Food and Agriculture Organization of the United Nations

FAO workshop on the safety and quality of water used in fisheries

Workshop Report

Choluteca (Honduras), 23–25 April 2025

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Abbreviations

AQH	Aquacultivos de Honduras
CAC	Codex Alimentarius Commission
CCFH	Codex Committee on Food Hygiene
CXG	Codex Alimentarius Commission Guideline
DT	decision tree
DSS	decision support system
ECA	Environmental Quality Standards (Estándares de Calidad Ambiental)
EWG	Electronic Working Group
FAO	Food and Agriculture Organization of the United Nations
FBO	Food Business Operator
GHP	good hygiene practices
HACCP	hazard analysis and critical control points
ICASUR	Industria Camaronera del Sur
JEMRA	Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment
MAPA	Ministério da Agricultura, Pecuária e Abastecimento (Brazil)
MGAP	Ministerio de Ganadería, Agricultura y Pesca (Uruguay)
MINAM	Ministerio del Ambiente (Peru)
MRA	Microbiological Risk Assessment
OIRSA	Organismo Internacional Regional de Sanidad Agropecuaria
SENASA	Servicio Nacional de Sanidad e Inocuidad Agroalimentaria (Honduras/Argentina)
SERNAPESCA	Servicio Nacional de Pesca y Acuicultura (Chile)
WHO	World Health Organization

Abstract

This FAO workshop in Honduras (April 2025) brought together 45 experts from 11 countries to address water safety and quality in fisheries. The primary goals were to present findings from Microbiological Risk Assessments, compare "fit-for-purpose" vs. "clean water" approaches, train participants on using JEMRA decision trees (DTs) for risk assessment, and support the development of Codex Alimentarius Commission (CAC) Guidelines.

Participants emphasized a risk-based, fit-for-purpose approach, highlighting the importance of assessing water sources, identifying hazards, and implementing multiple barriers. JEMRA decision trees were considered useful for FBOs in evaluating water quality, with recommendations for clarity and expanded hazard inclusion. Validation exercises demonstrated DT applicability in aquaculture and marine capture scenarios. Country representatives shared diverse regulatory frameworks and monitoring practices, noting challenges like inconsistent definitions and resource limitations. Field visits to shrimp farms provided practical insights into water management, allowing participants to apply the fit-for-purpose concept and DTs, identifying areas for improvement.

Key recommendations included developing supplementary guidance for DT implementation (case studies, monitoring protocols) and continued collaboration between Codex members, JEMRA, and national authorities to refine tools and promote consistent water safety principles in fisheries, facilitating trade and consumer confidence.

Executive summary

Background and objective

The FAO Workshop on the Safety and Quality of Water Used in Fisheries was held in Choluteca, Honduras, from 23–25 April 2025. Hosted by SENASA Honduras, the workshop convened 45 participants from 11 countries, including scientists, regulators, food business operators (FBOs), and food safety inspectors. The workshop aimed to:

- present key findings from the Microbiological Risk Assessment (MRA) 33 and MRA 41;
- compare the use of "fit-for-purpose water" and "clean water" in a real-world scenario;
- train participants in the use of decision trees (DTs) developed by JEMRA to facilitate their adoption as part of microbial risk assessments of water use and reuse in fish production and processing. Training activities comprised desktop exercises, group discussions, and field visits; and
- support the development of Codex Alimentarius Commission (CAC) *Guidelines for the Safe Use and Reuse of Water in Food Processing*.

Key messages and outcomes

Fit-for-purpose water use: Participants emphasized the importance of applying a risk-based, fit-for-purpose approach to water use in fish production and processing. This approach comprises assessing water sources, identifying hazards, evaluating treatment options, and implementing multiple barriers to ensure water safety.

Decision trees as practical tools: The JEMRA decision trees were found to be useful for guiding food business operators (FBOs) in evaluating water quality and managing risks. Moreover, participants recommended adaptation to improve clarity, applicability across diverse production systems, and inclusion of additional hazards (e.g. chemical and biological contaminants).

Validation of DTs: Desktop and field-based validation exercises demonstrated the practical application of DTs across various aquaculture and marine capture scenarios.

Country perspectives: National representatives shared regulatory frameworks and monitoring practices for water quality in fisheries and aquaculture. While approaches varied, common challenges included inconsistent definitions, resource limitations, and the need for harmonized standards.

Field visits: Visits to aquaculture shrimp farms provided real-world insights into water sourcing, treatment, monitoring, and risk management practices. Participants applied JEMRA's fit-for-purpose concept and DTs on-site. This practical application proved beneficial for clarifying definitions of safe water, assessing associated risks, and pinpointing improvements, particularly for managing mixed water systems and contamination risks.

Agreed actions and recommendations

Develop supplementary guidance to support DT implementation and adoption of the fit-for-purpose water concept, including:

- case studies and examples;
- monitoring protocols and frequency; and
- integration with Codex Alimentarius Commission Codes of Practice and national regulations.

Encourage continued collaboration among Codex Alimentarius Commission members, JEMRA experts, and national authorities to refine tools and promote consistent application of water safety principles in fisheries. This would facilitate international trade and maintain consumer confidence in fishery products.

1 Background

1.1 Context

Water plays a critical role in food production, from primary production through to processing and consumption. In the fisheries sector, water is used directly in contact with fish during washing, cleaning and chilling, as an ingredient, and indirectly for cleaning, sanitation, and temperature control (FAO and WHO, 2020). However, access to safe water is not guaranteed in all regions, and water scarcity is an increasing global concern (CFS, 2015). This has led to growing interest in the safe and sustainable use and reuse of water in food production systems.

Recognizing the need for clear guidance on water quality and safety, the Codex Committee on Food Hygiene (CCFH) requested the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) to provide scientific advice on the use of "clean water" in food production, particularly in relation to irrigation, clean seawater, and the safe reuse of processing water. In response, the *Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment* (JEMRA) initiated a programme of work to:

- develop a **fit-for-purpose** concept for water use, tailored to specific food production contexts;
- focus on priority sectors, including **fresh produce**, **fishery products**, **dairy products** and **water reuse** in food operations;
- review existing international and national guidance on water safety and risk management;
- create practical tools, such as **decision trees (DTs)**, to support risk-based assessments and monitoring of water quality; and
- identify communication strategies and critical research gaps to support implementation.

The outcomes of this work are documented in four key reports:

- **MRA Report No. 33 (2019), Safety and quality of water used in food production and processing**. It focuses on water safety in fresh produce and fishery sectors, and water reuse. It introduces the "fit-for-purpose" concept and decision support systems (FAO and WHO, 2019).
- **MRA Report No. 37 (2021), Safety and quality of water used with fresh fruits and vegetables**. It provides a detailed analysis of water use and reuse in fresh fruit and vegetable production and processing, including case studies, monitoring strategies, and recommendations for risk mitigation (FAO and WHO, 2021).
- **MRA Report No. 40 (2023), Safety and quality of water use and reuse in the production and processing of dairy products**. It provides a detailed analysis of water use and reuse in dairy production and processing, including case studies, monitoring strategies, and recommendations for risk mitigation (FAO and WHO, 2023a).

- **MRA Report No. 41 (2023), Safety and quality of water used in the production and processing of fish and fishery products.** It provides a detailed analysis of water use and reuse in fish production and processing, including case studies, monitoring strategies, and recommendations for risk mitigation (FAO and WHO, 2023b).

1.2 Objectives

The primary objective of the FAO Workshop on the Safety and Quality of Water Used in Fisheries was to support and facilitate the implementation of Codex Alimentarius Commission *Guidelines for the Safe Use and Reuse of Water in Food Processing*, with a specific focus on the fisheries sector. The workshop aimed to:

- **present and discuss key findings** from the MRA 33 and MRA 41, which provide scientific guidance on water safety in food production, particularly in fish and fishery product contexts;
- **compare** the use of the “fit-for-purpose” concept to the “clean” for safe water use in a real-world scenario;
- **validate the decision trees** through practical exercises, including desktop simulations and field visits to aquaculture operations, to facilitate their adoption across diverse fish production and processing systems;
- **facilitate knowledge exchange** among jurisdictions on regulatory frameworks, monitoring practices, and risk management strategies related to water quality in fisheries and aquaculture; and
- **gather feedback** to adapt the DTs and support the development of practical tools and guidance for broader application in Codex Alimentarius Commission member countries.

1.3 Training programme

Workshop participants, which included members of the CCFH EWG on water quality, national authorities, food business operators (FBOs) and stakeholders from across the fisheries value chain, were trained in the use of DTs developed by JEMRA to assess microbial risks associated with water use and reuse in the fishery setting. A list of participants is provided in Annex 1.

These objectives were pursued through a combination of expert presentations, group discussions, case study analyses, and on-site validation activities. The workshop agenda is presented in Annex 2.

2 Workshop proceedings

2.1 Day 1: Setting the scene and introducing the tools

2.1.1 Opening Remarks

The workshop commenced with welcoming remarks from Mirian Bueno (SENASA Honduras), who expressed appreciation to FAO and Codex Alimentarius Commission partners for their support in organizing the event. She emphasized the importance of the workshop in strengthening national capacity to apply risk-based tools for water safety in fisheries and aquaculture. She also highlighted Honduras' commitment to aligning with Codex Alimentarius Commission standards and the relevance of the JEMRA--developed tools for local implementation.

Kang Zhou (FAO) followed with an overview of JEMRA's role in providing scientific advice to governments and FBOs. He outlined the evolution of Codex Alimentarius Commission work on water safety, the rationale for developing DTs, and the importance of integrating these tools into national food safety systems.

2.1.2 Session 1: Introduction to Codex Alimentarius Commission guidelines on water use and reuse

1) Session leads

Mirian Bueno and Kang Zhou

2) Learning objective

To understand the principles of the Codex Alimentarius Commission *Guidelines for the Safe Use and Reuse of Water in Food Production and Processing CXG 100*-2023

3) Key points covered

- The Codex Alimentarius Commission Guidelines provide a risk-based framework (Box 1) for determining whether water is "fit for purpose" in food production and processing (FAO and WHO, 2024).

Box 1. Key definitions (for the purpose of this report) of water used in food production and processing[1]
Fit-for-purpose water: The quality of water used in food production and processing should be defined within the context of its use. The "fit-for-purpose" concept is a risk-based approach that articulates the relationship between the quality of the water, how it is used and for what purpose and the impact on the safety of the food. Achieving "fit-for-purpose" water requires an integrated

[1] https://doi.org/10.4060/CA6062EN

approach, linking water source, risk assessment, treatment options and efficacy, water use and food safety. This is water determined to be safe for an intended application or use through the identification, evaluation and understanding of potential hazards (e.g. microbiological, chemical) and other relevant factors (e.g. history of use, intended food use, and so on), including the application of control measures such as treatment alternatives and their effectiveness in ensuring the effective removal or mitigation of such hazards (Figure 1).

Clean water: This is water that does not meet the criteria for drinking water but does not endanger food safety in the context in which it is used.

Potable water: This is water that is suitable for human consumption.

Wastewater: This is used water that has been contaminated by human activities.

Reused water: This is water that has been recovered from a food processing step, including food components, or water that, after undergoing the necessary reconditioning treatment(s), is intended for reuse in the same, an earlier, or a later step of the food processing operation. Types of reused water include, but are not limited to, water reclaimed from food, water recycled from food operations, or water recirculated in a closed-loop system.

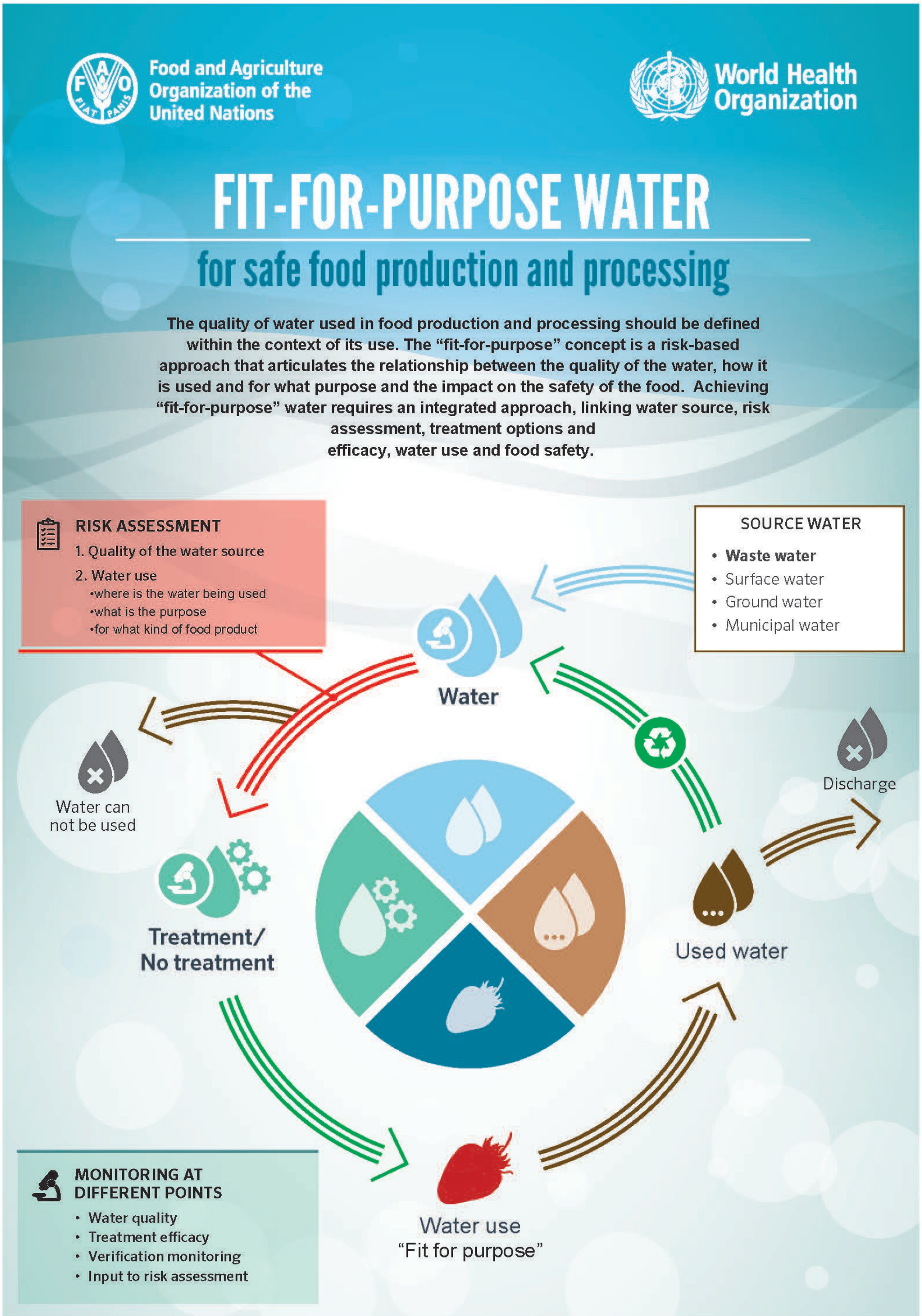

Figure 1. Diagram of the "fit-for-purpose water concept applied to food production

- The “*Guidelines for the safe use and reuse of water in food production and processing*” (FAO and WHO, 2024) provide practical advice, suggestions, and tools, as well as examples of risk-based microbiological criteria, to assist FBOs in assessing risks and potential interventions in water within their food hygiene system.
- Water, ice and steam used at any stage of the food chain must not compromise food safety and must be assessed for microbiological, chemical, and physical hazards.
- Reused water must be treated or reconditioned, monitored, and the treatment should be validated to ensure it meets safety standards for its intended use.
- The guidelines define key water types (e.g. fit-for-purpose, clean, potable, wastewater, reused; Box 1) and emphasize that water used as a food ingredient must be of potable quality.
- The guidelines are intended to support both competent authorities and FBOs in implementing effective water safety management systems.

Box 2. Types of risk assessment
Risk-based principles for evaluating water quality require an understanding of the water system, identification of physical, chemical and microbiological hazards, and monitoring and surveillance activities. There are three types of risk assessment, listed here from lower complexity to higher complexity: • **Descriptive/qualitative (rapid):** on-site assessment (health inspection) and existing documents/data • **Semi-quantitative:** risk matrices with categories of high, medium and low, probability and frequency of unacceptable health conditions leading to planning and prioritization • **Quantitative:** based on mathematical models to study the effects of pathogens on health

4) **Discussion outcome**

Participants acknowledged the value of the Codex Alimentarius Commission Guidelines but noted the need for practical tools and examples to support implementation, especially in resource-limited settings.

2.1.3 Session 2: Principles and practices in water safety for fish production and processing

1) Session lead

Carlos Campos

2) Learning objective

To understand the foundational principles, practical challenges, and risk management strategies related to water safety and quality in fish production and processing, with a focus on the application of decision support systems.

3) Key points covered

Global water scarcity and the need for reuse

- Water scarcity is a growing global concern, exacerbated by climate change, population growth, and environmental degradation.
- Many fish producers — particularly in low-resource settings — lack access to consistently safe water sources.
- Reusing water, when done safely, can reduce environmental impact and improve sustainability in fish production.

Fit-for-purpose water use

- The concept of "fit-for-purpose" water use allows for flexibility in water quality requirements based on the intended use (e.g. cleaning surfaces vs. use as a food ingredient).
- This approach requires a thorough understanding of:
    - the source and quality of water;
    - potential hazards (microbial, chemical, physical);
    - treatment options and their effectiveness; and
    - the final use of the product (e.g. raw vs. cooked consumption).

