Food and Agriculture Organization of the United Nations

FAO FISHERIES AND AQUACULTURE TECHNICAL PAPER

722

ISSN 2070-7010

A guide to the application of a multidimensional solutions approach to food loss and waste reduction in aquatic value chains

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2025

Required citation:
Ward, A. and Peñarubia, O.R. 2025. *A guide to the application of a multidimensional solutions approach to food loss and waste reduction in aquatic value chains.* FAO Fisheries and Aquaculture Technical Paper, No. 722. Rome, FAO. https://doi.org/10.4060/cd5069en

ISSN 2070-7010 [Print]
ISSN 2664-5408 [Online]

ISBN 978-92-5-139765-7

Cover illustration: © FAO/Zoe Brandizzi

Contents

Figures

Tables

Boxes

Acknowledgements

This work was undertaken as part of the Norwegian Agency for Development Cooperation (Norad) funded project "Responsible use of Fisheries and Aquaculture Resources for Sustainable Development".

The authors would like to thank Nianjun Shen and Arnljotur Bergsson of the Food and Agriculture Organization of the United Nations (FAO) for their support and early reviews of the text of this document.

Special thanks is given to the FAO country offices and the national project coordinators of Component 5: Chandrani Pushpalatha (Sri Lanka), Heysel Calderon (Colombia) and Joseph Luomba (United Republic of Tanzania). Their facilitation of the activities which helped to apply and promote the uptake of multidimensional solutions (MDS) to address fish loss and waste in their respective countries greatly enriched this document.

The authors are also grateful to the National Aquatic Resources Research and Development Agency in Sri Lanka, the Institute for Marine and Coastal Research in Colombia, the Tanzania Fisheries Research Institute and the national fish loss and waste working groups from each of these countries for their excellent collaboration, enthusiasm, expertise and guidance.

Recognition must also be given to Yahya Mgawe, FAO International Fisheries Consultant, Julia Heyl, FAO International Gender Consultant and Robert van Otterdijk, FAO Agro-industry Officer for their authoritative technical expertise and guidance which helped to shape and enhance immensely the MDS approach described and the final text of in this document.

Finally, the authors are grateful to Zoe Brandizzi, FAO Communication Specialist for graphic design, to Turan Rahimzadeh, FAO Knowledge Management and Communication Expert for helping to finalize the publication and to Claire Ward, FAO Editorial Consultant for final text editing.

Abbreviations

CoC FLW	Voluntary Code of Conduct for Food Loss and Waste Reduction
DFAR	Department of Fisheries and Aquatic Resources
EFLAM	exploratory fish loss assessment method
ExACT-VC	Ex-Ante Carbon-balance Tool for Value Chains
FAO	Food and Agriculture Organization of the United Nations
FLI	Food Loss Index
FLW	food loss and waste
FWI	Food Waste Index
GHG	greenhouse gas
INVEMAR	Institute for Marine and Coastal Research
MDS	multidimensional solutions
NARA	National Aquatic Resources Research and Development Agency
PIPDA	Inter-Institutional Panel on Aquatic Food Losses and Waste
PPA	priority programme area
SDG	Sustainable Development Goal
SMART	specific, measurable, achievable, relevant and time-based
SWOT	strengths, weaknesses, opportunities and threats
TAFIRI	Tanzania Fisheries Research Institute
TOC	theory of change

Introduction

This guide describes a multidimensional approach that has been used to address food loss and waste (FLW) in fishery and aquaculture value chains. It is an evolving approach, but early indications are that it warrants wider dissemination, discussion and application.

FLW is a manifestation of poorly functioning food systems. It is widely recognized that significant levels of FLW occur in the food supply chain from production to consumption. Between the post-harvest and retail stages of the chain, up to 14 percent of food produced globally undergoes quantitative food loss (FAO, 2019), while 17 percent of total global food production may be wasted at the retail, food service and consumer stages (UNEP, 2021). Adding to this, although precise data are lacking, it is believed there are significant levels of quantitative food losses at the pre-harvest/catch/slaughter and harvest/catch/slaughter stages, and food quality losses across the entire food supply chain (Diei-Ouadi and Mgawe, 2011; Flanagan, Robertson and Hanson, 2019). FLW affects the sustainability of food systems, with negative impacts on the economy, food security, nutrition and environment (FAO, 2022). Economically, for example, FLW equates to wasted investment that reduces the economic well-being of actors in the food value chain (Fahrenkamp-Uppenbrink, 2016).

Reducing FLW is therefore a priority. This is enshrined in Sustainable Development Goal (SDG) 12 (responsible consumption and production), which sets a specific target (SDG 12.3) to "halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses" by 2030. Improvements made to food systems to reduce FLW can also contribute to achieving many other SDGs, such as SDG 2 (zero hunger); SDG 6 (sustainable water management); SDG 8 (decent work and economic growth); SDG 11 (sustainable cities and communities); SDG 12 (responsible consumption and production); SDG 13 (climate change); SDG 14 (marine resources) and SDG 15 (terrestrial ecosystems, forestry and biodiversity). At the same time, progress made on other SDGs such as SDG 5 (gender equality); SDG 7 (affordable and clean energy); SDG 9 (infrastructure, industry and innovation) and SDG 17 (partnerships) can facilitate the reduction of FLW (FAO, 2019; FAO, 2022).

"Better Nutrition 4: Reducing food loss and waste" is one of 20 programme priority areas (PPAs) of the FAO Strategic Framework. Under the PPAs, FAO will support countries to identify and overcome challenges in addressing FLW at scale, by adopting a holistic systems approach to fill knowledge and capacity gaps; strengthen policy, regulatory and institutional frameworks; and to incentivize and stimulate action by food supply chain actors "from farm to fork" (FAO, 2021).

Prior to 2011 there was little if any distinction made between food loss and food waste and the term "post-harvest loss" was used indistinctively with no precise definition, although the terms "physical", "quality" and "market force losses" were used from the late 1990s to differentiate between fish that was completely lost or wasted from a supply chain and fish which had suffered quality or value degradation (Ward and Jeffries 2001). FLW is now, however, defined as the decrease in quantity or quality of food along the food supply chain (FAO, 2019):

- Food loss: The decrease in the quantity or quality of food resulting from decisions and actions by food supply chain actors from the production stage up to, but excluding, retailers, food service providers and consumers.
- Food waste: The decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers.

Reducing FLW is widely seen as an important way to reduce production costs and increase the efficiency of the food system, improve food security and nutrition and contribute towards environmental sustainability (FAO, 2019; FAO, 2022). According to "Wasted seafood in the United States" (Love *et al.*, 2015) loss prevention would also reduce unnecessary production and harvesting, which would improve the ecological sustainability of fisheries and aquaculture, contribute to increased future food security and reduce the carbon and energy used in production and trade per unit of seafood consumed (Cuéllar and Webber, 2010).

Solutions to FLW will provide economic benefits, have a positive impact on food and nutrition security, improve natural resource use efficiency and reduce negative environmental impacts and waste streams. Solutions typically require action by the public and/or private sectors. Actors in the value chain may need an incentive to change, such as cost effectiveness or increased profit, a secured environment for business in which there is sustained support for promoting effective loss reduction, and enforcement of the rules to deter irresponsible practices. Policymakers and the public sector require solutions to be economically advantageous and generate benefits for society. Looking beyond the business case for FLW reduction, there are also gains from reducing FLW for society at large that private stakeholders do not necessarily consider. This broader economic case provides a justification for public interventions on FLW reduction. It is built on three pillars for boosting societal well-being: improving productivity or job creation in the food supply chain as a whole; improving the food security or nutrition status of the most vulnerable; and mitigating the negative environmental impacts of FLW in terms of greenhouse gas (GHG) emissions and pressure on land and water resources (FAO, 2019).

Even though fish loss and waste is an important developmental issue and there have been improvements in technology, practices and regulatory frameworks, the success rate of donor and development agency-led interventions has been poor. One of the reasons for this has been a tendency to take a one- or two-dimensional approach to designing and implementing solutions aimed at reducing FLW. For example, focusing on the introduction of an improved technology without considering market dynamics, capacity building and investment requirements.

This guide describes a more multidimensional solutions (MDS) approach to reducing FLW, which, whilst more challenging to apply, is felt will likely lead to more successful interventions. The guide gives an overview of the MDS concept, followed by a description of a process that can be used to develop long-term multidimensional FLW solution strategies for the fisheries and aquaculture sector. Case studies are included, as well as observations on given application issues. The guide is aimed at development practitioners and decision-makers who want to take a more holistic view of how FLW can be addressed and are interested in applying and/or adapting a practical approach to the design of associated long-term strategies.

Multidimensional solutions to reducing fish loss and waste

This section presents some background to the MDS approach to addressing fish loss and waste. It begins with a look at aspects of fish loss and waste before providing evidence in support of a holistic approach to FLW solutions.

