection schemes, (iii) adhering to relevant international instruments, including the provisions of the ASD related to social protection and decent work, (iv) working with the private sector and certification bodies to promote and enshrine fair and equitable treatment of aquaculture actors and workers in market access instruments and mechanisms, (v) developing training and skills building opportunities for youth and women, vulnerable groups and indigenous people, including capacity building programs aimed at the professionalization and (self-) regulation of farmers and decision-making government personnel and the industry, throughout the aquaculture value chain and at all levels, (vi) bridging the rural divide and empowering youth and women to access information, services, technology, finances and markets, taking a gender-transformative approach.

Investing in social protection, particularly when combined with targeted pro-poor and aquaculture interventions, can have far-reaching effects on poverty reduction, economic growth and building resilient livelihoods. Social protection schemes, such as school feeding, cash transfer and health care, help provide income, food and nutrition security and decent employment to people, particularly women and children, living in challenging and often hazardous environments.

Aquaculture is not always a first choice by youth for building a career, earning an income and securing a livelihood. This is due to political, economic, technical, and social factors. Key factors are limited access to assets (land, water) and services (knowledge, information and education, financial services, markets) and limited involvement in policy dialogues on issues that affect youth. Addressing these issues requires developing aquaculture training and education, and integrating them in existing curricula, building a youth-oriented approach to engage young women and men by creating attractive skills development, employment and income opportunities, promoting policies that explicitly target impacts on young men and women's involvement, based on understanding the diversity among youth and their needs.

Future workforce for aquaculture expansion needs a set of competencies with strong information technology skills, which are attractive to the young. According to experts, digital technologies are likely to be implemented in all spheres of education (training, educational infrastructure, pedagogy, extension and teaching resources), as well as leadership and management. Extension agents and users are interested in learning digital tools and using them effectively in daily farm practices.

Improving aquaculture social responsibility with other sectors that share common ecosystems and or care for the use and conservation of natural resources is essential to increase perception and acceptance of the sector. This is particularly relevant in areas, regions where aquaculture is new. Therefore, efforts should be made to include all relevant stakeholders in discussions related to aquaculture use of space and water and facilitation mechanisms of social dialogues should be sought. Such efforts will provide the opportunity to show and share aquaculture potential benefits and opportunities specially for local populations.

11. Promote clean technologies and energies, decarbonization and circular economy

11.1. Rationale

Aquaculture systems are highly diverse, producing globally almost equal live weight amounts of fed species (49.4percent; mainly crustaceans and finfish, except carps) and extractive species (50.6 percent; herbivorous fish, molluscs, echinoderms and seaweeds). Aquaculture expansion since 2000 is mainly due to intensification, use of more and better feeds, Aquatic genetic resources management (breeding programs), improved technology, production management and biosecurity. Conversely, aquaculture contributes to the pollution of aquatic ecosystems and to global warming, due to increased energy and feed inputs linked to intensification and greenhouse gas (GHG) emissions, although these emissions

from aquaculture remain modest compared to terrestrial animal production (for example beef production).

Likewise, there is clearly a consensus that extractive species exhibit ecological footprints that are orders of magnitude lower than fed species. But they can also trigger environmental issues with negative impacts on the nearshore or offshore aquatic environment, caused for example by the use of fertilizers and chemicals to control grazers, or the competition for space between cultivated seaweeds and seagrass meadows.

Although considerable improvements were achieved in technologies to reduce pollution through water treatment processes and better feeding methods, the environmental impact of fed aquaculture remains high, challenging the industry to reduce pollution and global warming and becoming climate neutral.

The economic feasibility of such interventions will vary across scales and geographies, with its integration through producers' associations (cooperatives, clusters) being more likely feasible than by individual farmers. The high diversity in species, aquaculture systems, feeds, and salinity tolerance contribute to the resilience of aquaculture to climate change, but does not make aquaculture disaster proof.

11.2. Recommended actions

Both fed and extractive aquaculture need to pay more attention to scaling, site selection and the health of the wider production environment. In terms of land use, aquaculture is more efficient than terrestrial animal production, but water use remains a challenge, and more attention should be given to water recycling in land-based systems, reducing water consumption and facilitating nutrient recovery and re-use. Integration of aquaculture into local nutrition-sensitive, circular and sustainable food systems with reduced carbon intensity, should become a major driver for future aquaculture expansion. This requires actions for:

- Conserving, protecting, enhancing, and restoring ecosystems, their services and their biodiversity, including aquatic genetic resources, water and soil resources, and at the same time prevent water pollution and reduce greenhouse gas emissions.
- Taking action to decrease aquaculture environmental footprint throughout the aquaculture value chain, from production to consumption, including all the side industries associated with aquaculture, such as processing, transportation, storage and feed manufacture. This requires developing methods and parameters to value ecosystem services provided by aquaculture.
- Applying the concepts of physical, ecological and social carrying capacity in aquaculture planning, use of environmental impact assessments, environmental assessment and monitoring aquaculture operations to prevent and minimize environmental risks generated by aquaculture and also risks for aquaculture from other activities and hazards.
- Recognizing the advantages and promoting the use of extractive aquaculture species, including their provision of ecosystem services such as water quality improvement, habitat enhancement, carbon/nitrogen/phosphorus "sequestration", coastal deacidification and considering their lower impact on surrounding ecosystems.
- Promoting aquaculture systems, where appropriate, for their ability to provide habitat and refuge for both terrestrial and aquatic biodiversity;
- Addressing the risks of antimicrobial resistance and the impact of veterinary medicines and other chemicals in the environment associated with aquaculture.
- Promoting and incentivizing the use of clean and renewable energies and re-circulation of water and co-products in the feeding process.

12. Prepare to address impacts from global crises, such as climate change, natural disasters, pollution and pandemics

12.1. Rationale

Natural and human made crises of the recent decades, from tsunami in 2003 to the ongoing COVID-19 pandemic, have caused human suffering and death around the world, destroyed basic infrastructure and productive assets and disrupted supply chains and markets of goods and services in most countries. At the same time, they have raised global awareness about the serious and urgent need to tackle collectively and at the local level, preparedness for adaptation and mitigation of the risks of future natural and human made disasters; many are the result of increased greenhouse gas emissions causing climate change and ocean acidification. World experts warn that immediate actions are overdue, and that the next ten years will be crucial in addressing the impacts of the climate crisis in order to avoid irreversible damage to the environment.

It is increasingly clear that the goals of achieving food security and alleviating poverty while addressing the challenges of climate change are intertwined and need to be addressed in a coordinated manner. The targets of the Paris Agreement on climate change make it essential that agri-food systems and other land and water-use sectors be part of the climate solution. Because of the wide diversity of aquaculture systems, species and environments, the sector has margins to adapt to market forces, with more opportunities for lower 'carbon footprint' that can lessen or mitigate the impacts of the global climate crisis, and can help the overall food supply system be more resilient to other impacts of natural disasters.

12.2. Recommended actions

Expanding aquaculture in support of achieving the SDGs targets requires climate-smart approaches, providing greater access to resources, technologies, education, information and credit for investment to adapt the production systems and practices. This requires:

- Ensuring risk based spatial planning and management of aquaculture. These are the first non-regret actions that improve resiliency including to face disease as the most common hazard, which can also be enhanced by climate change.
- Ensuring that National Adaptation Plans (NAPs) include and support aquaculture adaptation needs and that aquaculture is included in nature-based opportunities and solutions in the Nationally Determined Contributions (NDCs).
- Embracing and expanding climate resilient aquaculture using appropriate planning and management to understand and act on where and how aquaculture can address climate change and other external impacts to the agri-food system. This requires: (i) identifying the sector's vulnerabilities to the impacts of climate change (for example, acidification, temperature changes, extreme weather events) and other external impacts specific to each area and developing disaster preparedness, risk mitigation and climate change adaptation strategies; (ii) implementing risk reduction strategies, including through contingency planning for droughts, floods, diseases, harmful algal blooms, and the adoption of more diversified and resilient production systems associated with effective safety nets, (iii) taking action to prepare for and adjust to both the current effects of climate change and the predicted impacts in the future, (iv) Enhancing and/or developing environmental monitoring systems to strengthen aquaculture resilience and improve early warning.
- Utilizing proven traditional and modern genetic technologies responsibly to develop aquatic farmed types adapted to changing environmental conditions caused by climate change, such as acidification, salinization and temperature and precipitation changes; diversifying aquaculture production, improving farming practices, promoting integrated farming systems and enhancing the capacity of farmers to respond to climate risks; recognizing that the changing global climate could provide new opportunities for aquaculture due to the diversity of farmed types and culture systems available to the farmer and proactively promote these opportunities. Where options

exist, using a variety of species and production technologies that have lower carbon and environmental footprint than terrestrial species.