Multiple barrier approach

- A layered strategy is essential to ensure water safety. This includes:
    - source water protection;
    - filtration and disinfection;
    - monitoring and verification; and
    - good hygiene practices (GHPs) and hazard analysis and critical control points (HACCP).
- The effectiveness of each barrier must be validated and monitored regularly.

Infrastructure and contextual variability

- Water quality and availability vary significantly across regions and production systems.

- Infrastructure limitations (e.g. lack of treatment facilities or monitoring equipment) can hinder the implementation of water safety measures.
- National regulations and enforcement capacity also influence how water safety is managed.

Challenges in implementation

- Inconsistent definitions of water types (e.g. “clean,” “potable,” “reused”) create confusion for food business operators (FBOs).
- Applying Codex Alimentarius Commission-aligned standards can be complex and resource intensive, especially for small-scale producers.
- There is a need for harmonized, practical guidance that is adaptable to different production contexts.

Application of decision support tools

Carlos Campos introduced the use of DTs as practical tools to help FBOs assess water safety risks and determine appropriate control measures (Appendix 3). These tools:

- provide a structured, step-by-step approach to decision-making;
- help identify critical control points and guide the selection of treatment and monitoring strategies; and
- are designed to be adaptable to various production systems, including freshwater aquaculture, marine capture, and processing facilities.

Participants were encouraged to consider how these tools could be integrated into their existing food safety management systems and what adaptations might be needed to reflect local realities.

4) Discussion outcome

Participants engaged in a lively discussion on the practicalities of implementing water safety measures in their respective countries. Key points raised include the following:

- Fish production systems are very diverse, and each system presents its own challenges and requires context-specific water safety solutions.
- There are inconsistencies in the definitions and operationalization of water quality standards, making it challenging for FBOs to implement the standards effectively. This causes confusion and difficulties in maintaining compliance. The application of the guidelines is often complex and requires significant resources and expertise.
- The training and capacity building for FBOs and inspectors is important.
- There is a need for simplified tools and checklists to support small-scale producers.
- Opportunities to align national regulations with Codex Alimentarius Commission guidance to improve consistency and compliance are needed.

- It is crucial that FBOs use water conservatively and explore possibilities for reuse. Reusing water can help reduce the demand for fresh water and reduce the environmental impact of food production, provided it does not present a health risk to consumers.
- Infrastructure and treatment capabilities also play a crucial role in determining water quality. Areas with advanced water treatment facilities can provide safer water for food production, while regions with limited infrastructure may struggle with contamination issues.
- To address these challenges, it is important to harmonize guidelines and develop practical implementation strategies. This includes creating clear and consistent definitions of water quality standards, providing detailed guidance on how to achieve and maintain these standards, and offering support to FBOs in implementing the standards. By improving the consistency and practicality of water safety guidelines, regulators help ensure that food producers and processors can effectively manage water quality and protect consumer health.

2.1.4 Session 3: Applying the "fit-for-purpose" concept and decision trees

1) Session lead

Carlos Campos

2) Learning objective

To introduce participants to the structure, logic, and practical application of DTs developed by JEMRA, and to explore how these tools support the implementation of the "fit-for-purpose" water use concept in fish production and processing.

3) Key points covered

This session transitioned from theoretical principles to practical tools, equipping participants with a structured method for assessing water safety risks. The DTs presented are designed to guide FBOs and regulators through a step-by-step process to determine whether water used in various stages of fish production and processing is safe and appropriate for its intended use.

The session emphasized that DTs are not prescriptive checklists but flexible tools that must be adapted to specific production contexts, water sources, and regulatory environments.

Key components of the decision trees

Carlos Campos introduced the DTs featured in MRA 33, explaining their structure and intended use. Each decision tree is built around a series of 'Yes/No' questions that help users:

- identify the type of water system (e.g. open vs. closed, continuous vs. batch exchange);

- assess the likelihood of contamination (e.g. from faecal matter, agricultural runoff, or industrial discharge);
- determine the need for treatment, monitoring, or additional control measures; and
- evaluate whether the water is "fit-for-purpose" based on its intended use (e.g. washing, chilling, ingredient).

The decision trees are designed to be used in conjunction with Codex Alimentarius Commission guidelines and national regulations, and to support risk-based decision-making in diverse operational settings.

Participants engaged in a detailed review of the DTs and shared insights from their own operational contexts. Key themes included the following:

Contextual adaptation

- Several participants emphasized the need to adapt the DT to local realities, such as mixed water systems (e.g. seawater blended with well water) and seasonal variability in water quality.
- It was noted that some DTs may lead to overly conservative conclusions (e.g. deeming water unfit) without considering long-standing safe practices or mitigation measures already in place.

Terminology and definitions

- There was some confusion around terms such as "clean water," "potable water," and "fit-for-purpose" water. The participants suggested using "fit-for-purpose" water , but they also recommended harmonizing definitions and including a glossary or reference guide.
- The distinction between reused water and recirculated water was also discussed, with calls for clearer guidance on treatment and monitoring requirements. Water from natural sources can be subjected to a wide range of treatments, including filtration and disinfection.
- The role of competent authorities in ensuring the effectiveness of water treatment systems was discussed. If water is from a municipal source, the responsibility for ensuring its quality would lie with the water utility or local authority.

Integration with existing systems

- Participants discussed how the DTs could be integrated into existing HACCP plans and food hygiene systems.
- The importance of training and capacity building was highlighted, particularly for small-scale producers and inspectors.

Practical recommendations from participants

- Include additional decision points for:
    - use of seawater and artificial seawater;

    - mixed-source systems; and
    - seasonal or event-based contamination risks (e.g. flooding, algal blooms).
- Provide examples or case studies to illustrate how the DTs can be applied in different production systems.
- Develop simplified versions or visual aids for use by operators of small-scale businesses and field inspectors. Translate the DTs into different languages for use in different regions.

4) Discussion outcome

This session laid the groundwork for the hands-on validation exercises that followed on Days 2 and 3. Participants left with a clearer understanding of how DTs can support risk-based water management and expressed strong interest in refining and applying these tools in their own countries and operations.

2.2 Day 2: Desktop validation and case studies

1) Session lead

Carlos Campos

2) Learning objective

To evaluate the practical applicability of the DTs through structured group exercises using real-world case studies. The session aimed to simulate diverse fish production and processing environments, enabling participants to apply risk-based thinking and identify areas for improvement in the DTs.

3) Session structure

The day began with a briefing by Carlos Campos, who outlined the purpose of the desktop validation exercise. Participants were divided into five multidisciplinary groups, each assigned a unique case study representing a different production system. These case studies were carefully selected to reflect a range of water sources, operational scales, and risk profiles.

Each group was tasked with:

- mapping the water system and identifying potential contamination points;
- applying the relevant decision tree to assess water safety;
- evaluating the effectiveness of existing hygiene and treatment practices;
- identifying gaps in the DTs and proposing refinements; and
- preparing a short presentation summarizing their findings.

Case study summaries and insights

Group 1: Tilapia aquaculture (freshwater)

- **Scenario**: Tilapia raised in natural lagoons and reservoirs near rice fields (Figure 2).
- **Water sources**: Surface water and groundwater.
- **Risks identified**: Runoff from nearby domestic and tourist activities; seasonal flooding.
- **Controls**: Chlorination, gravity sedimentation, and floodgate management.
- **DT application**: The group found the DT helpful but considered that it would benefit from additional prompts for seasonal variability and surface water runoff.
- **Recommendation**: Include decision points for flood-prone areas and guidance on managing surface water risks.

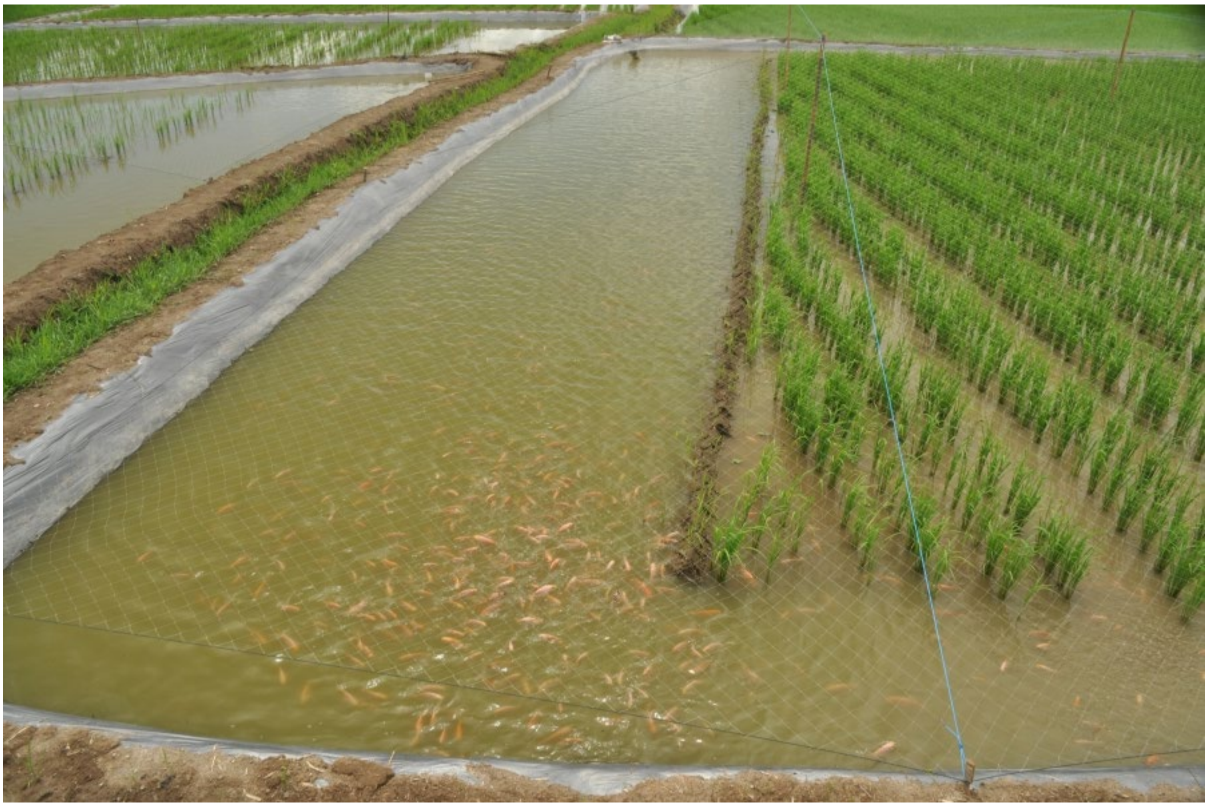

Figure 2. Production of tilapia in tank systems near rice field. © FAO Aquaculture Photo Library.

Group 2: Shrimp aquaculture (freshwater)

- **Scenario**: Shrimp raised in ponds using recycled municipal water (Figure 3).
- **Water sources**: Recycled water from a nearby town.
- **Risks identified**: High organic load, low oxygen, and potential for pathogen contamination.
- **Controls**: Proposed use of filtration, UV disinfection, and aeration.

- **DT application**: The group considered that the DT was applicable but suggested adding recycled municipal water scenarios.
- **Recommendation**: Add a branch for evaluating recycled water sources and treatment validation.

Figure 3. Shrimp farming in ponds. © FAO Aquaculture Photo Library.

Group 3: Marine capture – horse mackerel

- **Scenario**: Fishing vessels operating in coastal waters with potential industrial pollution (Figure 4).
- **Water sources**: Natural seawater.
- **Risks identified**: Heavy metals, hydrocarbons, and poor vessel hygiene.
- **Controls**: Use of potable water for washing, increased cleaning frequency, and environmental monitoring.
- **DT application**: The group considered that additional guidance on environmental contaminants and vessel-based operations would benefit the structure of the existing DT.
- **Recommendation**: Include environmental risk screening and vessel-specific hygiene protocols.

Figure 4. Horse mackerel fishing vessel. © FAO Aquaculture Photo Library.

Group 4: Marine capture – tuna

- **Scenario**: Tuna caught and processed using potable water and temperature--controlled systems (Figure 5).
- **Water use**: Potable water for washing and processing and seawater for fish storage and initial chilling and deck cleaning (Figure 6); temperature sensors and manual checks.
- **Risks identified**: Cross-contamination during handling and transport.
- **Controls**: Regular water testing, GHPs, and temperature monitoring.
- **DT application**: The group considered the DT applicable but suggested more detail on temperature control and verification.
- **Recommendation**: Add prompts for temperature monitoring and hygiene validation during transport.

Figure 5. Atlantic bluefin tuna in a temperature-controlled environment ready for marketing. © FAO Aquaculture Photo Library.

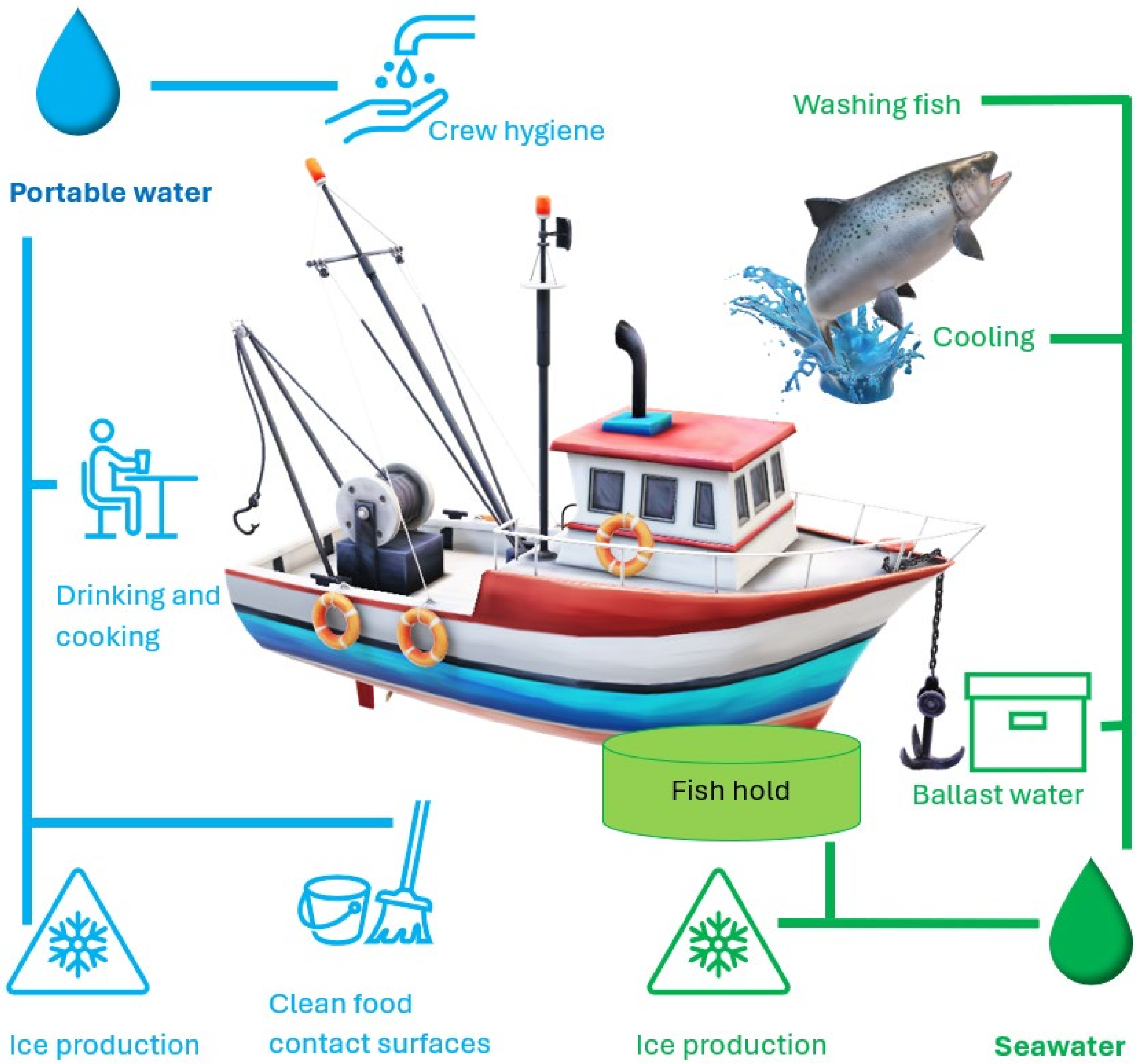

Figure 6. Diagram of water use on fishing vessels

This diagram was developed to visually represent the distinct roles of potable water and seawater on fishing vessels, based on insights from the workshop discussions. Key operational areas on a vessel where water is used were identified: crew hygiene, fish handling, cleaning, ice production, and storage. Potable water was mapped to functions requiring high sanitary standards — such as drinking, handwashing, and rinsing of fish — while seawater was linked to non-ingestive uses like fish storage, deck cleaning, and initial chilling. The diagram reflects the practical constraints discussed during the workshop, such as limited potable water storage, reliance on natural seawater, and the need for disinfection protocols.

Group 5: Catfish aquaculture (Freshwater)

- **Scenario**: Catfish raised in ponds near agricultural areas (Figure 7).
- **Water sources**: Surface water potentially contaminated by farm runoff.
- **Risks identified**: Pathogens, pesticides, and low oxygen levels.