Loss and waste are a feature of the fisheries and aquaculture sector and efforts to understand and characterize the causes of, as well as to research and develop ways of reducing fish loss and waste, have been ongoing. One could argue the development of fish preservation methods such as drying, salting and smoking and the use of ice were interventions designed to reduce FLW. Such interventions originated thousands of years ago with the ancient Greeks, Romans and Chinese (Sikorski 1990; Huss, 1995). More recently, the use of fish waste and bycatch or discards was noted in the 1950s (Borgstrom, 1962). In the 1960s researchers began to measure or estimate the levels of FLW, especially the physical loss of cured fish in Africa and Asia. This carried on into the 1970s and 1980s (Ames, Clucas and Scott Paul, 1991; FAO, 1981; TDRI/CEASM, 1986) and influenced the development of designated fish loss assessment methodologies in the mid-1980s, focused on measuring physical losses (Wood, 1985) and the later development of both qualitative and quantitative approaches to assess not only physical but also quality losses and loss due to market forces (Ward and Jeffries, 2001; Diei-Ouadi and Mgawe, 2011). More recently, assessing the gender dimension of FLW has been mainstreamed (Randrianantoandro, Ward and Safa Barraza, 2022) and fish is also the focus of the Food Loss Index methodology (FAO, 2018). These methods enable a greater analysis of both technical and socioeconomic factors which influence how fishery operators are affected by and respond to FLW, as well as to how these factors can be considered in the design of FLW solutions.

Despite ongoing efforts to assess, understand and reduce FLW, it persists today in the value chains of many fisheries. Many well-intentioned interventions have focused more on introducing improved technologies and practices, without sufficiently considering the broader range of factors, e.g. socioeconomic, gender- or market-related factors, which impinge on the uptake and sustainability of the interventions (UNIFEM, 1988). Development practitioners have promoted the idea of a multidimensional approach to small-scale fisheries interventions. In other words, a more multidisciplinary approach is more likely to lead to more sustainable FLW solutions (Gordon, 2009).

Further indications of the need for a broader approach can be found in the proceedings of a conference on food security and income generation through the reduction of losses and waste in fisheries, held in Mauritania in December 2013 (FAO, 2016) which suggests that the reduction of FLW should consider supportive policies and legislation as well as skills, knowledge, services, infrastructure and technology. The proceedings provide the following set of conclusions that should inform FLW solution design and implementation, highlighting the need for a more multidimensional approach:

- Technology must be well researched, proved to be effective and tried and tested.
- Infrastructure and services often require upgrading and/or modernization.
- Government support plays an important role in terms of policy and commitment.
- Legislation to support the adoption of technology and use of infrastructure must be clear.
- An intervention should meet national and, if appropriate, international standards.

- Capacity building in knowledge, skills and understanding is important for all beneficiaries, including service providers in technical and non-technical issues.
- Consumers must be involved.
- Local government must be involved and kept informed.
- Land tenure issues must be understood and addressed.
- Infrastructure and services must be designed and built to high environmental and social standards.
- Lessons learned from previous initiatives must be incorporated into planning and implementation.
- Technology must be affordable (simple/appropriate) and easily available.
- The market for products and the opportunities must be understood for improved quality and value-added products.
- Learn from and use existing coping strategies to reduce FLW.
- Involve and communicate with beneficiaries (FAO, 2016).

Echoing the need for a broader approach to FLW solutions, Love *et al.* (2015) suggest reducing losses of seafood requires complex and diverse actions by many different participants in the supply chain, from production to consumption. Furthermore, according to Fahrenkamp-Uppenbrink (2016), post-harvest loss interventions should be appropriate to the socioeconomic, business and political context of a country.

These researchers go on to state that collaborative initiatives can help to build capacity to reduce FLW, facilitate sharing and transferring of best practices and motivate and inspire action and joint problem solving (Fahrenkamp-Uppenbrink, 2016). Love *et al.* (2015) propose that waste prevention strategies to reduce seafood loss and create a more efficient and sustainable seafood system must involve governments, businesses and consumers. Fahrenkamp-Uppenbrink (2016) highlights that targeting solutions toward women may be especially effective.

At the global level, the Voluntary Code of Conduct for Food Loss and Waste Reduction (CoC FLW) promotes a multidimensional and multistakeholder approach. The CoC FLW highlights the importance of policy, technology, knowledge and skills, infrastructure, services, the regulatory framework as well as social and gender issues and market access. It informs the application of an MDS approach by providing:

- internationally recognized guiding principles and standards for responsible practices for FLW reduction;
- a framework for strategies, policies, institutions, legislation and programmes on FLW reduction; and
- guidance to gauge the effectiveness of FLW solutions.

Furthermore, the CoC FLW advocates that input suppliers, producers, processors, distributors, retailers and other food supply chain stakeholders should work together:

- Governments and development organizations provide facilitation and information to help the development of productive and fair partnerships among food supply chain actors and facilitate the inclusion of all actors.
- Governments encourage all stakeholders to work holistically and collaboratively towards improving food systems to reduce FLW.
- Countries and development partners should support, promote and coordinate multistakeholder FLW reduction initiatives (FAO, 2022).

The information and recommendations presented point towards a more holistic approach to addressing FLW. The next section describes how this approach can be operationalized.

Developing a multidimensional solutions strategy

This section describes a practical approach to the development of an MDS strategy to FLW in aquatic value chains (**Box 1**). The strategy development process is based on an FLW assessment or a current understanding of:

- where and when FLW occurs;
- what the causes are, and the reasons for those causes;
- how great the extent is (i.e. the volume and the economic, environmental and social impact); and
- who the key affected stakeholders are (as well as the potential beneficiaries of MDS).

The MDS strategy development process described here is ideally undertaken by a multidisciplinary team of public and private sector stakeholders with knowledge and experience in the national context of what are termed the seven key MDS entry points:

- policy;
- social and gender equity;
- services and infrastructure (including financial services);
- markets;
- technology;
- skills and knowledge; and
- regulatory framework.

This multistakeholder group develops an MDS strategy in a workshop setting using a participatory theory of change (TOC) process[1] adapted to the fish loss and waste context. The process, summarized in **Figure 1**, should be facilitated by people who understand the TOC process and FLW issues. It includes theory presentations, group activities and plenary discussions.

Box 1
Fish loss and waste data

Several of the CoC FLW generic principles for a multidimensional FLW approach touch on issues dealing with data: build the evidence base (magnitude, drivers/causes of FLW) using surveys and assessments, frameworks and incentives to collect and share FLW data; strengthen the data collection; ensure adequate technical capacity for data collection; and establish a FLW baseline for monitoring.

For many fisheries value chains there is a lack of recent data and information on fish loss and waste. If this is the case, then undertaking an assessment should be considered before developing an MDS strategy.

[1] Based on work by the FISH4ACP. For additional information, see: www.fao.org/in-action/fish-4-acp/en

(Cont.)

There are several FLW assessment and survey methods that can be used in fisheries and aquaculture value chains to generate valuable qualitative and quantitative data (Kruijssen *et al*., 2020). These include:

- Exploratory fish loss assessment (EFLAM) (Ward and Jeffries, 2001; Diei-Ouadi and Mgawe, 2011).
- Load tracking (Ward and Jeffries, 2001; Diei-Ouadi and Mgawe, 2011).
- Quantitative fish loss assessment (Ward and Jeffries, 2001; Diei-Ouadi and Mgawe, 2011).
- Gender-responsive fish loss assessment methodology (Heyl and Totobesola, 2025).
- Guidelines on measurement and assessment of fish loss data (FAO, 2020).
- Food loss analysis: causes and solutions – case studies in the small-scale agriculture and fisheries subsectors (FAO, 2016).

According to the CoC FLW, countries should follow the Food Loss Index (FLI) methodology and implementation strategy that they find most appropriate to collect the basic quantitative FLW data that will feed into the FLI (SDG indicator 12.3.1a, also referred to as the FLI and the SDG indicator 12.3.1b, also referred to as the Food Waste Index [FWI]) (FAO, 2022). For that purpose, guidelines for estimation measurements of fish and post-harvest losses have been prepared (FAO, 2020).

The FWI provides a consistent methodology to measure quantitative food waste at the retail, food service provider and consumer stages of the food supply chain. Countries should use the most appropriate methodology to collect food waste data for SDG 12.3 reporting, such as waste compositional analysis, direct measurement and mass balance for households; and waste compositional analysis or direct measurement for households; counting/scanning, interviews and surveys or mass balance for the retail sector (FAO, 2022).