- Supporting and promoting the development and expansion of climate-smart and more resilient forms of aquaculture which balance between increasing productivity and incomes; adapting and building resilience to climate change; and reducing (GHG) emissions.
- Integrating climate-proofing innovations that increase adaptation and resilience of the sector, including innovations in institutions, emissions reductions and renewable energy systems such as co-locating aquaculture with wind turbines or photovoltaic power generation or using renewable energy heating and cooling systems and water pumps.
- Strengthening preparedness should involve contingency plans, coordination arrangements, public information and training. It should include: (i) understanding and applying risk analysis for aquaculture planning and management (pathogen, food safety and human health, genetic, environmental, climate, ecological, financial and social risks); (ii) investing in early warning alerts that can trigger action before disasters strike and help governments and organizations mobilize and act rapidly to prevent and minimize disasters impacts; (iii) maintaining reserves of seeds and feeds or spare parts and the constitution of emergency funds; (iv) capacity building to institutions at national and local levels to strengthen their ability to support aquaculture resiliency and climate smart practices.

COMPONENT 3: IMPLEMENTING BEST PRACTICES ALONG THE AQUACULTURE VALUE CHAIN

13. Strengthen access to and facilitate adoption of Best Aquaculture Practices

13.1. Rationale

Technological developments and innovations and their transfer and adaptation throughout the aquaculture value chain have enabled sharing knowledge and practices on improved varieties, aquaculture systems, improved business management, financial facilitation or organizational set-ups such as public-private partnerships and farmers' cooperatives or clusters. In so doing, they improved a wide range of issues in areas from genetics and breeding, to feed formulation and feeding techniques, biosecurity, health management and monitoring, water use and waste management, energy consumption and saving, post-harvest processing and value addition technologies and quality control, business management of aquaculture value chains, marketing and distribution logistics.

Being one of the most globalized agri-food systems, aquaculture require continuous technology transfer and innovations to integrate scientific developments and align production systems and practices with retailing and distribution requirements and expectations of consumers. However, the transfer of know-how and technology and its uptake need to be rooted in the overarching context that the vast majority of production, over 90percent percent is in developing countries, primarily by small-scale farmers, whereas markets are all around the world, with varying needs and expectations in terms of price, presentations, shelf-life, convenience, sustainable and responsible sourcing.

The large-scale and high investment innovations have often their own expansion and transfer mechanisms, managed by the private sector, based on business models from other mature agri-food systems or other sectors. They concern for example, intensive land-based RAS systems, highly automated offshore net pen systems designed along the principles and scale of offshore oil rigs, increasing robotics and remote command-and-control, and novel financing tools for larger companies or small start-ups.

As stated earlier, the most impactful innovations in the industry target improved selective breeding for better growth, feed conversion and feed formulation efficiency, and environmental stressor and disease

tolerance (resistance), vaccination to prevent fish diseases, and better extension, outreach and training for farmers.

Like other mature agri-food systems, aquaculture has witnessed a significant shift in the way of extending knowledge to improve practices, with successful experiences progressively adopting integrated, market-oriented and farmer-driven methods, often involving multistakeholder participatory processes. In successful aquaculture development initiatives, smallholder family farmers, rural women and men, and their organizations are increasingly regarded as full partners in situation-analysis and problem-identification, and in redefining research and advisory services. Multi-actors' extension systems where public sector, private agents, CSOs and NGOs all deliver collaborative knowledge to farmers based on their areas of expertise. Participation in modern aquaculture value chains that trade harvest within or across country borders has enabled business-oriented approaches that include a set of skills in managing the farm both at the production as well as the marketing stages.

13.2. Recommended actions

Risk based spatial planning of aquaculture considering ecosystems carrying capacity is essential to reduce diseases, eutrophication of water bodies, reduce mortality and impact on biodiversity. Such consideration should render one of the most relevant advances in improving performance of aquaculture including of small-scale farming. Other simple measures such as careful consideration of farming density that reduce fish stress, improve oxygen conditions should be adopted by individual farmers.

Sharing knowledge, building capacities and investing in innovative technology are all part of the transformation to sustainable expansion of aquaculture in support of achieving the SGDs.
In supporting efficient know how and technology transfers in aquaculture, including producer organizations that provide services and give a voice to farmers' concerns, extension services need to play a greater role as coordinator, facilitator and regulator to ensure that services offered by the increasing number of actors are feasible, technically sound and balanced in addressing economic profitability, environmental resilience, access to markets and social inclusiveness.

The transfer of know how should be targeted, demand-driven, engage women and youth, and address the specific needs of different categories of producers. It should reach equitably all actors, including to those most left behind, bringing farmers' knowledge together through cooperatives and clusters and providing youth with training and education on sustainable socio-economic entrepreneurship, including human skills and linking agriculture to industry and services. Building the entrepreneurial and business skills and capacities of youth and smallholders will be fundamental for full market participation and taking advantage of new opportunities.