- **Controls**: Use of oxygenated tanks for live transport; sourcing water from cleaner areas.
- **DT application**: The group found the DT useful and suggested adding guidance on live transport and water quality during transit.
- **Recommendation**: Include decision points for transport water quality and contamination during harvest.

Figure 7. Ponds used in catfish production. © FAO Aquaculture Photo Library.

Across all groups, several common observations emerged:

- **Terminology confusion:** Clearer definitions and visual aids were recommended.
- **Environmental and seasonal factors**: Many groups highlighted the need for DTs to account for seasonal changes (e.g. rainy season runoff) and environmental pollution.
- **Mixed water systems:** Several case studies involved the use of blended water sources (e.g. seawater and well water), which were not adequately addressed in the current DTs.
- **Practical usability:** While the DTs were seen as valuable tools, participants suggested simplifying the language and structure for use by small-scale producers and field inspectors.

4) Discussion outcome

Each group presented their findings in a plenary session. The presentations sparked rich discussions, with participants sharing experiences from their own countries and offering suggestions for improving the DTs. The collaborative atmosphere encouraged open dialogue and highlighted the value of peer learning.

The desktop validation exercise successfully demonstrated the strengths and limitations of the current decision trees. Participants appreciated the opportunity to apply the tools in realistic scenarios and provided constructive feedback to inform future revisions. The session reinforced the importance of introducing and tailoring risk assessment tools to diverse production contexts and ensuring they are accessible to all stakeholders.

2.3 Day 2: Country perspectives on water quality management in fisheries and aquaculture

1) Session lead

Maria Eugenia Sevilla

2) Learning objective

To share national experiences, regulatory frameworks, and monitoring practices related to water quality in fisheries and aquaculture, and to identify common challenges and opportunities for harmonization across countries.

3) Overview

This session provided a platform for participating countries to present their national approaches to water quality control in fish production and processing. Representatives from Chile, Uruguay, Brazil, Peru and Argentina shared insights into their regulatory systems, monitoring protocols, and enforcement mechanisms. The session highlighted the diversity of legal frameworks and technical standards in place, while also revealing areas of convergence and shared challenges.

4) Country highlights

Chile

- Regulatory framework: This is governed by the Food Safety and Certification Manual (SERNAPESCA, 2018), which outlines comprehensive procedures for sanitary control across the production chain.
- Key features:
  - classification and monitoring of harvesting areas
  - control of pharmaceutical residues and unauthorized substances
  - sanitary management of factory ships and processing facilities

    - traceability systems and HACCP-based risk assessments
    - certification procedures for export and laboratory accreditation

- Notable strength: integration of environmental, chemical, microbiological, and traceability controls into a unified system

Uruguay

- Competent authority: National Directorate for Aquatic Resources (DINARA), under the Ministry of Agriculture
- Monitoring parameters
    - for aquaculture: dissolved oxygen, pH, ammonia, nitrites, carbon dioxide
    - for bivalve molluscs: toxic phytoplankton and biotoxins
    - for processing water: absence of coliforms, *E. coli*, enterococcus, and other pathogens; turbidity and chlorine levels

- Approach: emphasis on both environmental monitoring and end-product safety

Brazil

- Legal instruments
    - Law No. 11.959 (2009) on sustainable aquaculture and fisheries (Presidência da República, 2009).
    - Decree-Law No. 9.013 (2017) on sanitary controls for animal-origin products (Presidência da República, 2017).
    - Regulation No. 888/2021 on potable water standards (Ministério da Saúde, 2021). Further details are provided in the guidelines for inspection of fish and fishery products in establishments certified by the Federal Inspection Service (MAPA, 2021).

- Key requirements
    - Ice used in fish preservation must be made from potable water or clean seawater.
    - Water used in processing must meet strict microbiological and chemical criteria.

- Strength: There is a clear linkage between water quality and food safety legislation, with specific parameters for aquaculture and processing.

Peru

- Regulatory standards
    - Supreme Decree No. 004-2017-MINAM for aquaculture water quality
    - DS No. 031-2010-SA for potable water standards (MINAM, 2017, Ministerio de Salud, 2010)

- Parameters monitored: Coliforms, *E. coli*, helminths, viruses, protozoa, and other microbiological indicators

- Focus: strong emphasis on environmental protection and public health through water quality surveillance

Argentina

- Legal framework
    - Federal Fisheries Law No. 24.922 and related resolutions (Ministerio de Justicia de la Nación, 1998)
    - Argentine Food Code and SENASA regulations
    - Resolution No. 53/98 on bivalve molluscs for human consumption, as per Regulatory Decree 4238 (classification of harvesting areas) (Secretaría de Agricultura, Ganadería, Pesca y Alimentación, 1998)
    - Provision No. 22/2014: Manual of Procedures for the Hygienic-Sanitary Evaluation of Live Bivalve Mollusc Production Control Systems
    - The requirements for fish processing are defined in the following legislative documents:
        - Regulations for the Inspection of Products, By-products and Derivatives of Animal Origin approved by Decree 4238/68 Chapter XXXIII, Chapter IV Sanitary Works.
        - Argentine Food Code, Chapter XII Article 982 - (Joint Resolution SCS and SAGyP No. 33/2023. Parameters for potable water include absence of coliforms, E. coli, Pseudomonas aeruginosa and mesophile bacteria (500 CFU/ml).
        - Provision No. 3/2024 Instructions on Supervision Reports and Diagnostic Evaluations.
        - Circular No. 12 A Water quality in fishing establishments authorized by SENASA.
- Monitoring scope
    - classification of bivalve mollusc harvesting areas
    - microbiological and chemical testing of processing water
    - requirements for potable water in processing facilities
- Notable feature: use of integrated catchment management principles and detailed sanitary inspection protocols

Cross-country observations

- Diversity in standards: While all countries monitor similar parameters (e.g. coliforms, *E. coli*, turbidity), the frequency, thresholds, and enforcement mechanisms vary significantly.
- Common challenges
    - ensuring consistent monitoring across remote or small-scale operations
    - managing seasonal and environmental variability in water quality
    - aligning national standards with Codex Alimentarius Commission guidance while addressing local realities.
- Opportunities for harmonization
    - developing regional guidance or model regulations based on Codex Alimentarius Commission principles

- sharing best practices in laboratory testing, risk assessment, and enforcement
- promoting mutual recognition of certification and inspection systems

5) Discussion outcome

The country presentations underscored the importance of context-specific regulation and highlighted the benefits of international collaboration. Participants expressed interest in continued dialogue and technical exchange to support the implementation of Codex Alimentarius Commission-aligned water safety systems in fisheries and aquaculture.

2.4 Day 3: Field validation and group reflections

After technical training, the participants used the JEMRA decision trees to assess the microbiological risks associated with the water used for aquaculture in the fields (Figure 8).

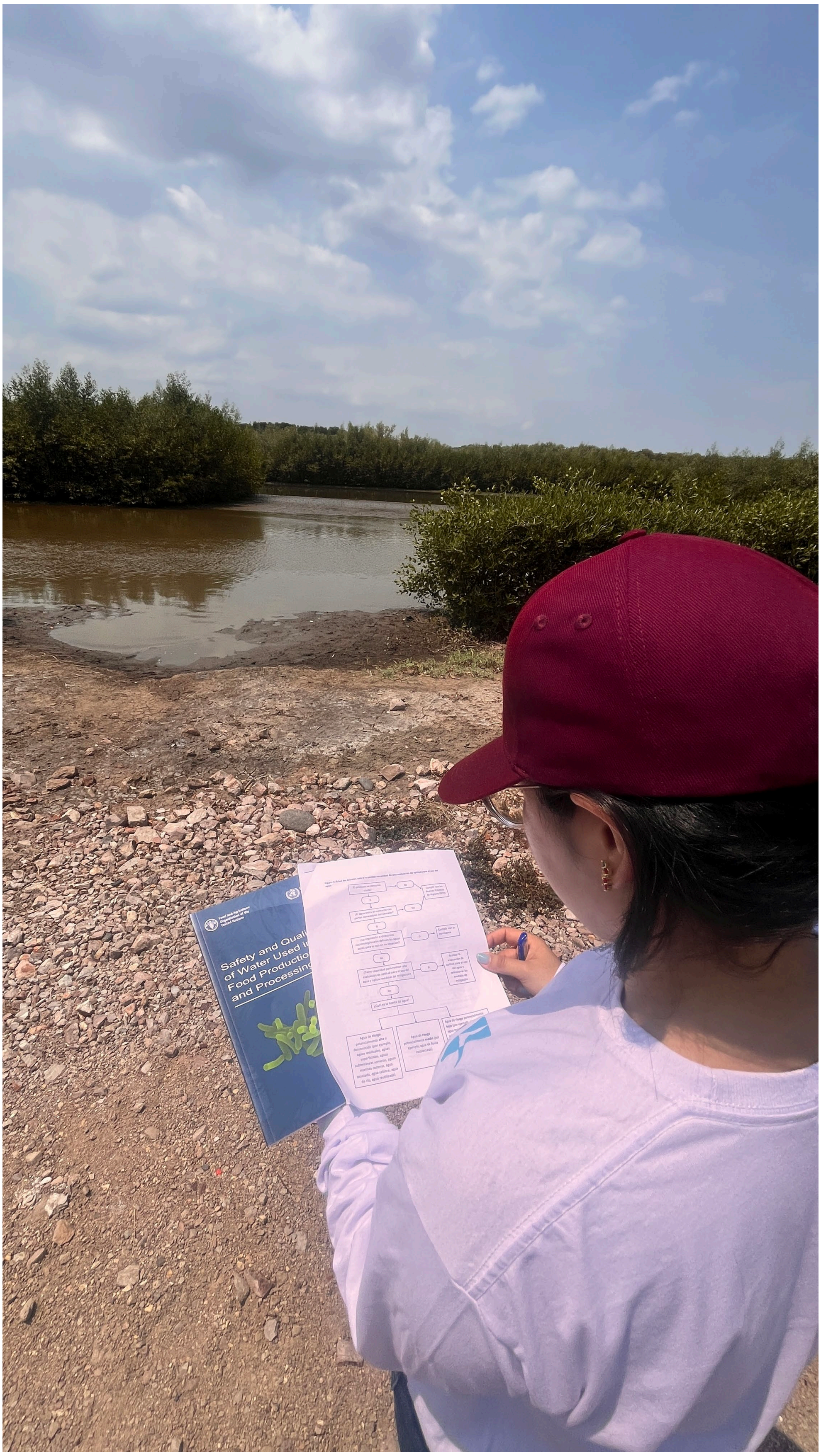

Figure 8. Workshop participant conducting field validation of the decision trees.

1) Session leads

Kang Zhou, Carlos Campos and María Sevilla

2) Learning objectives:

- to observe how safe water was used in the real-world aquaculture operations and assess how DTs apply in practice;
- to validate the usability and relevance of the DTs in live production environments; and
- to reflect on lessons learned and propose refinements to the tools based on field observations.

3) Morning session: field visits to shrimp farms

Participants were divided into three teams and conducted site visits to shrimp farms located in the Gulf of Fonseca region of southern Honduras. The farms visited were:

- Team A: Industria Camaronera del Sur (ICASUR)
- Team B: Rivermar
- Team C: Aquacultivos de Honduras (AQH)

These farms produce Pacific white shrimp (*Litopenaeus vannamei*) using semi-intensive systems. Each team was accompanied by site managers and technical staff who provided detailed briefings on farm operations.

Activities and discussions

During the workshop, the participants discussed the distinction between "clean" water and "fit-for-purpose" water. All participants agreed that "fit-for-purpose" is a clearer and more precise term. One example raised by the participants was that water considered "clean" for washing melons may not meet the same standard for leafy greens. Similarly, in fisheries, water deemed clean for one use might not be clean for another. Relying solely on the term "clean" is problematic; it's subjective, relative, and can be misleading. In contrast, "fit--for--purpose" eliminates ambiguity by defining the intended use.

Participants noted that while they were familiar with the concept of "clean" water, its meaning was often unclear in practice. However, "fit-for-purpose" was straightforward and easy to apply. One participant emphasized that this shift in terminology represents an opportunity to move from a hazard-based perspective to a risk-based approach, helping field workers determine appropriate water use without compromising food safety.

During farm visits, none of the workers referred to water as "clean". Instead, they described water sources, treatment methods (Figure 9 and 10), and specific uses (e.g. "*We get this water from [source], treat it by [method], and use it for [purpose].*"). Figures 11 and 12 illustrate different water types used across farms, each serving distinct purposes. For instance, Figures 11 and 12 show water with varying salinity levels, yet both are intentionally selected for their respective applications. Labelling such water simply as “clean” would be impractical and detrimental, as it ignores critical context. Instead, these operations exemplify the “fit-for-purpose” principle in action.

Figure 9. Culture of algae that will be used to feed shrimp larvae (early stages of production). The water sourced for this purpose must already be considered safe.

Figure 10. Tanks where algae have been inoculated (dark colour of the water comes from the algae - feed) for the shrimp larvae. Water at this stage should also be fit for purpose (safe) prior to its use.

Figure 11. Raw water sourced from the estuary. Water is treated to eliminate traces of heavy metals and other contaminants before being used for larvae production.

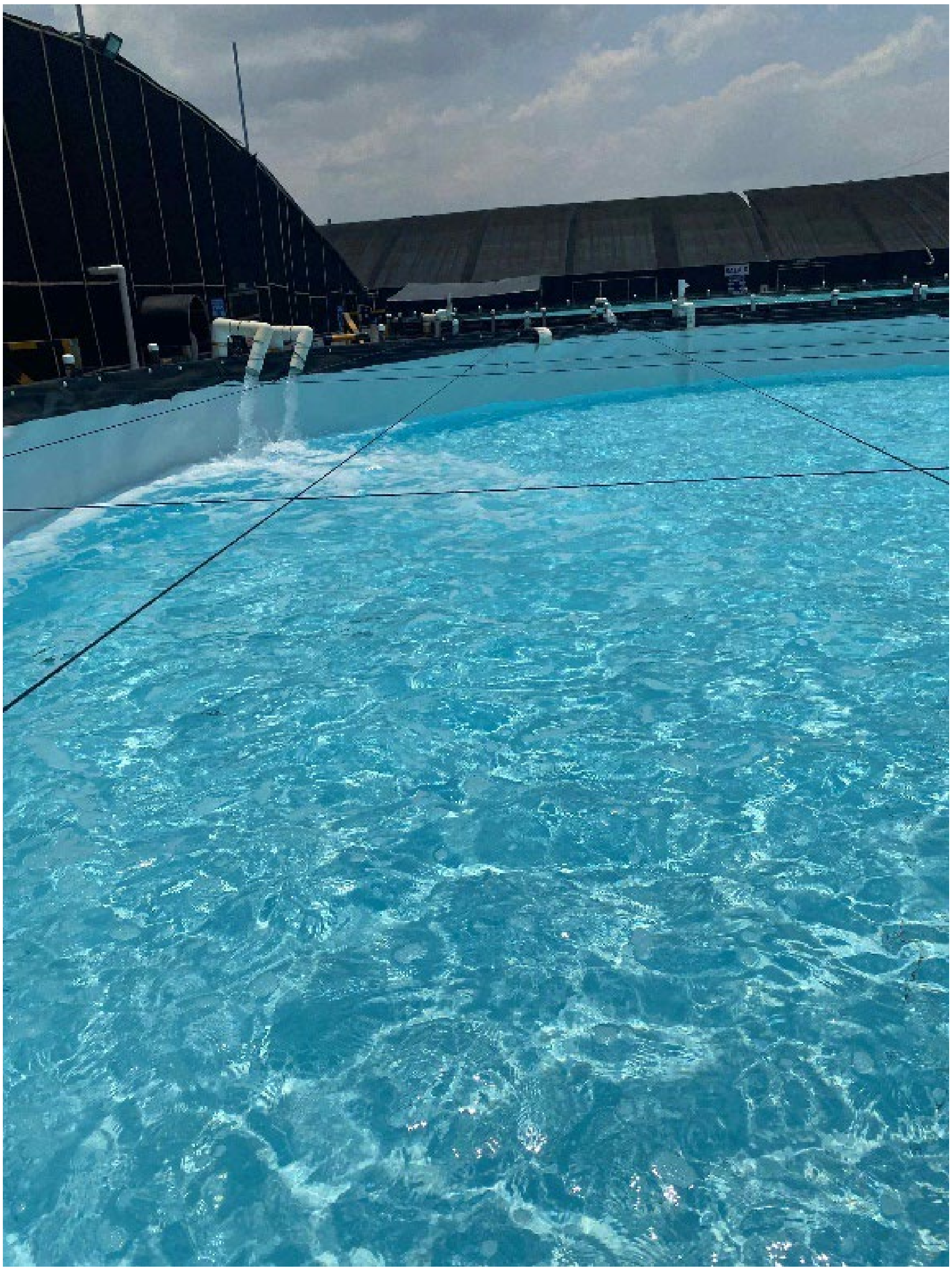

Figure 12. Water with lower saline content.

The participants also conducted a desktop review of the JEMRA and Codex Alimentarius Commission decision trees (DTs) using five real-world scenarios: freshwater aquaculture (tilapia); freshwater aquaculture (shrimp); marine capture (horse mackerel); marine capture (tuna); freshwater aquaculture (catfish). after field visits, they recognized that production and processing steps are often managed by different entities, making the *separate* DTs more practical and clearer for end-users. One participant highlighted that JEMRA's version's inclusion of hazard concentrations provides critical context by illustrating both the likelihood and degree of exposure, thereby reflecting the associated risk. This approach naturally guides users toward risk mitigation and control measures. In contrast, a binary "fit-for-purpose" assessment (as in the Codex Alimentarius Commission draft version) ends the evaluation (assessment) prematurely, requiring additional effort to determine actionable solutions. In follow-up discussions comparing the two versions of DTs, participants unanimously favoured the original JEMRA version for its:

- clarity and ease of use;
- stronger alignment with real-world practices; and
- deeper, more practical integration of the “fit-for-purpose” concept.