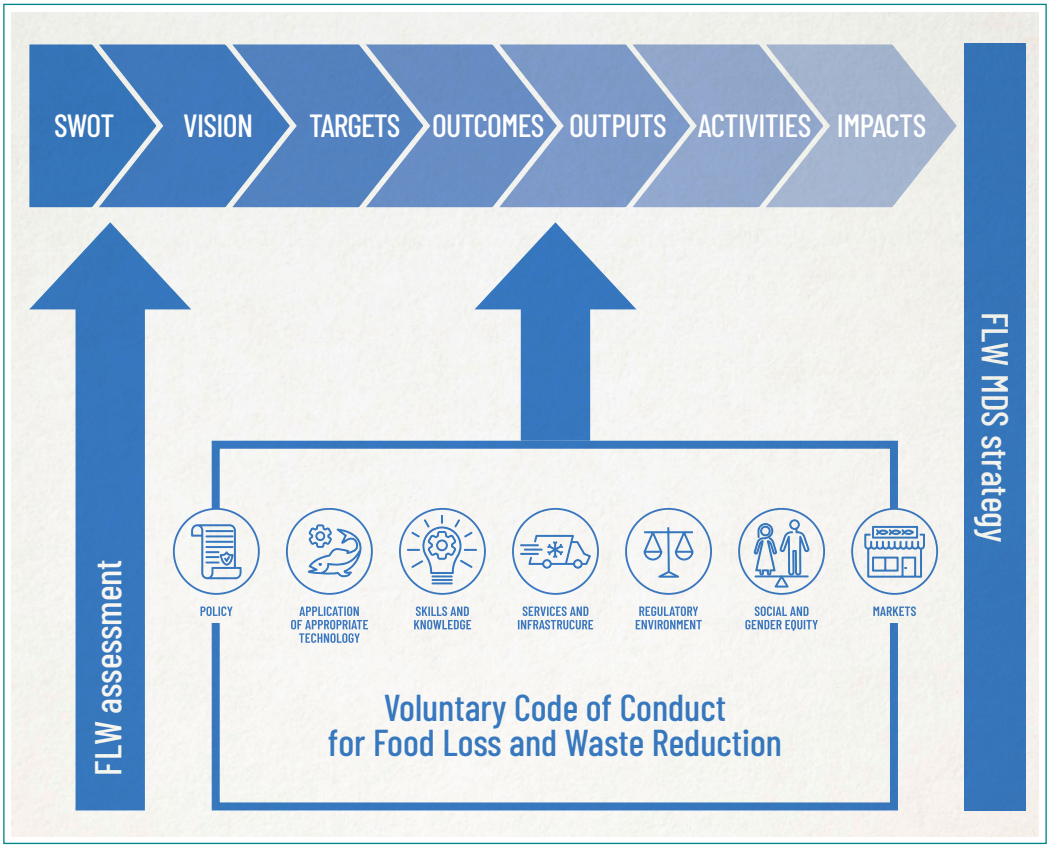
As there can be a myriad of FLW scenarios and potential solutions across a range of entry points, decision-makers must carry out cost-benefit analysis (CBA) as part of the decision-making process.

Measuring the economic and environmental impact and cost-effectiveness of solutions in terms of FLW reduction is important. One approach is to measure before and after situations. The concept of **load tracking** can be used to help with this (FAO, 2005). Repeating the application of FLI, FLW or other assessment tools could also be used in this regard. Subsequently, the impact analysis and cost-effectiveness analysis can be done with the Ex-Ante Carbon-balance Tool for Value Chains (ExACT-VC) (FAO 2017, 2023).

Source: Authors' own elaboration, based on **Kruijssen, F., Tedesco, I., Ward, A., Pincus, L., Love, D. & Thorne-Lyman, A.L.** 2020. Loss and waste in fish value chains: A review of the evidence from low and middle-income countries. *Global Food Security*, 26: 100434; **Ward, A. & Jeffries, D**. 2001. *A manual for assessing post-harvest fisheries losses.* Chatham, UK, Natural Resource Institute; **Diei-Ouadi, Y. & Mgawe, Y.I.** 2011. *Post-harvest fish loss assessment in small-scale fisheries: A guide for the extension officer*. FAO Fisheries and Aquaculture Technical Paper No. 559. 93 pp. Rome, FAO. www.fao.org/3/i2241e/i2241e.pdf; **FAO**. 2022. *Voluntary Code of Conduct for Food Loss and Waste Reduction*. 48 pp. Rome. https://openknowledge.fao.org/items/5d3c06c3-b570-43fc-adf4-74e04f9909bc; **Heyl, J.N. and Totobesola, M. 2025.** *A gender-responsive methodology for fish loss assessment in the small-scale fisheries sector*. FAO Fisheries and Aquaculture Circular, No. 1287. Rome, FAO. https://doi.org/10.4060/cd4304en; **FAO**. 2020. *Guidelines on the measurement of harvest and post-harvest losses – Estimating fish and post-harvest loss measurement in Guyana. Field test report*. Rome. www.fao.org/3/cb2497en/cb2497en.pdf; **FAO**. 2016. *Regional Conference on Food Security and Income Generation through the Reduction of Losses and Waste in Fisheries*, 15–17 December 2013, Nouakchott, Mauritania, p. 15–17. www.fao.org/family-farming/detail/en/c/449993; **Ndenn, J. Teutscher, F & Diei-Ouadi, Y., eds**. 2005. *Report and papers presented at the seventh FAO Expert Consultation on Fish Technology in Africa*. Saly-Mbour, Republic of Senegal. 10–13 December 2001. FAO Fisheries Report No. 712. Rome, FAO. **FAO**. 2017. *Ex-ante carbon-balance tool for value chain (Ex-ACT VC)*. Guidelines. Rome; and **FAO**. 2023. *Responsible use of fisheries and aquaculture resources for sustainable development (GCP/GLO/352/NOR)*. Rome. https://openknowledge.fao.org/items/5cad287b-cdc-4577-a799-96a831839ff3

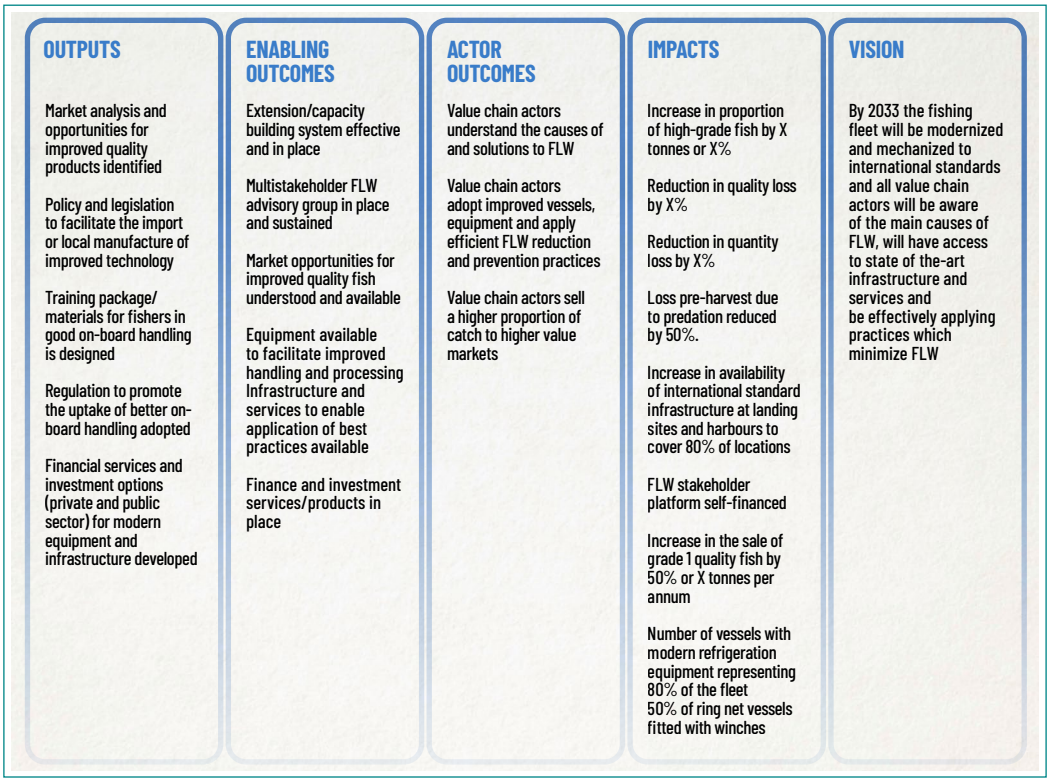
This section summarizes the key steps in the strategy development process, which are shown in **Figure 1**. It is important to try and keep a strategy and associated plan as clear and simple as possible. Targeting the strategy on a few entry points can help to achieve this simplicity, as illustrated in **Figure 2**.

FIGURE 1. **Multidimensional strategy development process**



Source: Authors' own elaboration.

FIGURE 2. **Example of key elements of a multidimensional solutions food loss and waste strategy**

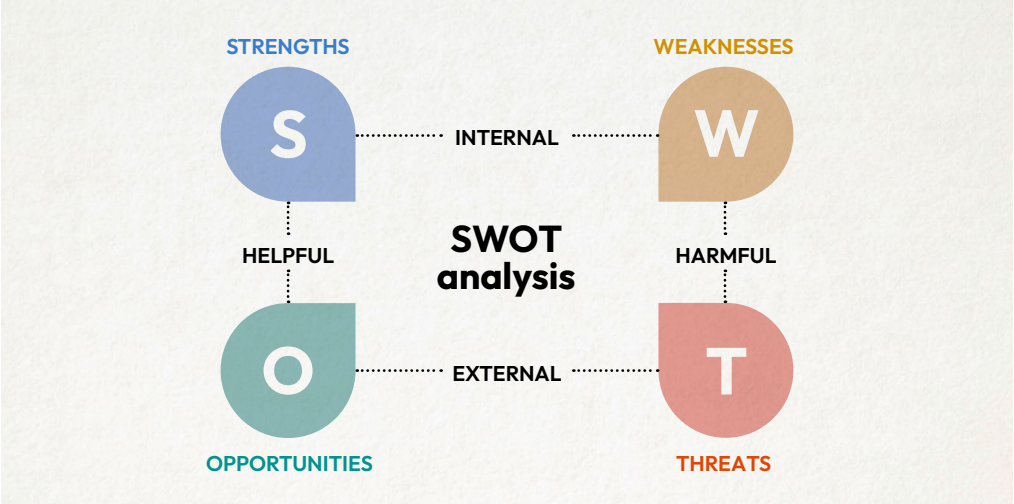


Source: Authors' own elaboration.