14. Enhance sustainable resource management

14.1. Rationale

Aquaculture expansion in a sustainable manner requires careful and efficient use and management of resources. These resources include land, water (abstraction), energy, inland and marine water spaces, feed, seed, capital and human resources. Land and water tenure and aquaculture inputs and the impacts of their use on the environment need careful management and considerations, within the context of their use by other sectors.

Aquaculture requires less land than terrestrial animal production. Experts estimate hypothetically that if the production volume of terrestrial animals from today onwards did not increase, with aquaculture fulfilling the increased demand for animal protein until 2050, then only a small proportion of extra cropland for feed production would be needed for aquaculture feeds. This further makes the point to a shift toward a human diet richer in aquaculture products by saving 70 to 76 million ha of cropland as compared to a scenario with no shift in the balance between terrestrial and aquatic meat consumption.

Likewise, water use in aquaculture is relatively limited, often not even accounted for in food-water schemes, compared to plant and terrestrial animal production. Major water uses are for feed production, on-farm water use and processing. Intensification reduces water use significantly, making aquaculture highly water efficient. Certain technologies, such as the RAS and biofloc technology (BFT) are efficient to reduce water use in aquaculture production. With the expected growth in marine aquaculture, the overall freshwater use efficiency by aquaculture can improve further.

Feed accounts for 40 to 60 percent of the operating cost for fed fish and crustacean farming operations. In addition, the quality of the feed will influence greatly the quality and safety of the farmed organisms. Key issues arise from the use of live feed and the production of fishmeal and fish oil from unmanaged small pelagic fisheries, which increases the pressure on these stocks, causing overexploitation and/or decreasing the availability of these affordable species for human consumption. There are also potential risks with the use of feed ingredients and feeds containing unsafe levels of heavy metals, pesticides, herbicides, environmental pollutants, mycotoxins, veterinary drug residues, chemicals, and adulterants, including melamine and micro-plastics.

Finally, energy is used in aquaculture for all mechanical operations, water pumping, processing of aquatic organisms, cold storage, transportation and distribution. Many countries have developed national strategies to promote and disseminate energy saving technologies and practices, renewable energies, in particular solar, wind and ocean wave energies.

14.2. Recommended actions

National strategies for sustainable use of water, land and energy should integrate the needs and challenges of the aquaculture sector. These strategies should include significant financial incentives and training activities to the farmers and the other aquaculture actors along the entire value chain.

Practical and up-to-date guidance that address best practices for the management and use of aquaculture resources should be developed and widely disseminated by extension services. It should be supported by regular and targeted training for optimal use of water, land, energy, seed and feed.

Sustainability of natural resources requires moving away, in particular by small scale fish farmers, from using trash fish/low-value fish as a feed source to formulated feed, thereby increasing the availability of fish for human consumption. Likewise, the use of wild marine fishery resources as feed inputs, including lower-value fish as a direct feed, and fishmeal and fish oil sourced from over exploited and/or non-sustainably managed fisheries should be avoided.

The future of fed aquaculture expansion requires:

- Engaging with the feed industry to encourage the development and utilization of diversified and improved feeds that are precisely designed for the needs of farmed types based on age, genotype, environment and immune status.
- Reducing dependency on wild caught fish as sources for aquafeeds, increasing the use of fishery processing wastes as raw material for fishmeal and fish oil, and promoting the use of alternative and sustainable feed ingredients (such as algae, insect meals, single cell proteins, or fish by-products), which are safe for the cultured organisms and the environment
- Exercising care to eliminate the use of non-approved feed additives, including antibiotics, hormones, antioxidants, binders, medicants, pigments, and possible adulterants. This will ensure that the safety, nutritional profile and potential health benefits of farmed organisms can be enhanced through dietary fortification prior to harvest.

15. Promote conservation of biodiversity and genetic resources

15.1. Rationale

Biodiversity is integral to ecosystem health. Its conservation, sustainable use and development are important to increase food production and necessary to sustain livelihoods. Populations of wild relatives still exist for all aquaculture species and these, represent a resource for utilization in breeding programs and whose conservation in the wild is critical. However, our knowledge and understanding of the status of aquatic diversity both in relation to wild stocks and farmed types in aquaculture is currently very limited, especially below the level of the species, and constrains the development of effective and informed strategies and policies for their effective management.

Conserving and utilizing genetic resources and aquatic biodiversity provides adaptability and resilience in the face of climate change, emerging diseases, pressures on feed and water supplies and shifting market demands. Today, however, pollution, invasive alien species (IAS), degrading habitats, climate change and ocean acidification are exacerbating threats to biodiversity by reducing the number of species, impoverishing their genetic diversity and stressing ecosystems, often beyond their resiliency.