Key observations across sites

- Water sourcing: Farms used a combination of estuarine water and groundwater. Some farms blended well water with brackish water to maintain optimal salinity. Water was categorized with different purposes.
- Water treatment: Sand filtration was commonly used before water entered the ponds. Some farms had in-house laboratories for water quality testing and shrimp pathology others use external commercial laboratories.
- Monitoring practices: Regular sampling was conducted for physical (e.g. turbidity, salinity), chemical (e.g. ammonia, nitrates), and microbiological (e.g. total coliforms, *Salmonella*) parameters.
- Biosecurity and pond management: Aeration systems, feeding schedules, and pond cleaning protocols were in place to maintain shrimp health and minimize contamination risks.

Challenges identified

- Seasonal changes in water quality due to rainfall and river flow.
- Presence of wild birds and other animals near ponds, increasing the risk of faecal contamination.
- Use of untreated water in some early stages of production, raising questions about risk thresholds and mitigation.

4) Afternoon session: group reflections and decision tree validation

Following the field visits, each team reconvened to apply the DTs to their observed scenarios and prepare a presentation summarizing their findings.

Key themes from group presentations

- Applicability of decision trees
  - The DTs were generally useful in guiding risk assessment but required adaptation to reflect the complexity of real-world systems.
  - Some questions in the DTs were too rigid or binary, failing to account for mixed systems or long-standing safe practices.

- System classification challenges
    - Participants debated how to classify systems as “open” or “closed,” especially when farms used both recirculated and replenished water.
    - A suggestion was made to introduce a “mixed system” category or provide clearer definitions and examples.
- Contamination risk assessment
    - Teams noted that the DTs often led to a conclusion of “water not suitable for use” when any contamination risk was identified, even if effective control or mitigation measures were in place.
    - Participants recommended incorporating a step for evaluating existing control measures before reaching a final determination.
- Contextual realities
    - In some cases, water that would be deemed “unfit” by the DTs had been used safely for decades with no adverse outcomes.
    - This highlighted the need for DTs to allow for risk-benefit analysis and historical performance data.
- Recommendations for improvement
    - Include prompts for seasonal variability, wildlife exposure, and seawater use.
    - Add flexibility to account for validated treatment systems and long-term monitoring data.
    - Develop simplified versions of the DTs for use by small-scale producers and inspectors.

Figure 12. Photos of the field visits.

5) Discussion outcome

The field validation exercise provided a valuable opportunity to test the decision trees in real -world settings and gather practical feedback.

There was a consensus that “fit-for-purpose water” concept should be adopted and should replace the “clean water” concept when defining water safety in fish production and processing. The participants compared:

- clean water: subjective, relative, and can be misleading; and
- water “fit for purpose”: eliminates ambiguity by defining the intended use.

Participants noted that while they were familiar with the concept of “clean” water, its meaning was often unclear in practice. However, “fit-for-purpose” was straightforward and easy to apply.

Participants also agreed that while the DTs are a strong foundation for risk-based water management, they must be refined to reflect the diversity and complexity of aquaculture systems.

The session concluded with a commitment to:

- incorporate workshop feedback into the next iteration of the DTs;
- develop supplementary guidance materials, including case studies and visual aids; and
- promote continued collaboration among Codex Alimentarius Commission members, JEMRA experts, and national authorities to support implementation.

3. Conclusions and recommendations

3.1 Overall reflections

The FAO Workshop on Safety and Quality of Water Used in Fisheries successfully brought together a diverse group of stakeholders, including regulators, scientists, FBOs, and Codex Alimentarius Commission experts, over ten countries to explore the application of risk-based approaches to water use and reuse in fish production and processing.

Over the course of three days, participants engaged in technical presentations, hands-on validation exercises, and field visits that deepened their understanding of the Codex Alimentarius Commission Guidelines and the DTs developed by JEMRA. The workshop provided a valuable platform for knowledge exchange, practical learning, and collaborative problem-solving.

Participants affirmed the importance of the “fit-for-purpose” water concept and recognized the DTs as useful tools for operationalizing Codex Alimentarius Commission guidance. They recommended several areas where further activities, materials and tools could be provided to better reflect and understand the complexity and diversity of real-world production systems and ensure that the JEMRA recommendations and tools can be adopted effectively.

3.2 Key conclusions

Terminology needs clarification

- Participants noted confusion around terms such as “clean water” and “fit-for-purpose water”.
- The “clean water” is a hazard-based concept. The risk-based concept is “fit-for-purpose water”. There was a consensus that the “fit-for-purpose water” concept should be adopted and should replace the “clean water” concept when defining water safety in fish production and processing.

Decision trees are valuable risk assessment tools

- Decision trees provide a structured, risk-based approach to assessing water safety and were considered extremely valuable tools to inform microbial risk assessments of fish production and processing systems. The DTs were considered especially helpful for guiding FBOs through complex decision-making processes.

Contextual adaptation is essential

- Water systems in fisheries and aquaculture are highly variable, ranging from open marine capture to closed recirculating aquaculture systems, and often involve mixed water sources.
- Decision trees must be adaptable to local conditions, including seasonal variability, infrastructure limitations, and long-standing safe practices.

Training and support materials are needed

- To ensure effective implementation, DTs should be accompanied by user-friendly guidance, case studies and visual aids.
- Training for FBOs, inspectors and regulators is essential to build capacity and promote consistent application.

3.3 Recommendations and next steps

Develop supplementary guidance

- Adopt the concept of "fit-for-purpose" water in lieu of "clean water" in future guidance when defining water that is safe to use in fish production and processing.
- Create a glossary of key terms to ensure consistent interpretation.
- Provide annotated examples and case studies from different production systems.
- Translate the DTs for small-scale producers and field inspectors in different regions with different languages.

Promote harmonization and knowledge sharing

- Encourage alignment of national regulations with Codex Alimentarius Commission principles while allowing for local adaptation.
- Facilitate regional workshops and technical exchanges to share best practices and lessons learned.
- Explore opportunities for mutual recognition of water safety as part of certification and inspection systems.
- Participants are encouraged to pilot the DTs in their national contexts and share further insights with the Codex Alimentarius Commission Electronic Working Group.
- Continued collaboration among Codex Alimentarius Commission members, JEMRA experts and national authorities will be essential to ensure the tools are practical, science based and widely applicable.

Support capacity building

- Design and deliver training modules tailored to different user groups (e.g. regulators, FBOs, auditors).
- Strengthen laboratory capacity for water quality monitoring and validation of treatment systems.
- Promote the integration of DTs into existing food safety management systems (e.g. HACCP, GHPs).

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Annexes

Annex 1. List of participants

Name	Organization	Position
Argentina		
Maria Ester Carullo	SENASA	Secretaria del Comité Nacional del CCFH, Argentina
Brazil		
Eduardo Cesar Tondo	UFRGS, CODEX ALIMENTARIUS BRASIL	Profesor de microbiología de alimentos
Chile		
Constanza Avello	ACHIPIA	Asesora en Evaluación de Riesgos
Ecuador		
Miguel Alejandro Ortiz Armas	Ministerio de Salud Pública	Especialista de productos de uso y consumo humano
El Salvador		
Lissette Esmeralda Marroquin Guardado	OIRSA	Asistente Técnico Dirección Regional de Inocuidad
Raul Peralta Giron	OIRSA	Director Regional de inocuidad de alimentos
Peru		
Carla Asunción Villena Llerena	SANIPES Peru	Especialista en gestión de alertas sanitarias
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Uruguay		
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Honduras		
Anderson Josue Urbina Godoy	Productos Frescos del Mar San Carlos	Jefe de laboratorio
Angelina Osorio Corrales	SENASA Honduras	Inspector Veterinario Oficial
Brayan Edgardo Alvarez Baca	SENASA Honduras	Inspector auxiliar de producción primaria
Candida Rosa Castro Marcia	NOVAHONDURAS	Sub-Gerente
Carlos E. Giron	Grupo Deli - Seajoy	Gerente técnico
Claudio Garay	SENASA Honduras	IVO
Daniel Francisco Calero Varela	Grupo Litoral	Gerente de Sistema de Gestión
Daniel Oswaldo Sanchez Alvarez	Empacadora San Lorenzo	Jefe de finca San Bernardo
Delia Cristina Martinez	Laboratorio de Patología Acuática SENASA	Jefe de Laboratorio
Dennis Marlon Alvarenga Sandoval	UNAH	Docente
Edmilson Geovanny Rico Osorto	SENASA Honduras	Inspector Auxiliar de Producción Primaria
Franklin Francisco Chicas Rubio	SENASA Honduras	Inspector Auxiliar de Producción Primaria
Franklin Osmin Galeas Ortega	SENASA Honduras	Inspector Veterinario Oficial
Giselle Guillen	JMC Fisheries / Apesca	Asesor / Directora
Hesler Ivanov Grandez Euceda	Exportadora e Importadora La Sirena	Jefe de Calidad
Joaquin Romero Ortez	Empacadora San Lorenzo	Gerente Relaciones Institucionales

Joel Levi Irias Chavez	AquaFinca St. Peter Fish	Jefe de Limnologia
Johnny Edgardo Mineros Domínguez	Inversiones lemug	Administración
José Antonio Alvarenga	Rivera Marina S.de R.L.	Asistente de Calidad
José Martín Laínez Meza	Empacadora San Lorenzo	Gerente Técnico
Lesvia Griselda Oseguera	Grupo Nauticus	Jefe de inocuidad
Liliam Carina Marroquin Tejeda	UNAH campus Choluteca	Docente
Lloyd Brooks	JMC FISHERIES	Director proceso langosta
Lourdes Teresa Morazán García	SENASA Honduras	Jefe de Departamento de Productos Pesqueros y Acuícolas
Maria de los ángeles Rodas Leon	Exportadora e Importadora La Sirena	Asistente de calidad
Maria Eugenia Sevilla	SENASA Honduras	Gerente Técnico Inocuidad Agroalimentaria
Maury Carbajal	SENASA Honduras	Inspector auxiliar de producción primaria
Mayra Yolany Reyes Rodriguez	Mariscos Reyes Rodriguez	Gerente General
Mirian Bueno	SENASA Honduras	Directora Técnica de Inocuidad Agroalimentaria
Sayra Luisana Fuentes	Empacadora Litoral	Jefe de producción
Selvin Antonio Guevara Arias	Mariscos Canales	Coordinador de inocuidad
Ulises Lenign Gonzales Flores	Mariscos Reyes Rodríguez	Jefe de Producción
Yesmin Gómez	Grupo Camaronero MILCIEN	Jefe de certificación

Yosari Calix Martínez	ARSA	Especialista en regulación sanitaria
FAO JEMRA expert		
Carlos José Alexandre de Campos	Jacobs	Water Quality Scientist
FAO Honduras		
Alicia Medina	FAO Honduras	AFAOR Programme
Juan Acxel Sandoval Guevara	FAO Honduras	Coordinador Nacional de Pesca y Acuacultura
Francis Julissa Mercado Benitez	FAO Honduras	Comunicadora de la Representación
FAO HQ		
Kang Zhou	FAO	Food Safety Officer

Annex 2. Workshop agenda

Joint FAO/WHO Workshop on the Safety and Quality of Water Used in Food Production and Processing

Objectives: To present updated reports and conduct desk and field validation of the tools developed by the Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment (JEMRA) on the Safety and Quality of Water Used in Food Production and Processing, with active members of the Electronic Working Group (EWG) and other stakeholders involved in developing the *Guidelines for the Safe Use and Reuse of Water in Food Processing* under the Codex Committee on Food Hygiene (CCFH).

AGENDA

Choluteca, Honduras, 23–25 April 2025

Day 1 (Wednesday, 23 April)

09:00–09:30	Welcome Remarks	**Mirian Bueno,** SENASA, Honduras
09:30–10:00	Welcome Remarks	**Alicia Medina Hernandez,** Assistant FAOR, FAO
10:00–10:30	Presentation: Introduction to JEMRA's Work	**Kang Zhou**, Food Safety Officer, FAO
10:30–11:00	Coffee Break	
11:00–11:30	Presentation: Introduction to Codex Alimentarius Commission Work on Water	**Mirian Bueno**
	Q&A	
11:30–12:00	Presentation: Introduction to JEMRA Microbiological Risk Assessment Report #33	**Carlos Campos,** JEMRA Expert
	Q&A	
12:00–13:30	Lunch Break	
13:30–15:00	Continuation: Introduction to JEMRA Microbiological Risk Assessment Report #33	**Carlos Campos,** JEMRA Expert
	Q&A	
15:00–15:30	Coffee Break	
15:30–17:00	Group Activity: Revision and validation of Decision Trees in the JEMRA reports	**All participants**
	Q&A	

Day 2 (24 April)

09:00–10:10	Latin American countries perspective	**International participants**
	Q&A	
10:10–10:40	Coffee Break	

10:40–11:50	Continuation: Introduction to JEMRA Microbiological Risk Assessment Report #41	**Carlos Campos**
	Q&A	
11:50–12:30	Group Activity: Risk Assessment in 5 scenarios	**All participants**
12:30–13:30	Lunch Break	
13:30–14:00	Presentation: Risk Assessment Activity	**Carlos Campos**
14:00–15:10	Presentation: Introduction to Annex II of Codex Alimentarius Commission Work on Water	**Maria Sevilla,** SENASA, Honduras
	Q&A	
15:10–15:40	Coffee Break	
15:40–17:30	Group Activity: hands-on workshop to apply or "validate" the definitions, section 6 and tools included in the Draft Annex II of Codex Alimentarius Commission Work on Water	**All participants**

Day 3 (25 April)

06:00–12:00	Field visit to aquaculture farms	**All participants**
12:00–14:00	Lunch break	
14:00–15:30	Continuation of practical workshop: validation of JEMRA risk assessment tools	**All participants**
15:30–16:00	Coffee break	
16:00–17:00	Group presentations: validation of tools	**All participants**
17:00–17:30	Conclusions and closing remarks	**Mirian Bueno**

Annex 3. Decision trees used and reviewed in the workshop

The below decision trees were used and revised in the workshop, which are from the report MRA 33.

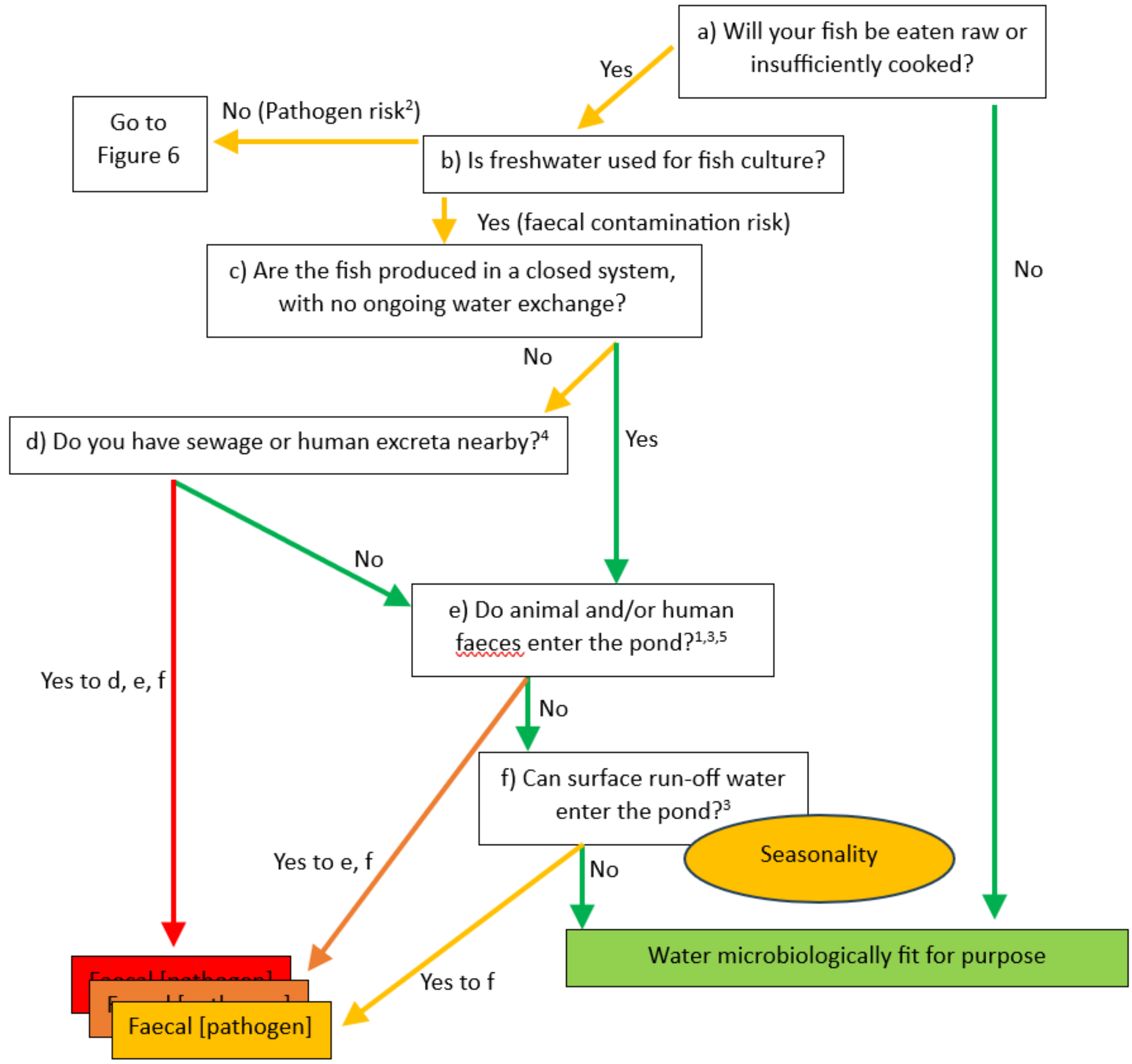


Figure A1. Decision tree for production level of fish and fish products

1.Section 6 of the Codex Alimentarius Commission Code of Practice for Fish and Fishery Products on aquaculture products, pp.54-64; 2. Risk assessment of *Vibrio parahaemolyticus* in seafood, FAO/WHO MRA Series 16, pp. 154-176; 3. WHO Water Safety Plan. WHO/Europe 2014; 4. WHO Sanitation Safety Plan Manual; 5. WHO Safe Use of Wastewater, Excreta and Grey Water. Vol. 3. Aquaculture