ANALYSIS OF STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS

The starting point for the MDS strategy development process is a FLW-focused strengths, weaknesses, opportunities and threats (SWOT) analysis of the fishery value chain and species or geographical area of interest. It is suggested that a SWOT analysis for discussion is prepared prior to the MDS strategy development process. This SWOT analysis should be based on a recent FLW assessment. The components of a SWOT analysis are summarized in **Figure 3** and **Box 2** summarizes the focus of the four pillars.

FIGURE 3. **A summary of a strengths, weaknesses, opportunities and threats analysis**



Source: Adapted from @TImCohn. 2024. A simple SWOT analysis diagram. In: *Author Tim Cohn's blog*. [Cited 21 October 2024]. https://timothycohn.com/2010/07/13/a-simple-swot-analysis-diagram

Box 2

Content of strengths, weaknesses, opportunities and threats analysis

- **Strengths**: Helpful internal factors such as economies of scale, skilled and well-equipped actors, strong collaborative networks, entrepreneurial youth, modern infrastructure or unique elements (such as unique species, locations or histories). When presenting strengths, it is useful to present the basis or origin of it, rather than only its manifestation, to learn from and apply in other value chains.
- **Weaknesses**: Harmful internal factors such as high-cost inputs, missing services, weak governance structures, lack of or inadequate enforcement of standards, lack of access to skills and knowledge and equipment, low levels of trust between actors, and time-consuming and costly regulations. When presenting weaknesses care should be taken to present the root problem/weakness itself rather than something which is a manifestation of or is caused by an underlying problem.
- **Opportunities**: Helpful external factors such as better technologies that are available elsewhere and which could be used, or growing or new markets that could be accessed under the right conditions. An opportunity is not a weakness addressed, but rather an enabling situation which the MDS strategy could use.
- **Threats**: Harmful external factors emerging from the enabling or natural environments such as the possible establishment of an unfavourable new trade agreement, weather hampering processing activities or pollution.

Source: Authors' own elaboration

FIGURE 4. **Analysis of strengths, weaknesses, opportunities and threats for a Sri Lankan multiday fishery**

Source: Authors' own elaboration influenced by outputs from the FAO-implemented Responsible use of Fisheries and Aquaculture Resources for Sustainable Development Project (FAO. 2023. *Responsible use of fisheries and aquaculture resources for sustainable development (GCP/GLO/352/NOR)*. Rome. https://openknowledge.fao.org/items/5cad287b-cdc3-4577-a799-96a831839ff3

The MDS strategy development team reflects on the SWOT analysis. This can be done using a working group activity. Key questions for the team to ask are:

- Does the SWOT analysis provide an accurate understanding of fish loss and waste in relation to the species and fishery or value chain of focus?
- What needs to be changed, added or removed?

This reflection will result in a refined SWOT analysis that has been agreed to by the whole team. **Figure 4** provides an example of a FLW SWOT analysis. The finalized SWOT analysis is used in the next step of the process – defining core strategic options.

CORE STRATEGIC OPTIONS

The SWOT analysis is used to identify and discuss core strategic options which later may become MDS strategy outcomes.

The core strategic options are identified by analysing the content of the SWOT analysis as follows:

- For each of the listed opportunities, what strengths can be leveraged and what weaknesses need to (and can) be addressed to take advantage of the opportunities?

Example: Leveraging economies of scale (strength) to access an improved technology (opportunity) that addresses an inefficient operation (weakness).

- For each of the listed threats, what strengths can be leveraged and what weaknesses need to be addressed to mitigate against the threats? Example: Using an effective network of value chain actors (strength) and partnering with a globally/regionally leading organization to access missing cutting-edge knowledge (weakness) to put in place a response mechanism for possible disease outbreaks (threat).

Which strategic options to use later to develop outcomes (and thus which factors to focus on) will depend on the vision for the MDS strategy. This is developed in the next step of the process.

VISION OF THE MULTIDIMENSIONAL SOLUTIONS STRATEGY

The next step in the MDS strategy process is to develop a vision. A good vision statement:

- is shared and agreed by the team;
- inspires (calls for action, is transformational and at scale);
- promotes the SDGs;
- deals with potential economic, social, environmental and resilience trade-offs;
- aligns with national development plans; and
- is realistic.

A shared vision statement should not be quantitative (apart from perhaps to include a date/year by which impacts should be achieved). Quantitative aspects will be captured in an accompanying set of specific, measurable, achievable, relevant and time-based (SMART) targets.

To develop the vision the team works in groups to propose what should be included in the vision.

Individuals in each group first propose three things they feel are important and should be included. Individual ideas are then organized into themes. These themes are prioritized by each group and then presented in a plenary discussion. Examples of themes include:

- duration of the MDS strategy e.g. five, ten or 20 years;
- reduced FLW aims/achievement; and
- inclusion of MDS entry points (examples provided below):
  - capacity building and development of actors (e.g. technology transfer and sustainable harvesting methods);
  - market development (through domestic and export market development, consumer awareness, new market outlets/restaurants, new product developments and valorization of shells);
  - improved equipment and infrastructure (e.g. community processing centres, personal protective equipment); and
  - improved access to finance.

An example of a vision statement is:

> By 2033, multiday boats will have increased their resilience and their profits (by 50 percent) through a reduction in quality and physical losses by 50 percent and enhanced value addition, facilitated by improved access to finance. These achievements will be brought about by revising policy and legislation, enhancing the capacity of value chain actors, improving on-board handling, developing new markets and products, and improving the equipment and infrastructure available to actors.

Specific, measurable, achievable, relevant and time-based targets

Once the vision has been drafted, a set of SMART targets is developed to go alongside it. These are the expected impacts that will determine whether the vision is being achieved. The targets should be:

- **S**pecific – the targets are concrete and specified as much as possible, e.g. specific numbers or specific standards, specific target locations or groups, etc.
- **M**easurable – to assess achievement (and encourage action) the targets need to be meaningful and measurable in terms of quantification (e.g. carbon emission levels reduced, jobs created) or presence (e.g. of a standard, a service).
- **A**chievable/agreed – a critical mass of value chain stakeholders agree on the targets, at least tentatively, based on realistic technical and behavioural assumptions as derived from the analysis (current dimensions, technical factors, political will, entrepreneurial drive, leadership buy-in).
- **R**elevant – the targets relate to something truly important to achieve, relative to the vision.
- **T**ime-based – the achievement of the target is linked to the vision date or a specific intermediate point in time.

Ideas for SMART targets include:

- Increase in proportion of improved quality fish by X tonnes or X percent by <year>.
- Reduction in quality loss by X percent by <year>, etc.
- Reduction in quantity/physical loss by X percent.
- Loss of fish pre-harvest due to predation reduced by 50 percent.
- Increase in availability of international standard infrastructure at landing sites and harbours to cover 80 percent of locations.
- National FLW stakeholder platform self-financed.
- Increase in the sale of high-quality fish by 50 percent or X tonnes per annum.
- Number of vessels with modern refrigeration equipment representing 80 percent of the fleet.
- 50 percent of vessels fitted with technology to improve on-board fish handling.

The vision and SMART targets should be reviewed to ensure they align with national priorities and policies. These targets will be used to inform the impacts of the MDS strategy.

OUTCOMES

To realize the vision requires a strategy, which is generally defined as "a method or plan chosen to bring about a desired future". The pillars of this are the outcomes.

These are either centred on behaviour change or changes to the enabling environment which are needed to affect a behaviour change. In terms of behaviour change outcomes these are typically changes in terms of practices, investments or governance required from the value chain actors to realize the vision. For example:

- Fishers adopt improved on-board handling practices.
- The private sector invests in modern ice-making facilities.
- Processors form associations which facilitate access to equipment and markets.

Enabling outcomes are equally important and are needed if behaviour change is to be effective. Examples of enabling outcomes include:

- Investment and financial services are available.
- Improved technology is affordable and available.
- Infrastructure to facilitate good fish handling has been upgraded.

Ultimately, the behaviour taking place should impact the performance of the value chain so that the vision is achieved. Performance then feeds back into the changing structure of the value chain.

After the outcomes have been finalized, outputs and activities are developed to support the achievement of these outcomes. **Figure 5** shows how the vision elements can be colour coded to highlight the key elements for which outcomes can be formulated.