15.2. Recommended actions

Mainstreaming conservation and effective management of biodiversity in agriculture, including aquaculture, requires implementing a series of initiatives established in the UN Decade (2011–2020) on Biodiversity, the Aichi targets and global action plans adopted by the Commission on Genetic Resources for Food and Agriculture. These require greater investment to ensure that conservation of biodiversity and the genetic resources for food and agriculture are mainstreamed across all sectors contributing to sustainable development, food security and nutrition by: (i) strengthening national institutions and creating legislation to manage genetic resources, (ii) monitoring the biodiversity of aquatic organisms to identify genetic resources and farmed types at risk of extinction and adopt measures to mitigate the risks, (iii) preventing the degradation of natural habitats, in particular in freshwater and coastal environments, by creating conservation areas, (iv) exploring incentives for valuing ecosystem services applied to biodiversity conservation. The Global Plan of Action for aquatic genetic resources for food and agriculture (AqGR), adopted by the FAO Council in December 2021 identifies and adapts these priorities to the specific properties and characteristics of AqGR, for example in promoting the wider adoption of genetic improvement for AqGR in aquaculture, where the sector lags far behind terrestrial agriculture.

Countries' broodstock and seed production and distribution systems should be strengthened for the conservation and sustainable use of farmed types of aquatic genetic resources and promote the appropriate development (with a focus on selective breeding), extension and application of improved farmed types. Recognizing the largely untapped potential of appropriate genetic technologies (both traditional breeding and modern biotechnology) to improve aquaculture production and production efficiency, risk assessment should be conducted before upscaling and dissemination of these technologies, to ensure that they are appropriate and adapted to local conditions.

16. Strengthen sustainable aquaculture value chains, transparent and predictable trade

16.1. Rationale

As aquaculture develops into a major commercial agri-food system, providing the majority of proteins worldwide, aquaculture value chain analysis, development and governance have emerged as a valuable and complementary approach to analyze and understand the dynamics at value chain nodes of key players, economic costs and benefits, value addition and creation and to inform the development of policy options and suitable market instruments for the promotion of sustainable aquaculture in international food trade.

Value chain analysis has proven useful in helping stakeholders (public, private, associations, NGOs and so on) to develop a shared understanding of how a specific aquaculture chain performs economically, socially and environmentally, and to identify collaborative relationships (for example PPPs) to improve the aquaculture value chain performance. The analysis can provide good understanding on how to empower the various, but often fragmented actors, as they recognize innovative opportunities to create and increase in a synergetic way the value of aquaculture products.

Aquaculture value chain analysis can help identifying and implementing actions to decrease aquaculture social and environmental footprints throughout the value chain, from production to consumption, including all the side industries associated with aquaculture, such as processing, transportation, storage and feed manufacturing.

16.2. Recommended actions

Expansion of sustainable aquaculture can be catalyzed by access for farmers to domestic and international markets with higher efficiency, transparency and competitiveness. These markets can offer important opportunities to generate employment, greater income and technological improvements. They also carry risks associated with longer food value chains in which external factors such as non-tariff measures (NTMs) play a bigger role and smallholder farmers have less control over input and output prices and markets.

Access to lucrative market and trade information and services should be facilitated to promote value creation and value addition. In particular, small-scale aquaculture farmers and other operators must be able to access timely and accurate market information and services to help them adjust to changing market conditions, enhancing traceability and market competitiveness, inter alia by using digital and organizational innovations. Timely capacity development is key for enabling aquaculture actors to adapt to and benefit equitably from opportunities of global market trends and local situations while minimizing any potential negative impacts.

Promotion of international trade and export of aquaculture products should not adversely affect the nutritional needs of people for whom fish is critical to a nutritious diet, their health and well-being and for whom other comparable sources of food are not readily available or affordable.

Promotion of a constant dialogue within the industry and with government institutions and organizing vulnerable groups in associations, cooperatives, and unions can facilitate equitable distribution of benefits to producers and workers, including overcoming international trade barriers and fostering suitable working conditions in the sector. Producer organizations can help smallholders access an array of services, including improved market information and food safety programmes, as well as focusing on value-added production and marketing.

17. Reduce food loss and waste and promote sustainable consumption

17.1. Rationale

It is estimated that every year, the world loses and wastes about a third of the food it produces. The sector of fisheries and aquaculture reports higher losses, estimated at 35 percent of the global harvest, because of the more perishable and fragile nature of fish and seafood. In affluent economies, more than 40 percent of losses are at the retail and consumer level. Developing countries, on the other hand, encounter the problem in primary production, storage, processing and distribution. In addition to the net economic cost of food waste and food loss, prices are higher, and availability is much less. Both constitute a threat to food security, a waste of resources, increased stress on ecosystems and a danger to

the environment in the form of GHG emissions. Fish waste and loss impact the four dimensions of food security: availability, access to food, stability of supply, and utilization of safe and nutritious food.