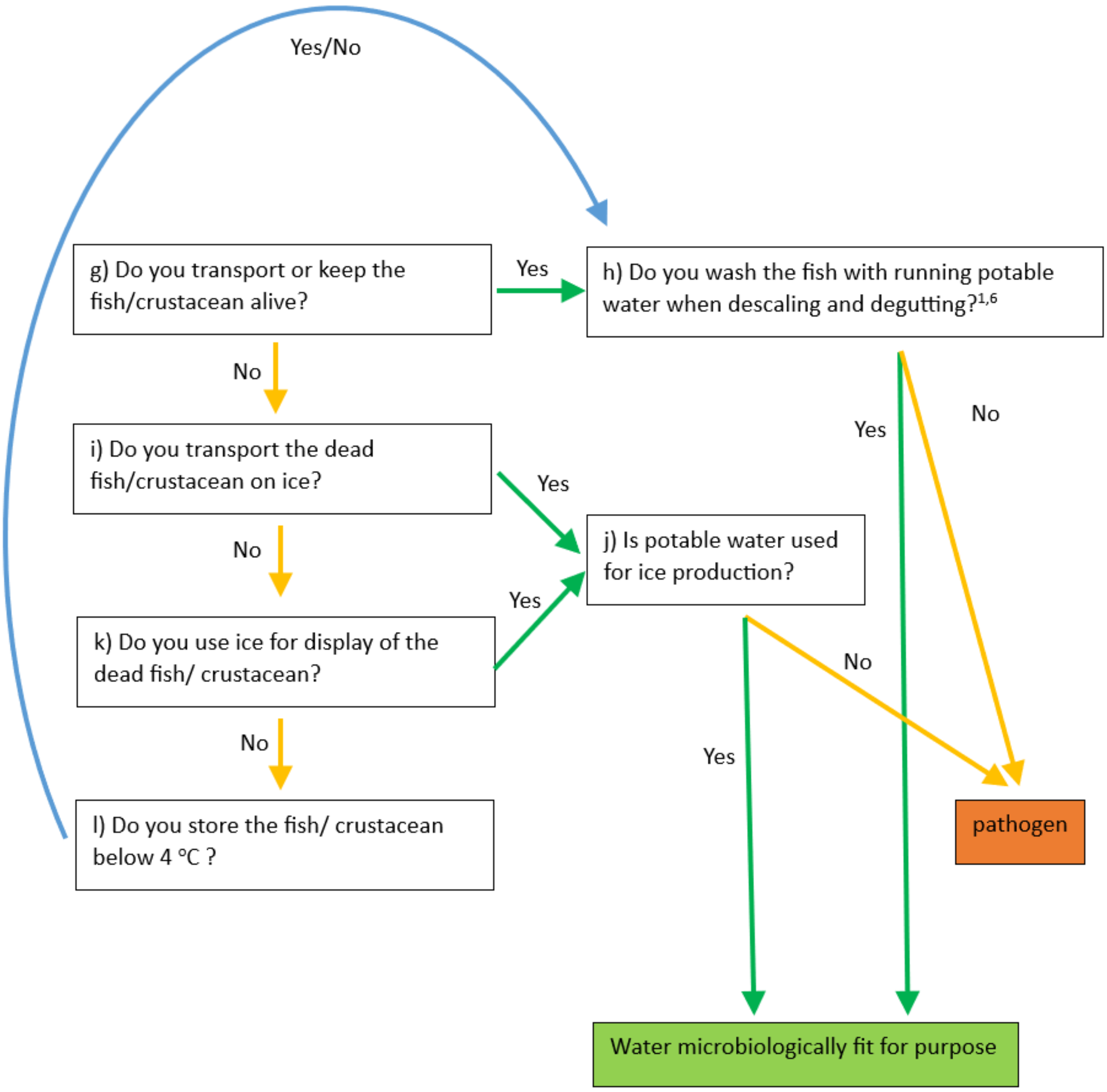


Figure A2. Decision tree for processing and handling of freshwater fish/crustaceans which will potentially be eaten raw

1 Codex Alimentarius Commission *Code of Practice for Fish and Fishery Products*, Section 6. pp. 54-64
6 WHO Guidelines for Drinking Water Quality

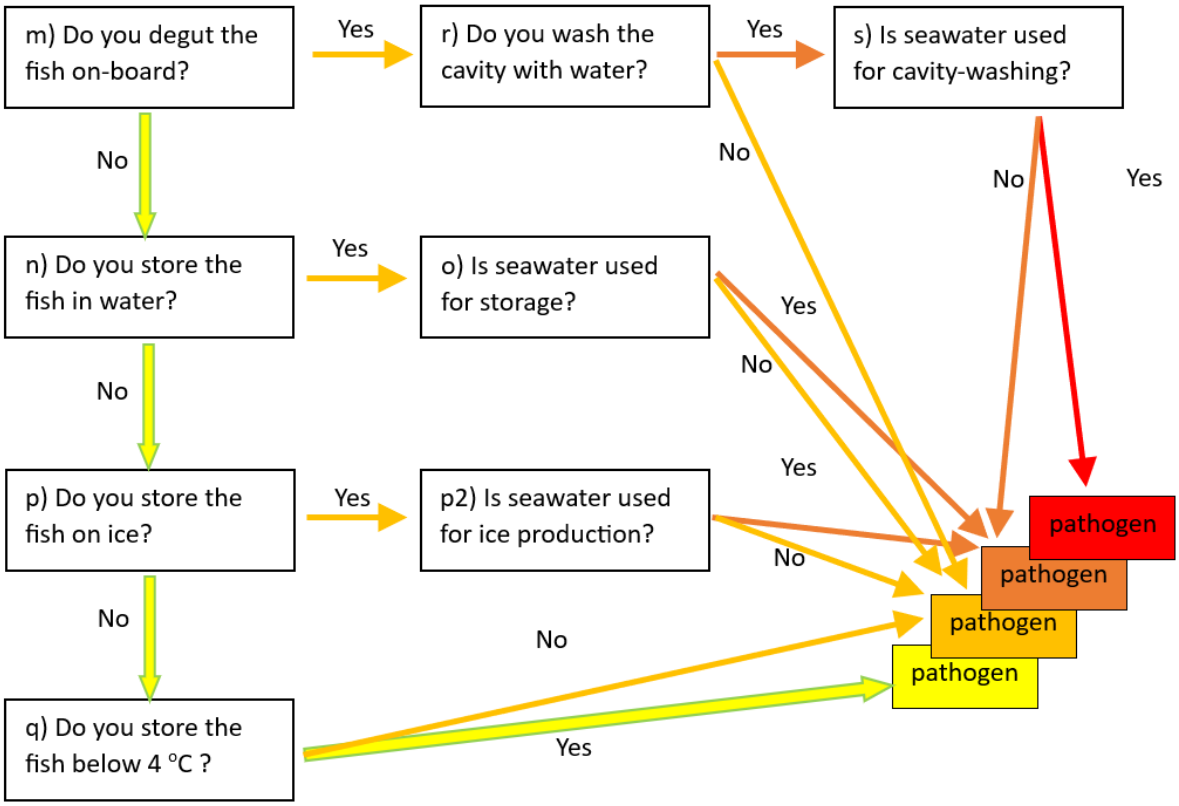


Figure A3. Decision tree for onboard processing and handling of marine/estuarine fish

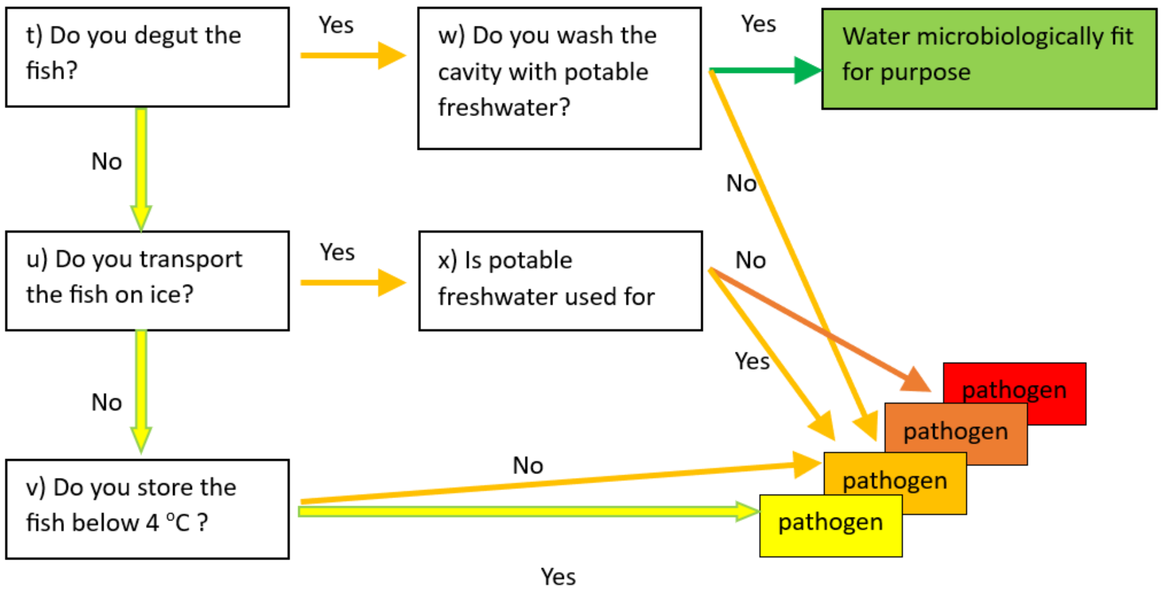
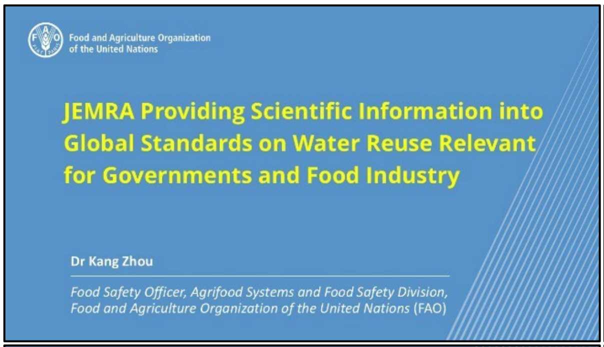
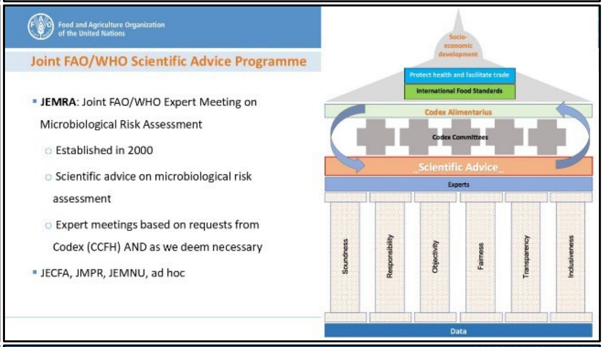


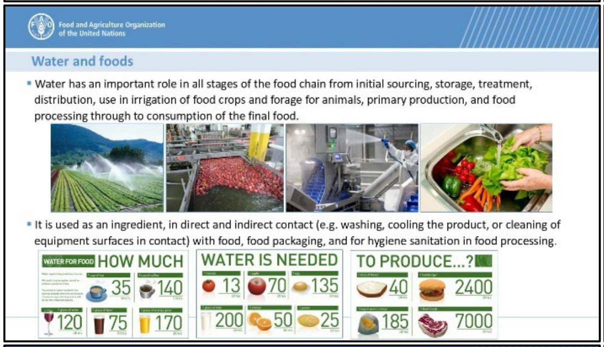
Figure A4. Decision tree for onshore processing of marine/estuarine fish

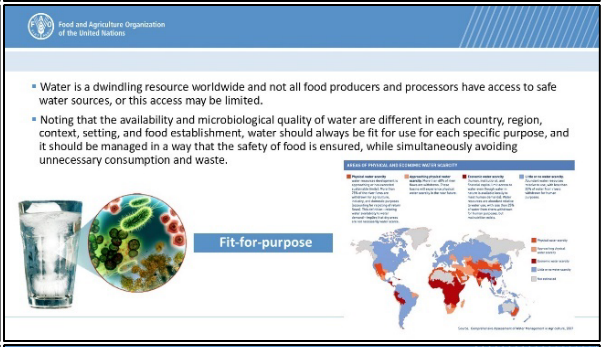
Annex 4 Presentations

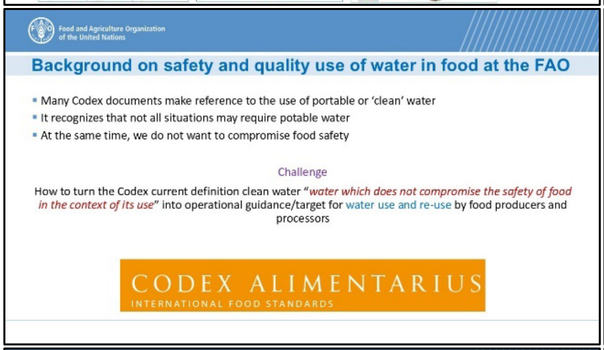
A4.1 Introduction to JEMRA's Work (Kang Zhou)

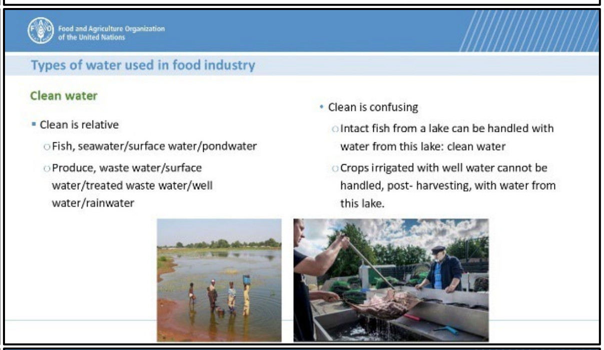


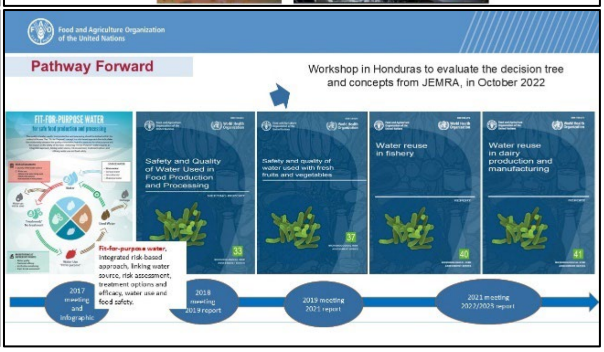


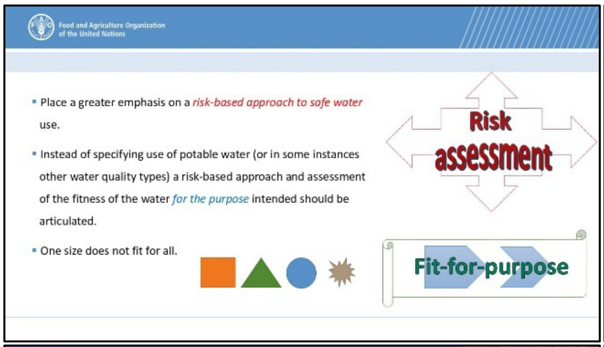


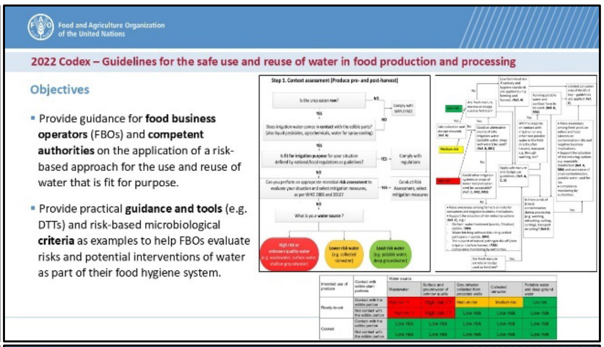




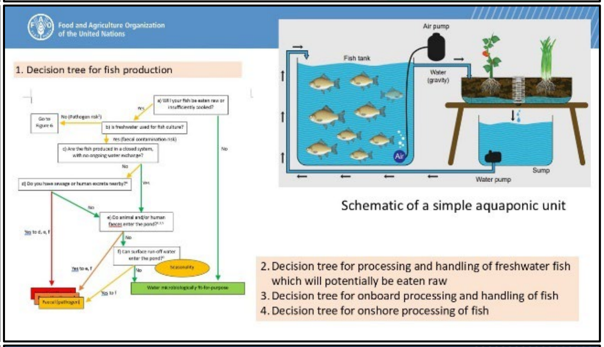


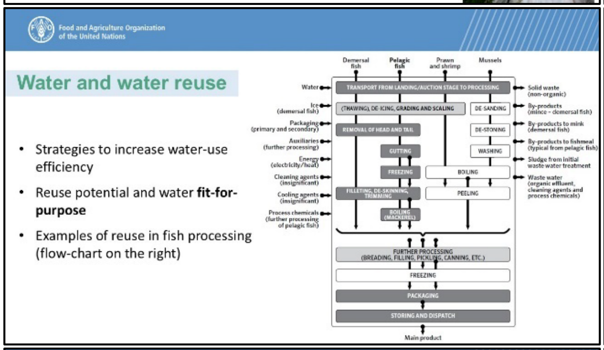


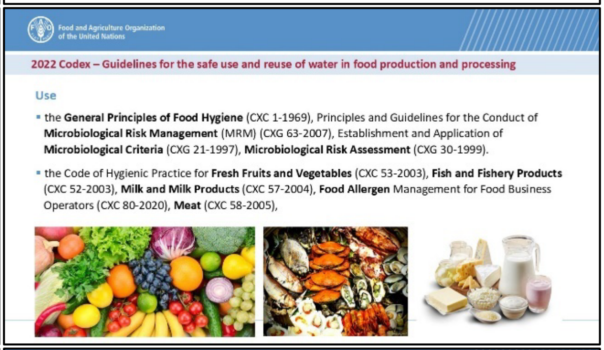

Food and Agriculture Organization of the United Nations
Place a greater emphasis on a risk-based approach to safe water use.
Instead of specifying use of potable water (or in some instances other water quality types) a risk-based approach and assessment of the fitness of the water for the purpose intended should be articulated.
One size does not fit for all.
Risk assessment
Fit-for-purpose