Figure 5 shows four colour coded statements. These refer to:

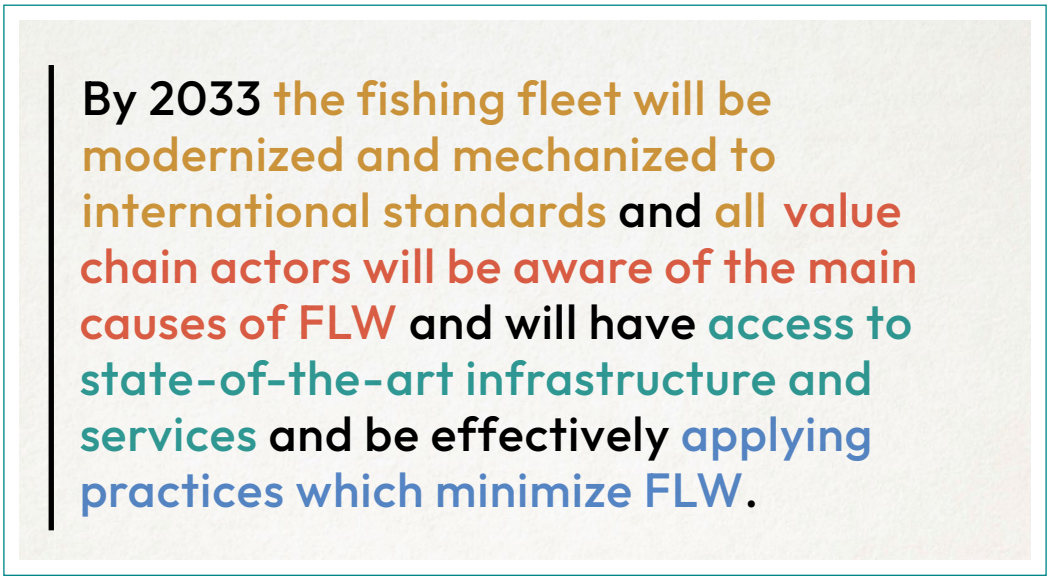
- modernizing the fleet (yellow);
- awareness amongst value chain actors (red);
- access to infrastructure and services (green); and
- uptake of better practices (blue).

Outcomes are created for each key element of the vision, ensuring that each element has an outcome and the vision is comprehensively addressed.

To ensure the outcomes effectively achieve the vision, the MDS team of specialists should ask:

- Who needs to change and how?
- What needs to be in place to help the behaviour change?
- What are the barriers and levers to the envisaged behaviour change?

FIGURE 5. **Colour coding a vision to help identify outcomes**



Source: Authors' own elaboration.

The discussion by the team of specialists should lead to the identification of:

- Behaviour changes outcomes by key actors that will contribute to achieving the elements of the vision.
- Enabling outcomes which provide the necessary environment for behaviour change to take place.

Strategic options from the SWOT analysis can be used to help this process. The outcomes should cover as many of the MDS entry points previously mentioned as possible. The outcomes are then consolidated and cross-checked against the SMART targets and vision.

OUTPUTS

The next step in the process is to identify the outputs needed to achieve the outcomes. Outputs resolve bottlenecks and change the incentives for, and capacities of, both private and public value chain stakeholders.

Take the following outcome, for example: **Fishers adopt improved on-board handling practices**.

To achieve this may require outputs centred on:

- Study (social and behavioural) of the reasons why fishers, traders and processors do not use improved practices.
- Policy or legislation is developed to facilitate the import or local manufacture of improved technology.
- Regulation is adopted to promote the uptake of better on-board handling.
- Guidance on appropriate on-board handling practices is produced and disseminated.
- A training package for fishers about good on-board handling is developed.
- Financial services and investment options for improved on-board handling equipment are produced.

Through discussion (group and/or plenary) a set of outputs is agreed for each behaviour change and enabling outcome.

ACTIVITIES

To produce an output requires a set of activities. Activities can include assessments, analytical work, reviewing legislation, lobbying, policy processes, pilot studies, reviews, production of information materials, communication, identification of sources of investment and financial support, organizational strengthening, creating partnerships and strengthening linkages between actors and organizations.

For example, the output "Guidance on appropriate on-board handling practices is produced and disseminated" may have the following activities:

- Assess equipment needs and specifications to enable application of best practices.
- Identify a set of proposed improved practices from the assessment.
- Procurement of equipment for a pilot demonstration of improved practices.
- Pilot demonstration of improved practices and measurement of impact and uptake issues.
- Review of practices and equipment.
- Development of a good practices guide.

- Production of materials e.g. posters, videos and handouts.
- Training of trainers in improved practices application.
- Roll out of training and capacity building programme for fishers.
- Matching grants for early adopters.
- Monitoring and evaluation plan designed.

A set of activities is identified and agreed for each output.

VALIDATION AND BUDGETING

The MDS strategy development process described here must be conducted by a multidisciplinary team of public and private sector stakeholders with knowledge and experience of the national context. The process described will have led to the development of a draft MDS strategy. An important next step will be to have the draft reviewed and validated by a wider group of specialists (e.g. economists, technologists, sociologists/gender, market specialists) and decision-makers with a view to finalizing the strategy and ideally having it adopted by national authorities as part of the implementation process.

The MDS strategy provides a plan and a set of activities that will need to be costed. Understanding the financial implications of strategy implementation is important for national internal budgeting purposes but also to attract investment from the private sector and development agencies, depending on the national capacity to fund implementation.

Case studies

TABLE 1. **Summary of case studies**

Country	Fishery of focus	FLW	Key features
Sri Lanka	Multiday pelagic fishery	High levels of quality losses due to on-board handling issues	Ten-year strategy to reduce quality loss by 30%. Focused on improved technology, better practices, consumer demand, legislation, local government and awareness raising
United Republic of Tanzania	Marine and inland small pelagic fisheries	Physical and quality losses at different stages of the supply chain	A seven-year strategy to reduce FLW by 60% with better fisheries management, reduced trade barriers, improved practices, market opportunities, services and enabling environment, with a focus on gender
Colombia	Tumaco region, Pacific coast	Physical losses including by-products	Ten-year strategy to reduce losses by 30% by improved fishing and on-board practices, market initiatives, by-product utilization, consumer awareness and improved governance

Source: Authors' own elaboration.

To illustrate how the multidimensional approach to FLW has been applied, this section provides three case studies from the FAO-implemented Responsible use of Fisheries and Aquaculture Resources for Sustainable Development Project (FAO, 2023) which summarize MDS strategies that address FLW in Sri Lanka, the United Republic of Tanzania and Colombia. These case studies show how the MDS approach can be used in different fishery and national contexts to address different types of FLW.

Table 1 highlights key features of, and differences between, the three case studies. The case studies are then presented in more detail. Please note that that the data referring to quality loss in each case study refer to the proportion of fish sold for a low price due to quality changes.

MULTIDIMENSIONAL SOLUTIONS FOR REDUCING LOSS IN MULTIDAY BOAT FISHERIES IN SRI LANKA

In Sri Lanka, marine fisheries provide over 80 percent of the average 500 000 tonnes of fisheries production per annum (Penarubia *et al.*, 2023). Even though per capita fish consumption in recent years has declined from 17.3 kg/year to 15.1 kg/year, fish contributes more than 50 percent of the animal protein intake of Sri Lankans.

FLW is a significant issue in Sri Lanka's fishing industry. Poor handling and storage practices, lack of processing and preservation technology and inadequate infrastructure lead to FLW at various stages of the value chain. FLW negatively impacts the income and livelihoods of fishing communities and food and nutrition security. However, the lack of data on fish losses makes it difficult to develop effective policies and solutions.

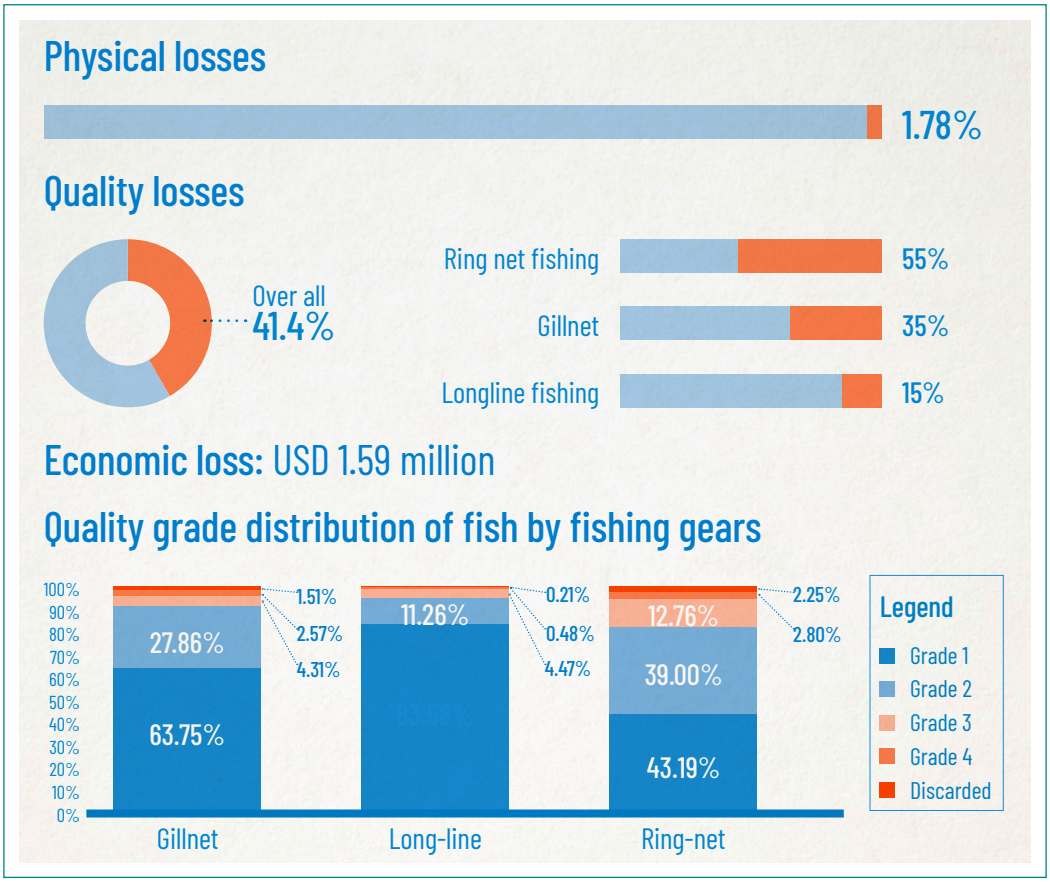
A key step to address the status quo has been the formation of a FLW Working Group, comprising representatives from the Ministry of Fisheries, Department of Fisheries and Aquatic Resources (DFAR), National Aquatic Resources Research and Development Agency (NARA), the Ceylon Fisheries Harbour Cooperation, National Aquaculture Development Authority, Ceylon Fisheries Cooperation, Export Development Board, Ministry of Health, academia, banking sector, media, private sector fisheries stakeholders, as well as non-governmental organizations and civil society organizations. This working group was formed to provide strategic direction, coordination and guidance for FLW activities, including planning, validation and dissemination of outputs and results and monitoring.