17.2. Recommended actions

All actors in the aquaculture value chain, from farm to fork, can and must play a role in reducing food loss and waste, reusing, recycling and promoting more sustainable consumption patterns. Often, it is necessary to perform a situation assessment, beginning with quantifying the main causes of food losses and wastes, proposing different solutions and comparing their respective technical and economic feasibility, and impacts on food quality and safety, social and environmental acceptability.

Awareness increasing, education and incentives are necessary to promote resilient and sustainable production and consumption, so consumers and producers are aware of environmental and social impacts when making decisions. These actions should be supported by policies and interventions to regulate production and distribution, traceability, to provide nutrition education to incentivize the general public to shift to nutritious and safe diets with a lower environmental footprint and energy use. Disseminating knowledge and technologies to reduce post-harvest losses can improve significantly the efficiency of food systems. Greater commitments to a circular economy in aquaculture, as an alternative to a traditional linear economy of producing, using and disposing, can optimize the use of natural resources, ensuring products, co-products and wastes are recovered and regenerated from production lines and across subsectors.

Recirculating water in aquaculture reduces water use and helps farmers to circumvent upstream disease outbreaks or water shortages and reduces the use of antibiotics and therapeutants. Continuous removal of solids (fish faeces and uneaten feed) prior to discharge reduces the discharge of particulate organic matter and phosphorus considerably, benefitting the recipient environment and improving internal water quality. Techniques such as biofiltration to convert ammonia to nitrate, and the use of denitrifying bioreactors to remove nitrates, help reduce eutrophication significantly, provide complimentary disinfection and reduce microbial contaminants. The use of locally available filter material (for example coconut shells and husks, woodchips, biochar) and locally manufactured equipment, as well as aquafeed developed using local ingredients, is often cheaper, more sustainable and might ensure a higher rate of success. The BFT, a closed aquaculture system based on the microbial-loop concept, enables the intensive and biosafe culture of aquatic organisms. The microorganisms - mainly heterotrophic and nitrifying bacteria - maintain water quality and contribute to the recycling of organic matter and residual nitrogen compounds, reducing the ammonia concentration. In addition, the consumption of the bioflocs reduces the feed conversion rate (FCR) and improves the zootechnical performance of the cultured aquatic species. However, BFT is highly dependent on electricity for adequate operation, and specialized labor. Finally, education and training are imperative if these technologies are to contribute significantly to sustainable production of healthy aquatic foods in the future.

Traditional and cost-efficient technologies for fish preservation, such as solar drying, fish smoking or salting, should be improved to promote environmentally sustainable practices that minimize the use of resources, such as water, wood for fish smoking, energy and ensure that final products are of good quality and safe for consumption.

18. Strengthen social responsibility of the aquaculture industry and markets

18.1. Rationale

Aquaculture expansion can benefit from optimizing wealth extraction through value addition and value creation, not only in pre-farming, input distribution and product retailing, but also during farming, with a particular focus on small scale farmers. However, the costs and benefits of the value creation and value addition need to be equitably distributed along the aquaculture value chain, with a particular attention to the needs of youth, women and vulnerable groups and indigenous people of the chain.

Aquaculture products are widely traded, and trade-liberalization has expanded opportunities for many producing countries to compete in international markets. In general, it is assumed that export-oriented aquaculture, in a framework of liberalization policies, facilitates economic growth and is associated with poverty reduction and the improvement of food security. This concept has been questioned by many who looked critically at the benefits of global aquatic organism trade in respect to its costs, particularly in relation to food security, social and environmental implications. It is argued that influential people and lead companies, including transnational corporations, outside the local community, are the primary beneficiaries of public funds and investment in aquaculture development. It is further argued that certain global aquaculture value chains are controlled by some of the world's largest agro-industry players, and more and more by input suppliers and food retailers which are able to dictate increases in costs of inputs and to keep down the farm gate prices, creating distorted competition and markets.

18.2. Recommended actions

Understanding the effect of trade restrictions and distortions in aquaculture markets will be key to forming healthy, sustainable and well-functioning national and international aquafood markets, and taking advantage of the opportunities that trade offers. While reduced tariffs have been a facilitating factor in trade-driven development, much of the focus has shifted to examining the role of NTMs in regulating and determining trade flows, by ensuring that imports meet domestic standards. Yet, NTMs are often supposedly made harder to comply with and less transparent than tariffs. NTMs regulations must be enacted in line with WTO principles of transparency, based on relevant international standards or other scientific justification, non-discriminatory, and not more trade-restrictive than necessary.