Food and Agriculture Organization of the United Nations
2022 Codex – Guidelines for the safe use and reuse of water in food production and processing
Objectives
Provide guidance for food business operators (FBOs) and competent authorities on the application of a risk-based approach for the use and reuse of water that is fit for purpose.
Provide practical guidance and tools (e.g. DTTs) and risk-based microbiological criteria as examples to help FBOs evaluate risks and potential interventions of water that is part of their food hygiene system.

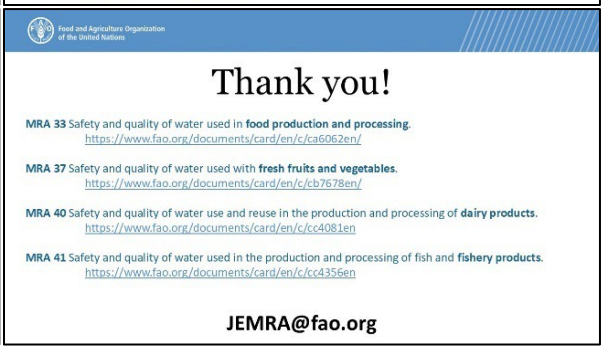

Food and Agriculture Organization of the United Nations
Workshop in Honduras (8 - 16 October 2022)
more than 60 participants from about 10 countries in the Latin American
JEMRA tools were used in several farms


Food and Agriculture Organization of the United Nations
1. Decision tree for fish production
Air pump
Fish tank
Water (gravity)
Water pump
Sump
Schematic of a simple aquaponic unit
2. Decision tree for processing and handling of freshwater fish which will potentially be eaten raw
3. Decision tree for onboard processing and handling of fish
4. Decision tree for onshore processing of fish


Food and Agriculture Organization of the United Nations
Water and water reuse
Strategies to increase water-use efficiency
Reuse potential and water fit-for-purpose
Examples of reuse in fish processing (flow-chart on the right)
Demersal fish
Pelagic fish
Prawn and shrimp
Mussels
TRANSPORT FROM LANDING/AUCTION STAGE TO PROCESSING
REMOVAL OF HEAD AND TAIL
CUTTING
FREEZING
BOILING
PEELING
WASHING
DE-SANDING
DE-STONING
FURTHER PROCESSING
FREEZING
PACKAGING
STORING AND DISPATCH
Main product


Food and Agriculture Organization of the United Nations
2022 Codex – Guidelines for the safe use and reuse of water in food production and processing
Use
the General Principles of Food Hygiene (CXC 1-1969), Principles and Guidelines for the Conduct of Microbiological Risk Management (MRM) (CXG 63-2007), Establishment and Application of Microbiological Criteria (CXG 21-1997), Microbiological Risk Assessment (CXG 30-1999).
the Code of Hygienic Practice for Fresh Fruits and Vegetables (CXC 53-2003), Fish and Fishery Products (CXC 52-2003), Milk and Milk Products (CXC 57-2004), Food Allergen Management for Food Business Operators (CXC 80-2020), Meat (CXC 58-2005),


Food and Agriculture Organization of the United Nations
2018 JEMRA Meeting on the Microbiological Safety and Quality of Water Used in Food Production and Processing
2019 JEMRA Meeting on the Microbiological Safety and Quality of Water Used in Fresh Fruits and Vegetables
2021 JEMRA Meeting on the Microbiological Safety and Quality of Water Used in Fishery and Dairy Products


Food and Agriculture Organization of the United Nations
Thank you!
MRA 33 Safety and quality of water used in food production and processing.
https://www.fao.org/documents/card/en/c/ca6062en/
MRA 37 Safety and quality of water used with fresh fruits and vegetables.
https://www.fao.org/documents/card/en/c/cb7678en/
MRA 40 Safety and quality of water use and reuse in the production and processing of dairy products.
https://www.fao.org/documents/card/en/c/cc4081en
MRA 41 Safety and quality of water used in the production and processing of fish and fishery products.
https://www.fao.org/documents/card/en/c/cc4356en
JEMRA@fao.org

A4.2 Introduction to Codex Alimentarius Commission Work on Water (Mirian Bueno)

CODEX ALIMENTARIUS HONDURAS

Directrices para el Uso y la Reutilización de Agua en la Producción y Procesamiento de Alimentos CXG 100-2023

Mirian Bueno Almendarez
Directora Técnica Inocuidad Agroalimentaria
SENASA HONDURAS
Punto de Contacto Codex Honduras

1 / AGENDA

- A ANTECEDENTES
- B DIRECTRICES
- C ÁRBOLES DE DECISIONES

2 / ANTECEDENTES

- Recirculación del agua en agenda de CCFH desde 1999 (30° reunion) e interrumpido en 2004 (36° reunion)
- Retomar discusión en 46° reunión durante revisión de Principios Generales de Alimentos y anexo APPCC
- Reunión conjunta FAO/OMS de expertos sobre la inocuidad y calidad del agua utilizada en la producción y la elaboración de alimentos – mayo 2018
- CCFH 50 acordó inicio de trabajo: "Directrices para el uso y la reutilización inocuos del agua en la elaboración de alimentos"

JEMRA Review 2018

https://www.fao.org/3/ca6062en/CA6062EN.pdf

3 / ESTRUCTURA

- Sección General
  - Principios Generales
  - Definiciones
  - Evaluación del agua adecuada para su finalidad
  - Gestión de la inocuidad del agua
  - Sistemas de apoyo a la toma de decisiones
- Anexo I - Productos Frescos
- **Anexo II - Pescado y productos pesqueros – 2/3**
- Anexo III - Leche y productos lácteos
- Anexo IV – Tecnologias y tratamiento de agua - 2/3

4 / OBJETIVOS

- Proporcionar orientaciones a los operadores de empresas de alimentos (OEA) y a las autoridades competentes sobre la aplicación de un **enfoque basado en el riesgo** para el uso y la reutilización de un agua que sea **adecuada para su finalidad.**
- Proporcionar orientaciones y **herramientas prácticas** (por ejemplo, los árboles de decisión), así como criterios microbiológicos basados en el riesgo como ejemplos para ayudar a los OEA a evaluar los riesgos y las **posibles intervenciones en el agua** en el marco de su sistema de higiene de los alimentos.

5 / FINALIDAD Y AMBITO

Estas directrices proporcionan un marco de **principios generales y ejemplos** para aplicar un enfoque basado en el riesgo con el fin de determinar si el agua que los OEA van a obtener, utilizar y reutilizar en la producción primaria y la transformación de los productos básicos pertinentes es **adecuada para su finalidad,** abordando los **peligros microbiológicos,** como los parásitos, las bacterias y los virus.

6 / PRINCIPIOS GENERALES

a) El agua, así como el hielo y el vapor de agua elaborados a partir de agua que se utilicen en cualquier etapa de la cadena alimentaria, deben ser adecuados para su fin previsto según un **enfoque basado en el riesgo** que comprenda la **evaluación de los peligros** microbiológicos, químicos y físicos, y no deben comprometer la inocuidad de los alimentos acabados para los consumidores.

b) Cuando se **reutilice el agua,** se debe **tratar o reacondicionar** y **supervisar** eficazmente, y el tratamiento se debe **validar** para eliminar o reducir los peligros microbiológicos hasta un nivel aceptable según su uso previsto.

7 / PRINCIPIOS GENERALES

c) En todas las situaciones, el abastecimiento, el uso y la reutilización del agua deben formar parte del **sistema de higiene de los alimentos de un OEA.**

d) Cuando se utilice agua como **ingrediente** en los alimentos, debe ser **potable.**

8 / DEFINICIONES

Agua adecuada para su finalidad: Agua que se determina que es **inocua** para **un fin previsto** mediante la **identificación, evaluación y comprensión** de los posibles peligros microbiológicos y otros factores pertinentes (como el historial de uso, el uso previsto de los alimentos, etc.), incluida la aplicación de **medidas de control** como las alternativas de tratamiento y su eficacia para garantizar la eliminación efectiva o la mitigación de dichos peligros.

9 / DEFINICIONES

Agua limpia: Agua que no cumple los criterios del agua potable pero que no pone en peligro la inocuidad de los alimentos en el contexto en que se utiliza.

Agua potable: Agua adecuada para el consumo humano.

Aguas residuales: Agua usada que ha resultado contaminada por actividades humanas.

10 / DEFINICIONES

Agua reutilizada: Agua que se ha **recuperado** de una fase de elaboración de la actividad alimentaria, incluso de los componentes de los alimentos, o el agua que, después de ser sometida al(a los) tratamiento(s) de reacondicionamiento necesario(s), está destinada a ser reutilizada en la misma fase, en una fase anterior o en una fase posterior de la operación de elaboración de alimentos. Los tipos de agua reutilizada son, entre otros, el **agua regenerada** de los alimentos, el **agua reciclada** de las actividades alimentarias o el **agua recirculada** en un sistema de circuito cerrado.

11 / EVALUACIÓN DEL AGUA

Principios de riesgo:

- **Enfoque de riesgo – conocer completamente el sistema de agua**
  - Abastecimiento
  - Recogida
  - Almacenamiento
  - Tratamiento
  - Manipulación
  - Uso
  - Reutilización

12 / EVALUACIÓN DEL AGUA

Principios de riesgo:

- **Enfoque de riesgo – Identificar peligros microbiologicos**
  - Agua y sus fuentes
  - Abastecimiento
  - Uso
  - Reutilización
  - Distribución - diseño higiénico

13 / EVALUACIÓN DEL AGUA

Principios de riesgo:

- **Enfoque de riesgo – Monitoreo/seguimiento**
  - Parámetros
  - Frecuencia
    - Fuente de agua - estado anterior
    - Eficacia de los tratamientos
    - Uso y reutilización prevista
    - Datos existentes

14 / EVALUACIÓN DEL AGUA

Principios de riesgo:

- **Enfoque de riesgo – evaluación del agua**
  - Descriptiva (rápida) – evaluación in situ (inspección sanitaria) y documentos/datos existentes.
  - Semicuantitativa – matrices de riesgo con categorias alto, medio, bajo, probabilidad y frecuencia de condiciones sanitarias inaceptables → planificación y priorización
  - Cuantitativa – modelos matemáticos – estimación de riesgos - efectos de patogenos sobre la salud (uso de aguas residuales).

14 / GESTIÓN DE LA INOCUIDAD DEL AGUA

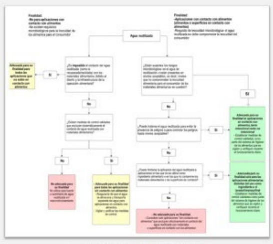
Principios de riesgo:

- **Gestión del riesgo – decisiones**
  - Objetivos – niveles de riesgo aceptables y tratamientos eficaces
  - Sistema de higiene - monitoreo/seguimiento, verificación, mapa del sistema (diagrama de flujo)
  - Prioridades de gestión – peligros identificados - matrices semicuantitativas
  - Tratamientos – analisis de peligros - eliminar o reducir a un nivel aceptable

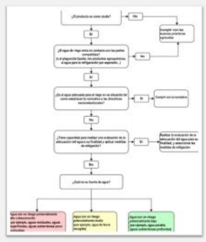
15 / GESTIÓN DE LA INOCUIDAD DEL AGUA

- **Gestión del riesgo – decisiones**
  - **Arboles de decisiones**
  - **Matrices de riesgo**
    - Herramientas cualitativas útiles y prácticas
    - Priorización – planificación
      - Adecuada – no adecuada para su uso
      - Criterios de riesgo – alto, medio, bajo

16 / GESTIÓN DE LA INOCUIDAD DEL AGUA



Reutilización del agua



Agua de riego

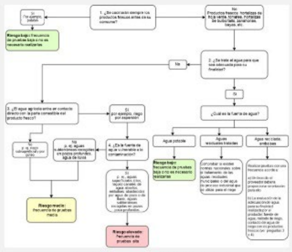
17 / GESTIÓN DE LA INOCUIDAD DEL AGUA

Cuadro 1[10]. Ejemplo para estimar el nivel potencial de riesgo que supone el uso o la reutilización de diversas fuentes de agua durante las fases previas a la cosecha de productos frescos según su uso previsto

Uso previsto del producto fresco	¿El agua contacta con la parte comestible?	Fuente de agua				
		Aguas residuales	Aguas superficiales y subterráneas de calidad desconocida	Agua subterránea recogida en pozos protegidos	Agua de lluvia recogida de forma higiénica	Agua potable, aguas subterráneas profundas u otras aguas, incluidas las aguas reutilizadas tratadas, que cumplan los criterios microbiológicos aplicables al agua potable
Listo para el consumo	SÍ	Riesgo alto	Riesgo alto	Riesgo medio	Riesgo medio	Riesgo bajo
	NO	Riesgo alto	Riesgo alto	Riesgo bajo	Riesgo bajo	Riesgo bajo
Cocido	SÍ	Riesgo bajo*	Riesgo bajo*	Riesgo bajo	Riesgo bajo	Riesgo bajo
	NO	Riesgo bajo*	Riesgo bajo*	Riesgo bajo	Riesgo bajo	Riesgo bajo

Agua de riego

18 / GESTIÓN DE LA INOCUIDAD DEL AGUA



Frecuencia de monitoreo

19 / PROXIMOS PASOS

- Validar las herramientas - retroalimentar GTE
- Discusión en CCFH56
- Avance del Anexo II a tramite 5 en CCFH 56

20 /

PREGUNTAS?

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A4.3 Introduction to JEMRA Microbiological Risk Assessment Report #33 (Carlos Campos)

Food and Agriculture Organization of the United Nations | SUSTAINABLE DEVELOPMENT GOALS

FAO Workshop on the Safety and Quality of Water Used in Food Production and Processing

MRA33 - Safety and Quality of Water Used in Food Production and Processing

Choluteca, Honduras, 23–25 April 2025

Carlos Campos

Presentation overview and objectives

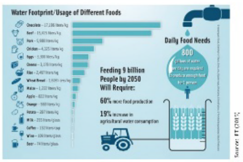
- Understand principles and practices on water safety and quality in food production and processing
  - Focus on fishery products (fresh produce and water reuse in food establishments not covered in this workshop)
- Review practical guidance on decision support systems (decision trees)
- Discuss practical applications and case studies - test the fit-for-purpose concept

Importance of water in food production

- Water is essential to all stages of the food chain from initial sourcing, storage, treatment, distribution, primary production, processing, and consumption
- Used as an ingredient, in direct and undirect contact (e.g. washing, cooling, cleaning)

Challenges

- Access to safe water sources is not guaranteed
- Water scarcity is a growing concern. Use water conservatively
- Importance of assessing water quality



Global water challenges

Water as a diminishing resource

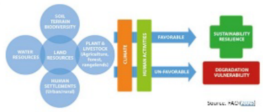
- Increasing demand due to population growth
- Impact of climate change and environmental degradation

Access to safe water sources

- Variability in water availability and quality
- Challenges faced by food producers and processors

Need for conservative use and reuse

- Strategies for water conservation
- Benefits of water reuse in food production



Questions:

- How has water scarcity impacted your operations?
- Have you explored water reuse options in your food production processes?