Sri Lanka's deep-sea multiday fishing fleet spends weeks at sea catching large pelagic fish such as tuna and scad. The fishery and its associated value chain were identified by the FLW Working Group as a priority. The fishery is important in terms of production volume as well as its contribution to national food security and to fish exports. It employs many people in both fishing and post-harvest activities. The fishery is also associated with FLW.

A team of researchers from NARA and DFAR undertook a fish loss and waste assessment of the multiday fishery using the exploratory fish loss assessment method (EFLAM) method and a quantitative questionnaire survey based on the FLI methodology. The assessment focused on vessels and activities at eight fishing harbours.

Figure 6 summarizes the results of the FLW assessment, which shows that poor on-board handling and preservation is a key cause of losses in fish quality, which lead to low prices and lost income. Vessels using ring nets and gillnets were found to be more closely linked to FLW than those using longlines.

FIGURE 6. **Summary of a food loss and waste assessment for the Sri Lankan multiday fishery**



Source: FAO. 2024. *Fish loss in the multiday fisheries subsector in Sri Lanka*. https://openknowledge.fao.org/server/api/core/bitstreams/86cf3800-b37f-4b5b-ab8b-b86c93e32a1a/content

Using the detailed results of the FLW assessment, an MDS strategy was developed by a multistakeholder team over the course of three days using the MDS TOC process. The MDS strategy was subsequently validated and endorsed by the FLW Working Group and the Sri Lankan government.

The vision of the MDS strategy is:

> By 2033, the quality loss in the multiday fishery of Sri Lanka will be reduced by 30 percent through the implementation of policies and the introduction of improved new technology, a strengthened regulatory framework, enhanced skills and knowledge, systems and practices, as well as the development of infrastructure, contributing to an improved domestic and export sector and ultimately to the national economy and food security and nutrition. Sri Lanka will be a leading country in south Asia in fish loss and waste reduction (Penarubia *et al.*, 2023).

The strategy has the following outcomes that highlight the multidimensional approach:

- Boat owners, skippers and fishers apply improved technology and better practices.
- Consumers appreciate, are prepared to and can afford to pay more for better quality fish.
- Ice producers supply better quality ice.
- Regulatory bodies and the government are better able to implement legislation e.g. food safety standards.
- Supply chain actors (transporters, wholesalers and retailers) improve handling practices.
- Processors and buyers supplying the domestic market demand better quality fish.
- Local government authorities are empowered to invest in and support fish loss and waste solutions.
- Research organizations disseminate and raise awareness of results at grassroots level.

To achieve each of these outcomes, outputs and activities in the MDS strategy focus on:

- plans and assessments;
- technology transfer, innovation and design;
- finance and investment;
- capacity building;
- policy and regulatory framework reviews and reform; and
- empowerment of stakeholders.

The Sri Lankan authorities and partners are now implementing aspects of the MDS strategy and using it to attract further investment to enable implementation of all the activities and outputs proposed.

MULTIDIMENSIONAL SOLUTIONS FOR REDUCING LOSS IN THE *DAGAA* FISHERIES OF THE UNITED REPUBLIC OF TANZANIA

The United Republic of Tanzania produces just under 475 000 tonnes of fish annually. The catch is dominated by various species of freshwater and small marine pelagic fish. These small pelagic fish species are known as "*dagaa*". Both the inland and marine *dagaa* fisheries have grown rapidly, accompanied by increased numbers of fishers and processors and added fishing pressure. Despite their importance, *dagaa* fisheries are associated with high FLW caused by inadequate handling, processing and storage facilities. Improved technology and facilities are not readily accessible to those involved in the supply chain which is one reason why FLW reduction has not gained traction.

To invigorate efforts to reduce FLW, a multidisciplinary working group was created comprising representatives from the Environmental Management and Economic Development Organization, national universities, the Tanzania Fisheries Research Institute (TAFIRI), Department of Fisheries, local government and the small-scale fisheries and aquaculture sector. The working group provides strategic direction, coordination and guidance for FLW activities, including planning, validation and dissemination of outputs and results, as well as monitoring of the FLW situation.

To fill the data gap and develop a robust way forward to tackle FLW, the FLW Working Group endorsed an assessment of the *dagaa* fisheries and aquaculture sector. A research team led by TAFIRI generated qualitative and quantitative data from respondents at key Indian Ocean, Lake Victoria and Lake Nyasa locations. The selection of locations was based on factors such as the importance of fishing, high processing and trading activities, large volumes of fish landed, as well as the presence of a significant number of fishers and other relevant actors.

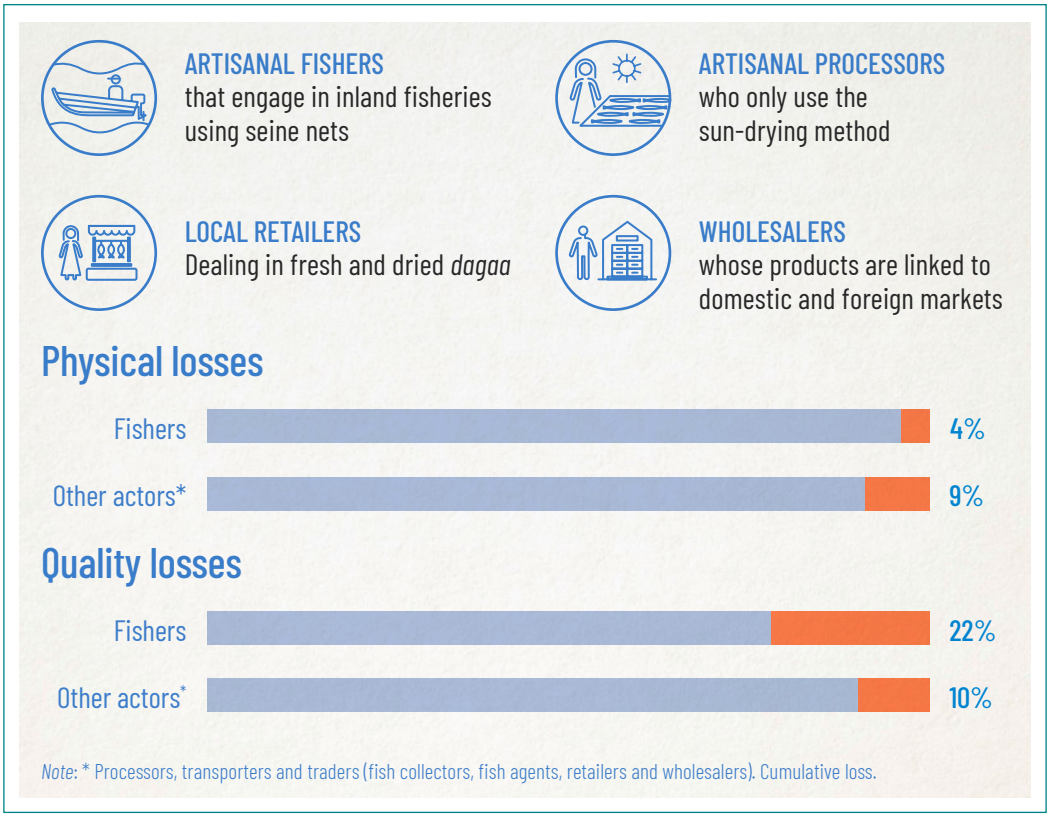
Qualitative FLW information was obtained using EFLAM, from fisheries officers, Beach Management Unit leaders and market leaders, as well as through focus group discussions and a stakeholders' validation workshop.

Quantitative data came from a FLI questionnaire survey. A Computer Assisted Personal Interviews system using Kobo Collect Tool software was used. The survey respondents were identified by random sampling.

The results of the assessment were shared with different stakeholders for review at a validation workshop. This workshop enabled a detailed examination of the causes of FLW in *dagaa* supply chains and included the development of a SWOT analysis.

The FLW assessment showed that *dagaa* has two primary marketing channels – domestic and export – and that each channel is associated with significant physical and quality losses. The key actors and their roles, as well as the estimates of losses, are summarized in **Figure 7**.