Promoting a more enabling market environment for smallholders can help to provide fair and transparent prices that adequately remunerate smallholders' work and investments. Producers and trading firms should implement corporate social responsibilities that address environmental impacts, decent employment and working conditions in aquaculture, including eliminating child labor. They should promote predictable, transparent and reliable market instruments for certification.

19. Develop integrated agriculture-aquaculture food systems

19.1. Rationale

In many parts of the world, aquaculture is integrated with other food production systems (for example combined rice and fish farming, integrated multi-trophic aquaculture, livestock/fish farming practices, culture-based fisheries, agri-aquaculture in arid and desert lands) to enhance the sustainability, productivity, efficiency and resilience of people, communities and ecosystems. The benefits that come from integrating different fish species or fish with crops, vegetables, livestock or trees include increased production, diversified diets and income, efficiency in resource use, enhanced biodiversity and conservation of the environment. In integrated farming systems, wastes of one food system become inputs to another, optimizing the use of resources and lessening pollution. Integrated agriculture-aquaculture offers special advantages over and above its role in waste recycling and is important for encouraging better water management for agriculture and forestry. Fish are efficient converters of low-grade feed and wastes into high-value protein.

In many rice field areas of Asia, different forms of culture-based fisheries, ranging from pure fisheries to nearly fully controlled aquaculture are practiced side by side. Through proper management, these systems contribute to food and nutrition security, rural livelihood diversification and income improvement, and biodiversity conservation.

More recent and promising developments in integrated farming system include IMTA and aquaponics. One concern of fed aquaculture, in particular marine fed aquaculture, is the release of organic and

inorganic wastes in the aquatic environment. In IMTA systems, fed species are linked to extractive species so that their excretive products and feed waste become food for extractive species and are, then, considered as co-products in a circular economy approach. The idea behind the IMTA approach is that re-cycling of nutrients results in a reduced nutrient release into the environment, while the overall productivity of the production system improves. Variations in nutrient retention efficiency in IMTA can reach up to 100percent depending on species, waste type, culture technique, and culture intensity.

In aquaponics, effluents from RAS supply bioavailable nutrients for plants. Plants that do well in hydroponics also do well in an aquaponic system. If nutrients for plants are lacking in the RAS effluent, extra fertilizers can be applied to the plants. Aquaponic systems are promising because nutrient losses from aquaculture are reduced and they are used to produce additional food (vegetables), diversifying the production. Major constraints to profitability of aquaponic systems include the need to have access to high-value markets for vegetables and for fish, the broad range of know-how involved, and the leading role of vegetables in securing financial success.

19.2. Recommended actions

Integrated agriculture – aquaculture systems should be promoted through proper policies and institutional framework to create incentives, promote research and development and multi-stakeholders' partnerships to attract investment and develop markets.

Aquatic food production can also be expanded through culture-based fisheries in the numerous seasonal water bodies scattered throughout the world. Fish production can be enhanced, contributing to food security and enhancing rural livelihoods. The potential contribution to global fish production from culture-based fisheries is estimated at 10.7 million tonnes per year in Asia alone.

Implementation of IMTA in open coastal and marine systems is a challenge because nutrients and co-products dilute and move beyond the limits of individual farm concessions. Therefore, a landscape ecosystem integration is required and aquaculture management areas under the EAA become a necessity. To implement it, however, requires relevant changes in national and international (as appropriate) norms and legislations moving beyond from individual farms and focusing on management at the ecosystem scale with special attention to the ecosystems carrying capacities.

20. Promote information and communication technology, artificial intelligence and digitalization in aquaculture

20.1. Rationale

The last decade have seen a significant development in ICT, robotics and artificial intelligence (AI), building on proven technologies such as mobile phones or cloud-based systems, high-resolution satellite imagery, DNA and genetic profiling, blockchain, the Internet of Things (IoT) and machine learning. These developments are significantly affecting data collection and management, enabling access to timely information on key aspects of planning and site selection of aquaculture farm management, environmental monitoring. Real-time remote sensing and improved sensor development are increasingly used by aquaculture farms to monitor feed management, organism health, escapes and biosecurity. Remote sensing tools and integrated geographic information system (GIS) are widely used for more efficient site selection, to map and analyze oceanographic conditions (for example currents, waves, temperature), bathymetry, multiple users of the area (for example shipping, fishing, recreation), and other factors to support evidence-based decision making for site selection. This trend has opened opportunities for predictive (instead of reactive) evaluation of threats such as oceanographic phenomena (anoxic upwelling), pollution and harmful algal blooms.