Water quality variability

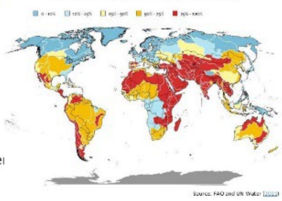
Factors influencing water quality and availability

- Local water sources (surface water, groundwater, rainwater, reused water)
- Infrastructure and treatment capabilities
- Regulatory standards and guidelines

Challenges and solutions

- Addressing variability in water quality
- Implementing context-specific improveme

Water stress (agriculture) (2018 data):



The concept of clean water as 'fit-for-purpose'

Deciding and applying water fitness

- Source assessment to identify potential hazards
- Evaluating treatment options
- Implementing multiple barrier processes
- Considering the end use of the product – different quality requirements for different uses
- Storage water vs. ingredient water
- Allows more efficient and sustainable use of water resources

Guidance and knowledge on water use and safety

Sources

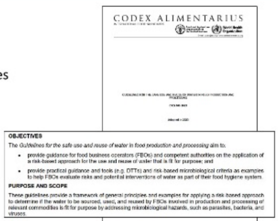
- Codex
- International guidelines
- National guidance from competent authorities

Challenges

- Inconsistencies in definitions and standards
- Operationalization by food businesses

Areas for improvement

- Harmonizing guidelines (clear and consistent definitions)
- Practical implementation strategies



Definitions in the Codex Guidelines for safe use and reuse

- **Clean water**: Water that does not meet the criteria for potable water but does not compromise the safety of the food in the context of its use.
- **Potable water**: Water fit for human consumption.
- **Recirculated water**: Water reused in a closed loop for the same processing operation without replenishment.
- **Reclaimed water**: Water that was originally a constituent of a food material, which has been removed from the food material by a process step and is intended to be subsequently reused in a food processing operation.
- **Recycled water**: Water which has been obtained from a step in the food production or food processing operation to be reused in the same, prior or a subsequent step of the operation, after reconditioning, when necessary.
- **Reuse water**: Water that has been recovered from a processing step within the food operation, including from the food components and/or water that, after reconditioning treatment(s) as necessary, is intended to be reused in the same, prior or a subsequent step of the food processing operation.

Risk management approaches

Ensuring safety of water and food supplies

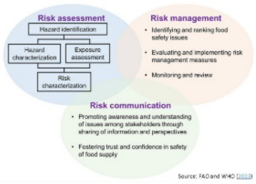
- Fit-for-purpose concept
- Decision support system approaches

Components of risk management

- Risk assessment
- Implementation of risk reduction measures
- Verification and monitoring

Benefits of risk-based approaches

- Tailored solutions for specific contexts
- Improved food safety and quality



Question:

- Can you share an example of a successful risk management strategy you have implemented?

Food production scenarios

Factors to consider

- Each production system requires context-specific solutions
- Fishery products rely heavily on water quality
- Microbiological criteria help ensure safety

Challenges

- Variability in food types/production systems
- Different types of hazards (physical, chemical, microbiological)
- Context-specific risk management

Importance of tailored solutions

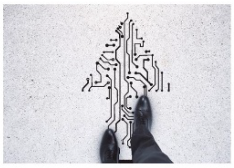
- Addressing specific needs of each system
- Implementing effective water safety strategies

Overview of decision trees

- Decision trees are valuable tools for managing water safety
- Provide a structured approach to decision-making

Steps in the decision-making process

- **Context assessment** to understand system conditions and requirements
  - Type of product, water source(s), hazards
- **Risk evaluation** to determine likelihood and impact of hazards
- Selection of **risk mitigation** measures



Key elements for safe water use

Food safety management programme

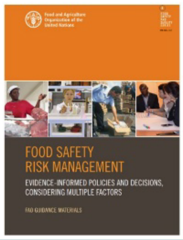
- General principles and guidelines
- Use of potable water
- Treatment of recirculated water

Guidelines and standards

- Codex / FAO/ WHO guidelines
- Industry best practices

Implementation

- Monitoring and verification
- Risk assessment and management
- Continuous improvement needed to maintain standards



Effects of water quality on end-product

Microbial growth

- Influence of water quality on microbial survival
- Factors affecting pathogen persistence

Monitoring and maintaining quality

- Importance of sanitized washes
- Methods of application and use of washing aids

Quantitative microbial risk assessment

- Connecting microbial loads with health risks
- Challenges in obtaining reliable data

Quantitative microbial risk assessment

1. Problem formulation

What are the scope and purpose of the assessment?

- Which hazards?
- Which exposure pathways (including hazardous events)?
- Which health outcomes?
- What level of certainty is needed for risk management?

2. Exposure assessment

What is the estimated dose of pathogens for the defined exposure pathway(s)?

- Source concentration
- Pathogen reduction achieved by barriers/control measures and recontamination risks
- Magnitude and frequency of exposure

3. Health effects assessment

What are the expected health effects of the defined hazards?

- Dose–response
- Illness and sequelae
- Secondary transmission and immunity
- Impact on disease burden

4. Risk characterization

What are the expected health effects of the estimated dose?

- Quantification of risk
- Variability and uncertainty analyses
- Sensitivity analysis

Source: WHO (2016)

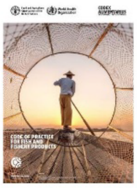
Water use in fishery products

Map of water use

- Storage on fishing vessels (refrigerated seawater, ice)
- Processing steps (washing, gutting, filleting, skinning, trimming, glazing, mincing)

Strategies to ensure water quality and safety

- Adhering to guidelines and standards
- Monitoring water quality
- Effective risk reduction measures



Question:

- Can you share an example of a successful risk reduction measure implemented for fishery products?

Decision support systems for fishery products

Key elements of decision support systems

- Relative exposure levels
- Requirements for sanitary surveys and water treatment
- Stringency of microbiological criteria

Benefits

- Ensuring health protection
- Guiding risk management decisions

Example application:

Decision support tree to recommend conducting regular sanitary surveys to assess the quality of seawater used for fish storage and processing.

Based on the survey results, processors can implement water treatments to meet the required microbiological criteria.

This approach helps reduce the risk of microbial contamination and ensures the safety and quality of fishery products.

Water safety/quality targets for fishery products

Microbiological criteria

- Definitions and standards for clean water
- Variability in criteria across regions

Guidelines

- Potable water standards
- Definitions of clean water

Risk-based approaches

- Application of HACCP principles
- Assessment of health risks

Definition of clean water:
'water from any source, where harmful microbiological contamination, substances, and/or toxic plankton are not present in such quantities that may affect the safety of fish, shellfish, and their products intended for human consumption

Effects of water quality on fishery products

Impacts on end products

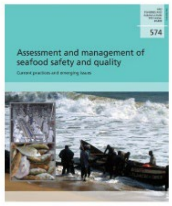
- Pathogen monitoring (*E. coli*, enterococci, *Listeria monocytogenes*)
- Hygiene and sanitary practices

Risk reduction strategies

- HACCP principles
- Good hygiene practices

Questions:

- How do you monitor and assess the effects of water quality on your fishery products?
- What types of hygiene and sanitary practices do you implement to reduce contamination risks?



Risk reduction options for fishery products

Monitoring and control

- Regular monitoring of water quality
- Corrective actions when issues are detected

Examples of risk reduction measures

- Ensuring potable water for washing and processing
- Implementing sanitary surveys and water treatments

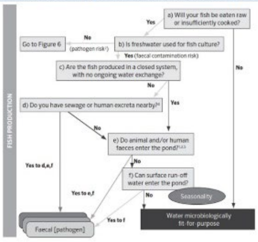
GHP involve maintaining clean and sanitary conditions throughout the fish handling and processing stages.

This includes regular cleaning and sanitizing of equipment, surfaces, and storage areas.

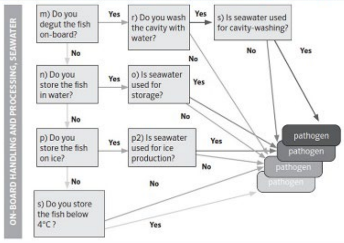
By adhering to GHP, processors can minimize the risk of cross-contamination and ensure the safety and quality of fishery products

Decision trees

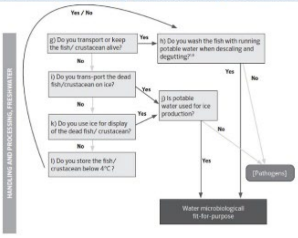
Decision tree for production of fish and fish products



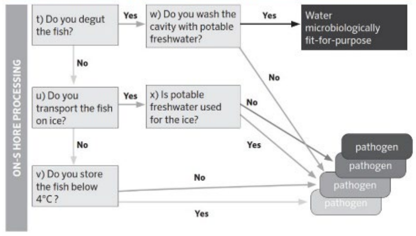
Decision tree for onboard processing and handling of marine/estuarine fish



Processing and handling of freshwater fish/crustaceans which will potentially be eaten raw



Decision tree for onshore processing of marine/estuarine fish



Critical control points

Multi-barrier approach is possible regarding water quality management in the production of fish and crustaceans consumed raw

Example CCPs:

- Washing of the fish with (running) potable water after gutting
- Controlling temperature to avoid pathogen growth
- Avoiding cross-contamination by using good hygiene measures
- Protecting ponds from faecal contamination avoids introduction of microbial hazards

Summary

- Water is essential in fish production and processing.
- Sustainable water management practices are crucial to ensure water safety and quality.
- Water availability and quality vary between countries, regions and sectors.
- Guidance on water quality and safety criteria exists from many national and international guidelines.
- Inconsistencies in definitions and operationalization of water quality standards.
- QMRAs have been used to demonstrate the importance of control measures in preventing contamination of fishery products.
- Decision support systems / decision trees help ensure that water used in fish handling and processing meets the necessary quality standards and effectively controls hazards.

A4.4 Introduction to JEMRA Microbiological Risk Assessment Report #41 (Carlos Campos)

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FAO Workshop on the Safety and Quality of Water Used in Food Production and Processing

MRA 41 - Safety and quality of water used in the production and processing of fish and fishery products

Choluteca, Honduras, 23–25 April 2025

Carlos Campos

Food and Agriculture Organization of the United Nations | SUSTAINABLE DEVELOPMENT GOALS

Background

Fish production and consumption

- Global fish consumption is increasing
- Fish utilization methods differ between continents, regions, and countries

Safety of fishery products

- Fishery products are associated with infections and intoxications mediated by viruses, bacteria, protozoans, and helminths
- The global burden of illnesses associated with fishery products is substantial - water acts as a vector to transmit pathogens

FIGURE 1 World utilization and apparent consumption of fish, 1950–2018

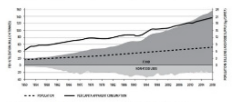
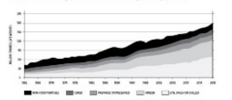


FIGURE 2 Utilization of products from fisheries and aquaculture, 1962–2018



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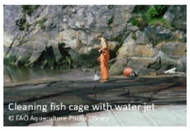
Use and reuse of water in fish and fisheries

- Water is used for various purposes during handling and processing of fish and shellfish, including:
  - for rearing or harvest product
  - as an ingredient
  - to transport / convey products
  - to wash, cool down, and cook food
  - to clean and sanitize facilities, utensils, containers and equipment
  - to make ice and glazed products
  - as an ingredient
- The concept of fit-for-purpose water allows various possibilities for reusing water in the production of fish and fishery products



Question:
- Can you share examples of water uses in your industry?

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The concept of fit for purpose water

- Water quality should be matched to its intended use (rather than requiring all water to meet the same high standards).
- Allows tailoring the treatment and quality requirements to specific applications and more efficient and sustainable use of water resources.

Questions:
- Have you applied this concept to your industry?
- What benefits and efficiencies have been gained?

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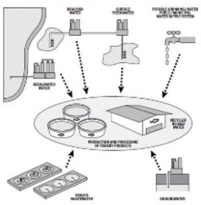
Water sources

Types of water used

- Drinking (potable) water from public / municipal water supply systems
- Other:
  - Freshwater from surface and groundwater sources
  - Harvested rainwater
  - Seawater and brackish water
  - Desalinated water
  - Recycled / reused processing water
  - Reused wastewater from public / municipal systems

FIGURE 4 Sources of water used in the production and processing of fishery products



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Microbiological hazards in water used in fish production and processing

Common pathogens

- **Bacteria**: *A. hydrophila*, *B. cereus*, *C. jejuni*, *C. botulinum*, *E. coli*, *L. monocytogenes*, *Salmonella* sp., vibrios (*V. cholerae*, *V. parahaemolyticus*, *V. vulnificus*)
- **Viruses**: enteroviruses, Hepatitis A virus, Hepatitis E virus, norovirus, rotavirus
- **Protozoans**: *Acanthamoeba* spp., *C. parvum*, *C. cayetanensis*, *E. histolytica*, *G. lamblia*, *T. gondii*
- **Helminths**: *Anisakis* spp., *D. medinensis*, *Schistosoma* spp., *D. latum*

- Monitoring for indicators is essential to assess water quality:
  - Heterotrophic plate count
  - Total coliforms / faecal coliforms / *E. coli* / enterococci

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Characteristics of waterborne pathogens

- Can cause acute or chronic health effects
- Certain groups can grow in the environment
- Able to aggregate / adsorb to suspended solids in water
- Concentrations vary spatially and temporally
- Likelihood of infection cannot be predicted only from concentration in water.
- Disease occurrence depends upon infectious dose, virulence and immune status of the infected person.
- Unlike many chemical contaminants, do not exhibit a cumulative effect.

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Water reuse in fish production and processing

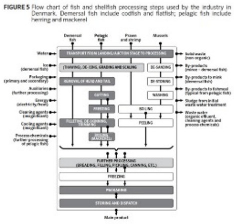
Strategies for water use efficiency

- Water mapping, improved planning, improved equipment maintenance, water recycling/reuse after treatment
- Concept of fit-for-purpose water allows for water reuse in fish production and processing

Treatment technologies

- Chemical treatments: chlorine, ozone, peracetic acid
- Physical treatments: membranes, UV light
- Biological treatments: aerobic, anaerobic bacterial degradation

FIGURE 5 Flow chart of fish and shellfish processing steps used by the industry in Denmark. Demersal fish include codfish and flatfish; pelagic fish include herring and mackerel



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Water use in the seafood industry

CONTINENT	COUNTRY	PRODUCT	WATER USE (L WATER/KG RAW)	REFERENCE
Europe	Türkiye	Anchovy	21-75	Alkaya and Demirer (2016)
	Denmark	Peeled shrimp	50	Casani, Leth and Knøchel (2006)
	Sweden	Shrimp	17	Holland (2018)
		Marinated herring	7–8	
South America	Brazil	Tambaqui, matrinxã and spotted surubim	15	Ferraciolli *et al.* (2018)
	Chile	Jack mackerel	2–3	Bezama *et al.* (2012)
Asia	Thailand	Aquatic products	10–40	Sridang *et al.* (2006)
		Tuna	10–20	Nair (1990)
	Viet Nam	Shrimp	15–84	Anh *et al.* (2011); Dan Viswanathan and Kumar (2003)
Africa	Tunisia	Cuttlefish	50	Walha *et al.* (2008)

Source: Authors' own elaboration.

- Very little information on water utilization in fish production and processing
- Data suggest higher water requirements for shrimp than herring or mackerel
- Level of processing correlates directly with water usage

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Water quality characteristics of wastewater streams from seafood industries

PRODUCT	CANNED FISH[a]	SARDINES	FISH[b]	CANNED ANCHOVIES	SHRIMP
Reference	Cristóvão *et al.* (2015)	Duarte *et al.* (2015)	Ferraciolli *et al.* (2018)	Corsino *et al.* (2016)	Anh *et al.* (2011)
pH	6.13–7.14	6.5–6.9	5.5–9.2	NA	NA
COD (mg/L)	1 147–8 313	6 000–15 767	110–1 722	16 984	1 200–2 300
BOD_5 (mg/L)	463–4 569	2 122	43.85–890	7 060	720–1 100
TN (mg/L)	21–471	NA	10.8–102	1 152	45–77
TP (mg/L)	13–47	56.8	0.058–16.4	NA	18–71
TSS (mg/L)	324–3 150	NA	60–940	4 621	122–872
Conductivity (mS/cm)	4.73–24.8	NA	NA	160	NA

COD: chemical oxygen demand; BOD_5: 5-day biochemical oxygen demand; TN: total nitrogen; TP: total phosphorus; TSS: total suspended solids; NA: value not available.
[a] Canned fish includes sardines and mackerel.
[b] The fish category includes tambaqui, matrinxã and spotted surubim.
Source: Authors' own elaboration.

- Important to characterize individual water effluents to define treatment requirements and uses of fit-for-purpose water
- Large variation of COD / BOD / nutrient values
- High levels of fats and oils, blood and suspended solids in evisceration and cooking water

Monitoring and control

Water monitoring

- Monitoring of water is required for ensuring water quality and safety in the seafood sector.
- Monitoring programmes should focus on numerical compliance with parameter limits

Sampling and analysis

- Sampling and analysis of water constituents should follow international standards
- QA/QC are essential to produce reliable data

Elements of a water monitoring plan:

- Monitoring objectives
- Critical limits and control measures
- Monitoring frequency
- Monitoring locations

Questions:
- How do you define monitoring objectives?
- Which parameters do you monitor to assess microbiological quality of the water?