FIGURE 7. **Summary of *dagaa* food loss and waste assessment data**



Source: FAO. 2024. *Fish loss in the dagaa fisheries in the United Republic of Tanzania*. Rome. https://openknowledge.fao.org/server/api/core/bitstreams/83a31866-fe3c-49c8-8bf8-4c2819515505/content

The main causes of FLW were:

- trade barriers;
- weak cold chain systems, storage and transportation;
- poor organization, coordination and communication among actors;
- inadequate capital associated with a lack of credit facilities;
- flaws in land tenure and ownership rights limiting ability to establish improved technical solutions such as drying racks;
- oversupply of *dagaa* in markets (particularly during rainy seasons);
- longer holding time of *dagaa* by fishers;
- poor quality of *dagaa* products;
- low level of technology applied throughout the *dagaa* value chain;
- ineffectiveness of the sun-drying method during rainy season;
- poor packaging materials and practices;
- lack of knowledge and skills on fish handling and value addition;
- market inaccessibility and lack of market information among actors;
- low level of social inclusion for women at the production node; and
- lack of access to production technologies by women.

The results of the FLW assessment were used by a multistakeholder team to develop an MDS strategy. The MDS strategy was developed in a workshop setting using a TOC process. The strategy aligns with and complements the CoC FLW and contributes towards realizing the National Development Vision (2025) and the National Fisheries Policy of 2015. The MDS strategy was validated and endorsed by the Tanzanian government.

Its vision is:

> By 2030, *dagaa* value chain actors will reduce fish losses by 60 percent with improved availability of appropriate infrastructure and technologies, supportive policies and legal framework, adequate market access and gender equity.

The strategy has several outcomes to achieve the vision. These are:

- Small-pelagic fisheries management plans operationalized and adopted.
- Trade barriers reduced.
- Product diversification and market opportunities expanded.
- New low-cost technologies, facilities, value addition, quality control and safety standards and practices adopted.
- Legal framework and regulations strengthened.
- *Dagaa* product quality improved.
- Weekly auction operationalized.
- Border market points operationalized.
- Value chain actors improve handling and storage practices.
- Government improves fish landing, marketing and storage infrastructure.
- Government upgrades feeder roads and creates an enabling environment for the private sector.
- Effective capacity building programmes developed.
- Value chain actors acquire and use new skills and techniques.
- Value chain actors use systems offering weather information.
- Microcredit schemes established and prioritizing women and women's groups.
- Opportunities for women to better participate in and benefit from supply chains.

The Tanzanian authorities and partners are now implementing aspects of the MDS strategy and using it to attract further investment to complete all the activities and outputs proposed. A global fisheries development organization has already shown interest in implementing aspects of the strategy.

MULTIDIMENSIONAL SOLUTIONS FOR REDUCING LOSS IN THE TUMACO FISHERIES AND AQUACULTURE SECTOR IN COLOMBIA

In October 2022, the national Inter-Institutional Panel on Aquatic Food Losses and Waste (PIPDA) was established to steer fish loss and waste activities in Colombia. The PIPDA FLW Working Group selected Tumaco, a relatively marginalized area of Colombia in the Department of Nariño on the Pacific coast, known for its important fisheries and aquaculture sector and pressing FLW challenges, as a pilot location for FLW assessment and reduction.

The Institute for Marine and Coastal Research (INVEMAR) undertook an FLW assessment. Focus group discussions and semi-structured interviews with fisheries stakeholders provided detailed information on FLW, gender and the value chain. This information was backed up by field observations and the results of a FLI questionnaire survey. The data from the latter was generated from 422 interviews and was analysed using ArcGis Survey®.

A summary of key results from the FLW assessment for four important value chains associated with Tumaco is provided in **Figure 8**.

The main causes of FLW were:

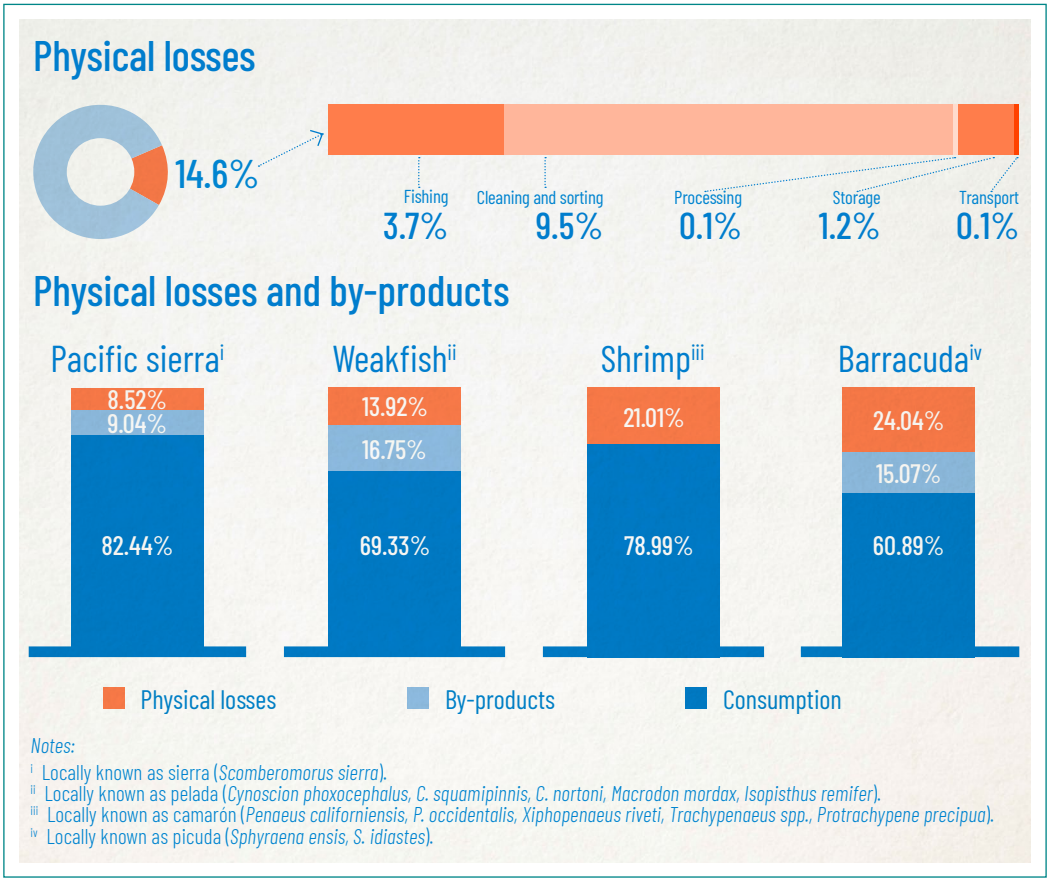
- inadequate fishing gear;
- vessel design did not favour good handling and preservation on board;
- limited knowledge of good handling;
- inefficient processing methods;
- limited knowledge of hygiene and sanitation practices;
- inadequate cold chain;
- inadequate conservation methods;
- cross-contamination;
- catch of species with a low market value;
- inadequate storage of products;
- discarded parts or products;
- lack of technology and tools for proper handling;
- factors that may contribute to FLW at the consumer level;
- non-compliance with aesthetic and safety standards; and
- abundance of food and low prices.

Using the FLW assessment results, an MDS strategy was developed in Tumaco by regional and national representatives of the Ministry of Agriculture and Rural Development, National Aquaculture and Fisheries Authority, Colombian Agricultural Institute, Tumaco Mayor's Office, National Learning Service, Agroindustrial Centre, National University of Colombia Palmira Campus, University of Magdalena, Nariñense Federation of Artisanal Fishermen, INVEMAR, FAO and Conservation International Colombia. The strategy was agreed and validated at local and national workshops.

The MDS vision is:

> By 2033, Tumaco will be a model municipality of a consolidated strategy for the 30 percent reduction of losses in the small-scale fishing value chain, which contributes to the improvement of livelihoods and food and nutritional security of the fishermen. The actions will be aimed at updating and implementing public policies, the generation and transfer of knowledge, access to sustainable infrastructure with appropriate technology, the development of new products, market diversification and a differential approach, stimulating the spirit of community in the communities, entrepreneurship and collective governance.

FIGURE 8. **Physical losses in the Tumaco value chain**



Source: FAO. 2024. *Fish loss in the artisanal fisheries subsector in Tumaco, Colombia*. Rome. https://openknowledge.fao.org server/api/core/bitstreams/11a3d90b-3a2d-43f8-ad12-a5f8e41d1281/content

The strategy has the following outcomes to achieve the vision. These highlight the multidimensional approach:

- Fishers adopt responsible fishing strategies, use selective fishing gear and improve the handling and conservation of raw material with the required financial education and application of safety and quality standards.
- Build capacity in fishers based on exchanges of experiences related to on-board handling.
- Fair trade practice and incentives from the markets that promote responsible fishing.
- Markets that demand fish products that meet quality standards and thus promote responsible consumption.
- Economic initiatives for the use of by-products.
- Consumer awareness to promote consumption of fish products that meet quality standards and environmental sustainability.
- Government facilitates inclusive participation and advocacy mechanisms that strengthen local governance.
- Optimize and make efficient use of available resources (infrastructure and information systems).
- Strengthen organizational capacity.

Assessments, capacity building, the introduction of improved practices, new equipment and technology, networking, value addition, organizational strengthening, market development and planning are the main approaches that will be used to achieve the outputs.

Application of a multidimensional approach to fish loss and waste management

This section introduces issues related to data, MDS strategy design and its implementation

DATA AND INFORMATION

An MDS strategy will only be as good as the data and information used to inform it and the knowledge and understanding of those who develop it. Good and recent data and information is crucial to designing a realistic MDS strategy and to implementation, monitoring and evaluation. Earlier, the importance of FLW assessment was introduced (**Box 1**).