Initially driven by cost efficiency and competitiveness, the use of ICT and AI has been significantly accelerated following the outbreak of COVID-19. Now, in a world concerned about pandemics, health

and safety considerations have become a central motivation to reduce microbial transmission during production, processing and distribution. Increased production costs, restrictions on travel and on the mobility of workers and goods, and social distancing have accelerated further digitization and automation technologies for measurement, monitoring and tracking.

Born out of necessity, the use of video conferencing, remote learning, webinars, electronic surveys and e-administration have developed at an unprecedented scale to become part of the new normal. The COVID-19 emergency forced many to break through rigid hierarchies, slow procedures, complex bureaucracies and adapt rules using electronic payment, exchange of documentation, clearances and approval. E-commerce has shown its potential for diversifying the scope and geographic reach of trading opportunities and expanding the range of both established businesses and new enterprises. It also plays an increasingly important role in the supply and distribution of both goods and services in domestic and international markets.

20.2. Recommended actions

Responsible use of ICT, AI, IoT, robotics, remote sensing, GIS, blockchain technology and other tools should be promoted to make aquaculture systems more precise, intelligent, climate resilient and sustainable. Digitalization and rapid adoption of these technologies by a country depend on the quality of digital connectivity available, the availability of reliable communications networks, the existence of online platforms and services, and the digital literacy of the population.

Policies should be put in place to break barriers, address the adverse effects of the digital divide, not least for small scale farmers and low-income households, and build trust and confidence in online business. These policies should protect against unfair trade practices, product safety and cybersecurity concerns, which have been amplified in the pandemic context.

In the future new normal, consumers will require a safer online commerce environment and companies to adjust and provide more transparency and cybersecurity. Likewise, technologies that improve safety at work and generate efficiency gains are likely to be retained beyond the COVID-19 crisis. Countries and companies prepared to deploy these innovations and technologies would gain competitive advantage and market access.

Directing stimulus investments to accelerate adoption of smart aquaculture technologies can support science and improve observation and understanding of the aquatic eco-systems more efficiently and effectively. New digital programmes collecting and interpreting data using satellites and enhanced drones can support, replace or expand traditional programs that collect scientific data for management and enforcement of regulations. Promotion of citizen science using mobile phones to collect and disseminate data on aquaculture operations and aquatic environment can prove cost-effective and enable participatory approaches.

COMPONENT 4: MONITORING, DATA COLLECTING, DATA ANALYZING AND REPORTING

21. Monitoring, data collecting, data analysing and reporting

21.1. Rationale

A significant factor in efforts to achieve the SDGs, regular monitoring and reporting can make collaborative action more focused and conducive to evidence-based policymaking, co-management and investment. Indicator monitoring can also serve as a dashboard to measure progress, guide resource

allocation and support implementation towards sustainable aquaculture development, helping to ensure the accountability of all stakeholders.

International agencies are providing assistance to country efforts by strengthening national capacities and by ensuring that data are comparable and aggregated at sub-regional, regional and global levels. FAO is custodian UN agency for 21 of some 230 SDG indicators across SDGs 2, 5, 6, 12, 14 and 15, and a contributing agency for 6 more. These indicators, which are chiefly directed towards capturing information on hunger, food insecurity and the sustainable use of natural resources, are designed to be disaggregated, adopted universally, and reported regularly and cost-effectively. The indicators to monitor achievements of the SDGs are at high level requiring adaptation and streamlining into aquaculture indicators suitable to feed into higher level indicators.

21.2. Recommended actions

Aquaculture expansion in support of SDGs requires the design and implementation of a robust indicator framework to monitor and report progress and build accountability. Indicators must be selected carefully to ensure ease and cost-effectiveness in their collection, analysis and dissemination. Overly complex data collection and analysis protocols might be prohibitive technically and financially. Data disaggregation by gender and other specific needs will be instrumental in targeting interventions of aquaculture expansion to specific groups, leaving no one behind.

Several countries have been involved in the Voluntary National Review (VNR) reporting on SDGs. Some have been able to report on fisheries and aquaculture. These experiences should be shared and upscaled through FAO support to ensure that aquaculture is well included.

FAO has a long tradition and experience reporting through COFI and its two Subcommittees on aquaculture and trade on the implementation of the Code by FAO Members. Digitalization of the reporting forms has improved significantly reporting rates and the quality of the information reported, including in relation to the reporting on the contribution of fisheries and aquaculture to achieving SDGs. The Blue Transformation framework is developing further the monitoring and reporting methodology that can track achievements of its three pillars against specific targets and indicators and relate them to SDGs targets and indicators.

COMPONENT 5: OTHERS

This section will be completed as part of the final document, and it will include case studies, selected information sources, and so on.