Risk assessment

Risk assessment approaches

- **Qualitative sanitary inspection**: visual evaluation of the conditions at/near the water supply and upstream catchment
- **Risk matrix**: qualitative or semiquantitative evaluation of the likelihood that a hazardous event will occur and the severity or consequences of the hazard, combined into a categorical risk score or rank
- **Quantitative microbial risk assessment**: mathematical modelling of a water system combining information about the pathogens, their fate and transport, routes of exposure to humans and health effects

Case studies

Harvesting and processing of live oysters (UK)

Microbiological hazards

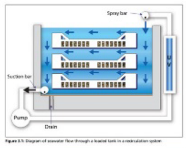
- Oysters are often harvested from areas impacted by wastewater and land runoff
- Viruses (norovirus, Hepatitis A), bacteria (vibrios)

Microbiological controls (primary production)

- Sanitary surveys
- Classification of growing areas

Microbiological controls (post-harvest)

- Depuration, relaying
- Process control parameters



Routine monitoring for norovirus in oysters is currently not legally required, but some authorities have implemented interim measures

Fishing and processing of pelagic fish (Norway)

Fish products

- Herring, Atlantic mackerel, blue whiting, and Barents Sea capelin
- Raw, semi-processed, processed

Safety and quality of products/processing operations

- Fish are placed in tanks with refrigerated seawater shortly after capture
- Norwegian Regulations require clean water for rinsing fish on board and for ice production

Risk management measures

- Appropriate temperature controls, adequate water recirculation, GHPs, reduced fish densities in tanks

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Guide to good practice

For establishments producing fish oil intended for human consumption

Implementing relevant EC hygiene regulations

Fish processing in the canning industry (Portugal)

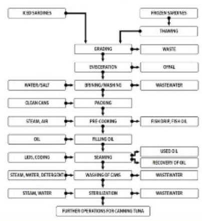
Processing operations

- Double seaming, sterilization, sanitation of cooling water
- Large volumes of water for cleaning, washing, cooling, thawing and ice production

Risk management measures

- Specific HACCP requirements:
  - regular parameter checks
  - conformance to pasteurization and sterilization standards

FIGURE 11 Flow diagram of steps involved in the production of canned sardines in oil



Production of rainbow trout in tank systems/raceways (Brazil)

Operations and water quality

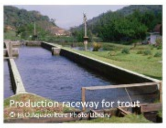
- Water sources: groundwater or surface rainwater
- Inputs: feed utilization, aeration, tank cleaning, fish grading

Water treatment

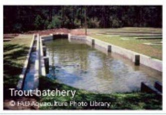
- Settlement, biofilters and constructed wetlands

Risk management measures

- Water exchange
- Source water protection
- Regular water quality testing
- HACCP/BMPs



Production raceway for trout
© FAO Aquaculture Photo Library



Trout hatchery
© FAO Aquaculture Photo Library

Farming and processing of shrimp (Madagascar)

Farming system and water source

- Semi-intensive farming in ponds with low density.
- Clean seawater is pumped and treated by desalinization, chlorination/dechlorination)

Microbiological hazards

- Vibrios, zoonotic pathogens, enterobacteria and viruses

Risk management measures

- Water treatment
- Physical barriers
- Physico-chemical and microbiological monitoring
- Disease surveillance

Shrimp rearing pond
© FAO Aquaculture Photo Library

Hatchery algal cultures
© FAO Aquaculture Photo Library

Summary

- The global burden of illnesses associated with fishery products is substantial; water acts as a vector of pathogen transmission.
- Water quality should be matched to its intended use (fit for purpose water).
- Fishery products can cause infections/intoxications mediated by a wide range of pathogens.
- Risk assessments help identify hazards, evaluate risks, and implement control measures.
- Monitoring of water is a core element of food safety management systems.
- Many technologies are available to achieve any desired water quality for specific applications. Economic, safety and environmental impact assessments are needed to inform decision on appropriate treatments.

Q&A

A4.5 Risk assessment activity (Carlos Campos)

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FAO Workshop on the Safety and Quality of Water Used in Food Production and Processing

Proposed scenarios for decision tree validation

Choluteca, Honduras, 23–25 April 2025

Carlos Campos

Food and Agriculture Organization of the United Nations | SUSTAINABLE DEVELOPMENT GOALS

Overview

- Five proposed scenarios for decision tree validation:
  - Freshwater aquaculture (tilapia)
  - Freshwater aquaculture (shrimp)
  - Marine capture (horse mackerel)
  - Marine capture (tuna)
  - Freshwater aquaculture (catfish)
- Each breakout group will validate decision tree for 1 scenario.
- After the group discussion/decision tree validation, each group will:
  - Present their scenario analysis and validation outcomes
  - Engage in a Q&A session

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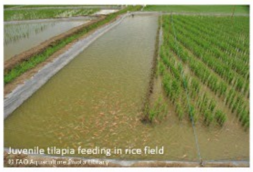
Group 1: Freshwater aquaculture - tilapia production

Scenario

- Tilapia are raised in a pond that is subject to seasonal flooding, which introduces contaminants from nearby agricultural fields.


Juvenile tilapia feeding in rice field
© FAO Aquaculture Photo Library

- Flooding occurs during the rainy season (2-3 weeks)
- Pond receives water from nearby rivers and streams
- Floodwater is turbid (runoff from rice field)
- Water quality testing is conducted (pH, temperature, turbidity, dissolved oxygen, total coliforms)
- Physical barriers present (nets)

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Group 1: Freshwater aquaculture - tilapia production

Tasks

- **Map the water sources and potential contamination points**: identify the sources of water for the pond. Determine the points where contaminants might enter the pond.
- **Assess the effectiveness of hygiene practices**: identify practices for maintaining pond hygiene and their effectiveness in reducing risks.
- **Validate the decision tree steps for managing water quality and contamination risks**: assess water sources, identify contamination risks, and mitigation measures.
- **Propose risk mitigation measures**.

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Group 2: Freshwater aquaculture - shrimp production

Scenario

- Shrimp are raised in a pond that uses partially treated wastewater


Shrimp farming in ponds
© FAO Aquaculture Photo Library

- Wastewater sourced from a nearby urban area
- Treatment includes settlement and chemical dosing
- Approximately 500 m³ of wastewater used daily
- Dark brown color in wastewater indicating high organic content
- Shrimp are experiencing stress and reduced growth
- Aeration in ponds to improve water quality and reduce odor
- Ponds are regularly cleaned to reduce contamination risks

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Group 2: Freshwater aquaculture - shrimp production

Tasks

- **Identify the critical control points for water quality**: determine the key points in the water supply chain where contamination risks are highest (e.g. source of wastewater, pond environment).
- **Evaluate the impact of using untreated wastewater on shrimp safety**: assess the potential health risks to shrimp and consumers.
- **Validate the decision tree steps for ensuring safe water use**: assess water sources and identify potential contamination risk management and treatment options.
- **Recommend improvements to water treatment and hygiene practices**

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Group 3: marine capture - horse mackerel

Scenario:

- Horse mackerel are caught in an area with high levels of marine pollution and processed on board the vessel


Horse mackerel fishing vessel
© FAO Aquaculture Photo Library

- Capture area is near a major port city, known for high levels of marine traffic and industrial activity
- Water temperature varies seasonally, ranging from 15°C in winter to 25°C in summer
- Seawater with dark greenish-brown color indicating high organic content and pollution
- Poor hygiene practices on board the vessel
- Equipment and storage tanks are cleaned monthly

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Group 3: marine capture - horse mackerel

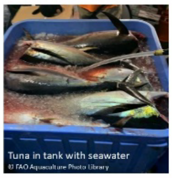
Tasks:

- **Analyze the onboard processing steps and water sources**: map the steps involved in processing horse mackerel on the vessel. Identify the sources of water used in these processes.
- **Assess the risks associated with using seawater for washing and storage**: assess the potential contamination risks from using polluted seawater.
- **Validate the decision tree steps for onboard handling and processing**: assess water sources, contamination risk management, and mitigation measures.
- **Suggest alternative methods to reduce contamination risks**.

Group 4: Marine capture - tuna processing

Scenario

- Tuna are caught and stored in tanks with refrigerated seawater before being processed at a land-based facility



Tuna in tank with seawater
© FAO Aquaculture Photo Library

- Large insulated tanks designed to store seawater and maintain low temperatures.
- Seawater is pumped directly from the ocean into the storage tanks.
- Tanks are equipped with advanced refrigeration systems to maintain water temperatures at 0-4°C.
- Sensors are installed to continuously monitor water temperature.
- Refrigeration system designed to quickly cool the seawater and maintain consistent temperatures.

Group 4: Marine capture - tuna processing

Tasks

- **Map the storage and processing steps**: identify the steps involved in storing and processing tuna.
- **Evaluate the effectiveness of temperature control measures**: review the methods used to maintain the temperature of seawater in storage tanks.
- **Validate the decision tree steps for onshore processing**: use the decision tree to assess water sources, contamination risk management, and mitigation measures.
- **Propose additional measures to ensure water quality and food safety**.

Group 5: Freshwater aquaculture - catfish production

Scenario

- Catfish are raised in a pond that is prone to contamination from nearby livestock farms

Catfish pond
© FAO Aquaculture Photo Library

- The pond covers an area of 2 ha (max. depth 1.5 m).
- The pond is filled with water from a nearby river and supplemented with groundwater from wells.
- There is a continuous flow of water into the pond from the river, with an outflow system to maintain water levels.
- Nearby livestock farms contribute runoff containing animal faecal matter.
- Runoff levels increase during the rainy season.
- Elevated levels of nutrients due to agricultural runoff and livestock waste.

Group 5: Freshwater aquaculture - catfish production

Tasks

- **Identify the sources of contamination and critical control points**: determine the points where contaminants from livestock farms might enter the pond.
- **Assess the impact of faecal contamination on catfish safety**: analyze the potential health risks to catfish and consumers.
- **Validate the decision tree steps for managing water quality**: follow the decision tree to assess water sources, contamination risk management, and mitigation measures.
- **Recommend strategies to prevent contamination and improve hygiene practices**.

A4.6 Introduction to Annex II of Codex Alimentarius Commission Work on Water (Maria Sevilla)

CODEX ALIMENTARIUS HONDURAS

Anexo II (pescado y productos pesqueros) de las Directrices para el Uso y la Reutilización de Agua en la Producción y Procesamiento de Alimentos CXG 100-2023

1 / ANTECEDENTES

- Elaborado por el Comité del Codex sobre Higiene de los Alimentos (CCFH)
- Sólo aborda los peligros biológicos
- Base científica: Serie de Evaluación de Riesgos Microbiológicos de la FAO/OMS (JEMRA) sobre inocuidad y calidad del agua

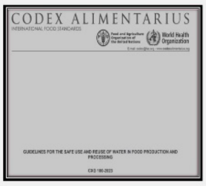
MRA 33: Producción y elaboración de alimentos
MRA 41: Pescado y productos pesqueros
MRA 37: Productos frescos y hortalizas
MRA 40 : Productos lácteos

JEMRA Review 2018

https://www.fao.org/3/ca6062en/CA6062EN.pdf

2 / ANTECEDENTES

Seccion General	CXG 100-2023
Anexo I: Productos Frescos	CXG 100-2023
Anexo III: Leche y Productos Lacteos	Adoptado en CAC47 (Noviembre 2024)
Anexo II: Pescado y productos Pesqueros	Grupo de trabajo electrónico, presidido por la Unión Europea, copresidido por Marruecos, Honduras, Mauritania, India y la Federación Internacional de Lechería Se presentará en la CCFH55 (dic. 2025)
Annex IV: Evaluación de la «aptitud para el uso» del agua, gestión y tecnologías de recuperación y tratamiento del agua	



3 / ESTRUCTURA

1. INTRODUCCIÓN
2. OBJETO Y ÁMBITO DE APLICACIÓN
3. USO
4. DEFINICIONES
5. FUENTE DEL AGUA
6. USO DEL AGUA: acuicultura - a bordo de buques - transformación
7. AGUA DESTINADA A REUTILIZACIÓN p. ej. unidad acuapónica
8. EVALUACIÓN DEL USO O LA REUTILIZACIÓN DEL AGUA PARA SU PROPÓSITO: Ejemplos de árboles de decisión
9. GESTIÓN DE LA INOCUIDAD DEL AGUA: Buenas Prácticas de Higiene - Aplicación de un plan de gestión de la seguridad del agua - Tratamiento

4 / FINALIDAD Y AMBITO

Proporcionar recomendaciones para el abastecimiento, uso y reutilización del agua de forma microbiológicamente segura en la producción y el procesamiento de pescado y productos pesqueros destinados al consumo humano, aplicando el principio de «adecuada para su finalidad» y utilizando un **enfoque basado en el riesgo**.

Este anexo también proporciona ejemplos de árboles de decisión para determinar el uso y la reutilización del agua conforme a su uso previsto, en el caso de pescado o productos pesqueros que potencialmente se consuman crudos o poco cocinados

5 / DEFINICIONES

Agua limpia:

Agua adecuada para su finalidad:

5 / DEFINICIONES

Agua limpia: Agua que no cumple los criterios del agua potable pero que no pone en peligro la inocuidad de los alimentos en el contexto en que se utiliza

- Se utiliza en las normas existentes del Codex y en la legislación pertinente de distintas partes del mundo.
- Considerado poco claro por algunos, pero a menudo bien entendido por la industria pesquera

Agua adecuada para su finalidad: Agua que se determina que es inocua para un fin previsto mediante la identificación, evaluación y comprensión de los posibles peligros microbiológicos y otros factores pertinentes (como el historial de uso, el uso previsto de los alimentos, etc.), incluida la aplicación de medidas de control como las alternativas de tratamiento y su eficacia para garantizar la eliminación efectiva o la mitigación de dichos peligros.

- Nuevo concepto - Riesgo
- Destaca claramente la necesidad de evaluar y aplicar medidas de control en función de la finalidad prevista

6 / USO DEL AGUA

Opción 1 (en proyecto actual para debate): 3 niveles de uso previsto segun su finalidad (FFP)

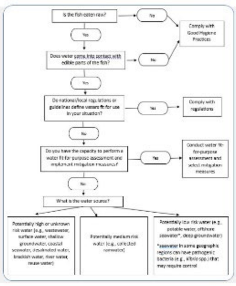
- FFP nivel 1 (FFP1): Agua potable: Agua FFP para todos los usos.
- FFP nivel 2 (FFP2): Agua limpia: Puede utilizarse en todos los usos excepto como ingrediente.
- FFP nivel 3 (FFP3): Puede utilizarse pero previo análisis de riesgos o aplicando medidas de control adicionales.

Opción 2 (borrador actual): hacer referencia a «agua adecuada para su finalidad», pero hacer referencia a «agua (de mar) limpia» cuando se considere pertinente, por ejemplo, en el párrafo 55: «Cuando se utilice agua de mar a bordo de buques pesqueros, será apta para el uso previsto cuando esté limpia, por ejemplo, deberá tomarse, siempre que sea posible, de zonas mar adentro que estén suficientemente alejadas de fuentes de contaminación conocidas (por ejemplo, vertidos de aguas residuales).“

Opción 3: ya no se hace referencia a «agua (de mar) limpia», sólo a «agua adecuada para su finalidad».

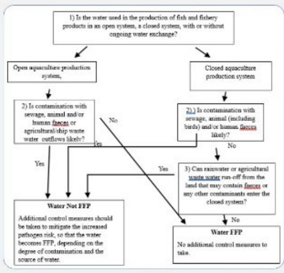
7 GESTIÓN DE LA INOCUIDAD DEL AGUA

Figura 2 (modificación de la Figura 2 del Anexo I de la CXG 100-2023) Árbol de decisión sobre la posible necesidad de una evaluación de la aptitud para el uso en el agua



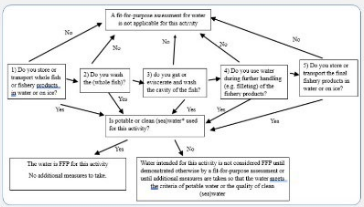
7 GESTIÓN DE LA INOCUIDAD DEL AGUA

Figura 3 Ejemplo de árbol de decisión para determinar la aptitud del agua utilizada en la acuicultura de agua dulce, marina o de estuario para la producción de pescado y productos pesqueros que puedan consumirse crudos o poco cocinados.



7 GESTIÓN DE LA INOCUIDAD DEL AGUA

Figura 4 Ejemplo de árbol de decisión para determinar el agua apta para el uso previsto en la manipulación o transformación posterior a la captura de pescado y productos de la pesca que puedan consumirse crudos o poco cocinados (Figura 4)



8 PROXIMOS PASOS

- Validar las herramientas - retroalimentar GTE
- Discusión en CCFH55
- Avance del Anexo II a tramite 5 en CCFH 55

FAO workshop on the safety and quality of water used in fisheries

Workshop report

The FAO Workshop on the Safety and Quality of Water Used in Fisheries was held in Choluteca, Honduras, from 23–25 April 2025. Hosted by SENASA Honduras, the workshop convened 45 participants from 11 countries, including scientists, regulators, food business operators (FBOs), and food safety inspectors. The workshop aimed to:

- present key findings from the Microbiological Risk Assessment (MRA) 33 and MRA 41;
- compare the use of "fit-for-purpose water" and "clean water" in a real-world scenario;
- train participants in the use of decision trees (DTs) developed by JEMRA to facilitate their adoption as part of microbial risk assessments of water use and reuse in fish production and processing. Validate these tools through desktop exercises and field visits; and
- support the development of Codex Alimentarius Commission *Guidelines for the Safe Use and Reuse of Water in Food Processing*.

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