Understanding the causes of FLW is essential to identifying appropriate solutions to reduce them, and priorities for action. FLW along the food supply chain often results from interrelated causes, which can be at micro, meso and macro level (HLPE, 2014). **Table 2** provides an overview of some of these causes and some possible solutions to consider.

In summary, microlevel causes of FLW occur at each stage of the food supply chain, from production to consumption, and result from actions or non-actions of individual actors at a stage in response (or not) to external factors.

Mesolevel causes may occur at the same stage or at a different stage of the chain where FLW takes place, or result from the ways in which different actors are organized together, relationships along the food supply chain and its suppliers, the state of infrastructure, etc. Mesolevel causes can contribute to the existence of microlevel causes or determine their extent.

Macrolevel causes of FLW account for how FLW can be explained by more systemic issues, such as a malfunctioning food system, the lack of institutional or policy conditions to facilitate the coordination of actors (including securing contractual relationships) to enable investments and the adoption of good practices.

Macrolevel causes are those that favour the emergence of all the other causes of FLW, including meso and micro causes. In the end, they are a major reason for the global extent of FLW (HLPE, 2014).

TABLE 2. **Summary of food loss and waste causes and possible solutions**

Macro		Meso		Micro	
Causes	**Solution ideas**	**Causes**	**Solution ideas**	**Causes**	**Solution ideas**
Lack of investment, policies and institutions, or inappropriate (or missing) policy or regulatory framework to facilitate coordination of actors (including securing contractual relations), their investments and the adoption of good practices (HLPE, 2014)	Policy review and revision	Lack of or inadequate equipment, transport and storage capacity	Promote investment in, access to and use of appropriate equipment, transport and storage practices	Inadequate inputs to production operations	Promote investment in, access to and use of appropriate inputs
Inadequate policies that lead to unstable prices that in turn cause producers to leave produce unharvested in fields	Policy review and revision	Poor organization, coordination and communication between food supply chain actors	Organizational capacity building	Poor scheduling and timing of harvesting operations	Appropriate technology and awareness raising amongst producers
Excessively stringent food quality regulations that pose barriers against food producers and processors accessing markets for their products	Support to assist producers to meet standards Facilitate access to new and alternative markets	Inadequate infrastructure	Facilitate investment in infrastructure (e.g. ports, harbours, landing sites, markets and access roads)	Inappropriate production, harvesting and handling practices	Capacity building in improved practices
Fiscal policies that lead to artificially distorted food prices that in turn reduce the attention consumers pay to avoid food waste (FAO, 2022)	Policy review and reform	Unsuitable conditions, practices and actions that generate FLW in downstream stages of the food supply chain	Focus on upstream causes of FLW	Poor storage conditions and temperature management for perishable products	Upgrade storage practices and capacity building
Emergencies and crises such as pandemics, natural disasters, social unrest and conflicts can disrupt local, regional and global food supply chains, which can lead to drastically increased levels of FLW	Awareness of the impact of emergencies on FLW and prevention factored into planning and preparedness processes	Insufficient information, inability to anticipate market conditions	Market research and access to market information	Inadequate conditions and marketing techniques at the retail stage	Upgrade facilities and practices
Lack of comparable and reliable information constitutes a major obstacle to the development of effectively targeted policies to reduce food losses or waste	Improving data collection and statistics on FLW (FAO, 2019).	Excessively stringent quality standards imposed by processors, retailers or target markets	Review of quality standards and dialogue with value chain actors	Poor practices of food service providers	Awareness raising and capacity building
		Confusion arising from the limited understanding of different food date labels (FAO, 2022; HLPE, 2014)	Awareness raising Review of labelling requirements	Inappropriate consumer behaviour during food purchase, preparation and consumption (FAO, 2022; HLPE, 2014).	Awareness raising

Source: Authors' own elaboration.

MULTIDIMENSIONAL SOLUTIONS STRATEGY DESIGN

Setting realistic, achievable limits or targets in terms of FLW reduction is important. While it is possible that a significant portion of FLW could be prevented, reduced or recovered for human consumption, a zero FLW scenario as the end goal in a vision is impossible. FLW solutions will most likely have economic cost implications, whether it be public sector investment in improved landing site facilities or private sector procurement of new equipment and technology, or the time and resources spent formulating policy. Individuals working in the value chain will only be willing to bear additional costs if the benefits that accrue to them outweigh such costs. In this respect, a certain level of FLW is unavoidable, depending among other things on the technology available to suppliers and consumers, as well as the perishability, distribution systems and consumption patterns of food products (FAO, 2019).

There are also the environmental connotations of FLW which accounts for 8 percent to 10 percent of global GHG emissions. Carbon dioxide is generated at every step of the supply chain, from catching to handling, processing, transportation, storage and distribution, and regardless of whether the fish produced is consumed or not, leaving a significant carbon footprint. Rotting food waste in landfills and open dumps adds considerably to GHG emissions. At the same time, solutions to FLW may have implications for GHG emissions. For example, cold chains are viewed as an important means to reduce FLW, yet in the food sector they are responsible for significant electricity demand and GHG emissions globally. Such considerations should be noted, and the trade-offs minimized when designing MDS strategies. The ExACT-VC is a quantitative multi-appraisal tool that aims to support policymakers in identifying GHG emissions along an agri-food value chain (read more about it here: www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en).

It is important to recognize that value chains are complex and changes at one stage can depend on or influence what happens at other stages. According to *Reducing food loss and waste* (Fahrenkamp-Uppenbrink, 2016) technical solutions can be effective only when other parts of the food supply chain are effective. For example, improved on-farm storage will not ultimately lead to reductions in food loss if farmers have no access to a market where they can sell their harvest surplus. Retailers using poor forecasting techniques may place food orders and later cancel them, negating per unit efficiency gains made by food processors. Therefore, progress in reducing FLW will require an integrated supply chain approach. This analogy applies equally to fisheries and aquaculture value chains. For example, efforts to introduce improved technology may have limited success if there is no development of the market for improved high-value products.

IMPLEMENTATION

The MDS approach to fish loss and waste reduction provides a systematic and integrated approach to achieving sustainable FLW reduction. Implementation is likely to require significant resources, which could come from a mixture of public, private sector and donor support. Significant investments are likely to be associated with outcomes that concern infrastructure development and upgrading of equipment, for example. Whereas assessments, planning, policy and regulatory reforms are likely to be less costly.

As these strategies are relatively long-term, it will be important to monitor and report on progress regarding implementation and bear in mind the possible need to periodically review and adapt MDS strategies over time during implementation.

Conclusions

Reducing FLW is widely seen as an important way to reduce production costs and increase the efficiency of a food system, improve food security and nutrition and contribute towards environmental sustainability. Despite past and ongoing efforts to assess, understand and reduce FLW, it persists today in many fisheries and aquaculture value chains.

Evidence suggests that a broader, more multidisciplinary and multistakeholder approach to reducing FLW will be more effective and yield sustainable results. Such an approach encompasses and combines interventions that link policy, the regulatory framework, social and gender equity, services and infrastructure, market issues and technology, as well as skills and knowledge. Guidance for practitioners wishing to adopt this approach can be found in the CoC FLW.

MDS strategies for FLW reduction have been developed using a TOC process for different fisheries contexts in Sri Lanka, the United Republic of Tanzania and Colombia. The process has led to comprehensive and holistic long-term plans, the ownership of which resides with national authorities that appear committed to seeing through the implementation process. One of the reasons for the strong ownership has been the involvement of national multistakeholder advisory groups, which include key decision-makers. These advisory groups have assisted in the development and validation of the MDS strategies.

In conclusion, the MDS approach to fish loss and waste reduction offers a systematic and integrated approach to sustainable FLW reduction. This guide is designed to inspire those who would like to take a broader and more challenging approach to FLW reduction. Implementation of the resulting MDS strategies is likely to require significant resources, which could be funded from a mixture of public, private sector and donor investment. As these strategies are relatively long-term, monitoring, reviewing and adapting them over time will be important.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Loss and waste is a feature of the fisheries and aquaculture sector and efforts to understand and characterize the causes of, as well as research and develop ways of reducing fish loss and waste are ongoing. Reducing food loss and waste (FLW) is widely seen as an important way to reduce production costs and increase the efficiency of a food system, improve food security and nutrition and contribute towards environmental sustainability.

Evidence suggests that a broader multidisciplinary and multistakeholder approach to reducing FLW will be more effective and yield sustainable results. Such an approach encompasses and combines interventions that link policy, the regulatory framework, social and gender equity, services and infrastructure, market issues, technology, as well as skills and knowledge. Guidance for practitioners wishing to adopt this approach can be found in the *Voluntary Code of Conduct for Food Loss and Waste Reduction* (CoC FLW).

This guide describes a multidimensional solutions (MDS) approach to reduce FLW, which, whilst more challenging to apply, is felt will likely lead to more successful interventions. An overview of the MDS concept and a description of a process that can be used to develop long-term multidimensional FLW solutions strategies for the fisheries and aquaculture sector are provided. Case studies are included, as well as observations on given application issues. This MDS approach is evolving but early indications are that it warrants wider dissemination, discussion, and application.

ISBN 978-92-5-139765-7 ISSN 2070-7010

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CD5069EN/1/04.25