Enhancing Food Safety in Artisanal Aquaculture in Papua New Guinea: A HACCP-Based Approach and Overview of Post-Harvest Losses

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Fisheries Training Programme

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Introduction

Background

·Aquaculture was traditionally practiced in Kiribati, Nauru, and French Polynesia, but not in PNG.
·Most Pacific Island countries focused on marine aquaculture, while Melanesian countries like PNG and Fiji explored freshwater due to geographic suitability.
·PNG began freshwater aquaculture in the 1950s with carp and trout; GIFT tilapia was introduced in 1999.

Figure 1. Map of PNG showing current farm clusters in yellow triangle.

Sector Objectives & Growth

·*Goals:* improve rural nutrition and create income-generating opportunities.

Food Safety Research Gaps

·Significant lack of sector-specific guidelines tailored for aquaculture in PNG.
·Post-harvest losses due to poor handling and lack of adequate cold chain and transport infrastructure.
·Lack of targeted food safety standards to improve quality, market access, and economic returns.

Objective

To develop and present a practical HACCP-based food safety framework tailored to small-scale artisanal aquaculture in Papua New Guinea, focusing on identifying critical control points across the production chain and summarising key factors contributing to post-harvest losses affecting quality, food safety, and market accessibility.

Figure 2. Largest of the artisinal Trout farms in PNG.

Methodology

This study used a systematic, multi-phase approach to develop a HACCP plan tailored to the operational realities of an artisanal freshwater fish farm in Papua New Guinea. The methodology was grounded in principles outlined by the Codex Alimentarius Commission and was adapted to the scale, resource limitations, and ecological context of small-scale aquaculture operations.

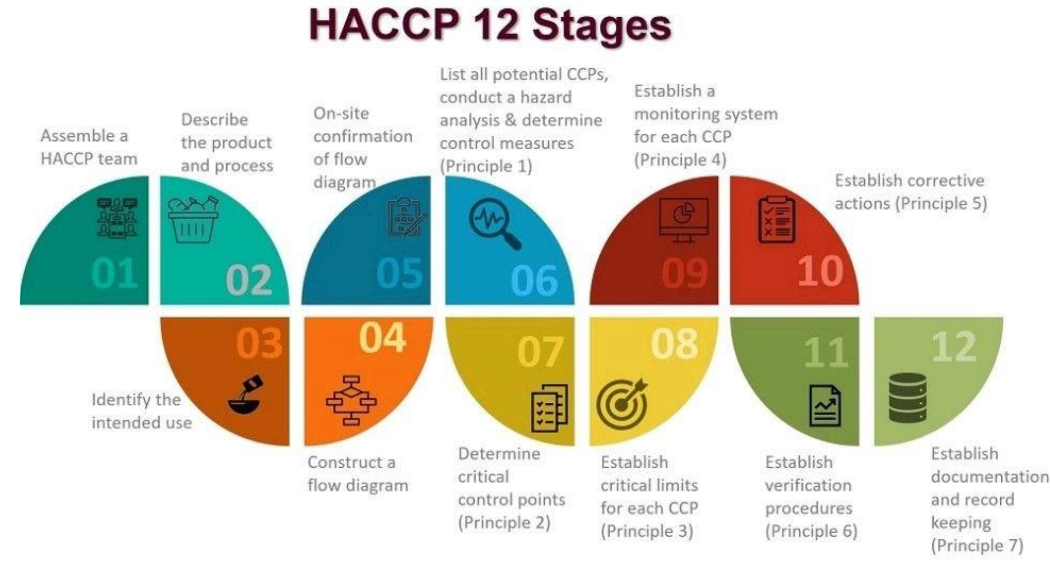

Figure 3. 12-step process of creating a HACCP Plan (Online source).

Phase 1: Farm Assessment and Process Mapping
Target farms were site-assessed through observation, structured interviews with farm personnel, and protocols reviewed. From data collected a detailed process flow diagram was created, covering all relevant stages.

Phase 2: Hazard Identification and Risk Assessment
Potential biological, chemical, and physical hazards were identified at each process step using literature review, expert input, and hazard checklist tools (e.g., FAO/WHO guidelines). Each hazard was evaluated based on likelihood of occurrence and potential severity using a semi-quantitative risk matrix.

Phase 3: Determination of Critical Control Points (CCPs)
A decision-tree analysis, guided by Codex logic sequences, was applied to each identified hazard to determine appropriate CCPs.

Phase 4: Establishment of Critical Limits, Monitoring, and Corrective Actions
For each CCP, measurable critical limits were defined based on regulatory standards and expected benchmarks from published sources and industry norms. Monitoring procedures are to be practical for artisanal operators, relying mostly on manual logs, visual checks, and low-cost test kits. Corrective actions were outlined for each CCP breach and will be validated through scenario simulations and stakeholder feedback.

Figures 4 (left) & 5 (right). Examples of transport infrastructure deficiencies for PNG artisanal farmers. Both show access roads to farms.

Phase 5: Verification and Documentation
The draft HACCP plan will be presented to farm stakeholders for validation and feasibility assessment and adoption. Minor adjustments expected to be made to align with seasonal variability, infrastructural availability, and local regulatory frameworks.

Results

From hazard analysis across all process steps, the following were determined to pose **significant food safety risks**:

Hazard Type	Significant Hazards	Process Steps at which Hazards are Significant
Chemical	Heavy Metals, PCBs, Dioxins, Veterinary Drugs	Recieving, Grow-Out, Harvest
Biological	Pathogenic Bacteria	Receiving, Harvesting, Packaging
Chemical	Leached Chemicals from Packaging Materials	Packaging
Allergens	Fish Allergen Labelling	Labelling
Toxins	Algal Toxins (Microcystins)	Receiving

Figure 6. Summary table of significant hazards as assessed

A **semi-quantitative risk matrix** (severity × probability) was used to prioritise hazards.

All significant hazards had a combination of **"High" severity and probability warranting CCP designation**, particularly where contamination could bioaccumulate or evade pre-harvest controls.

Critical Control Points (CCPs)
Only **two stages** were identified to require CCPs due to *unacceptable residual risk* even after prerequisite controls: this keeps the HACCP plan lean and implementable at artisanal scale.

•Receiving of Fingerlings and Feed
→ Risk of algal toxins and veterinary drug residues.
•Harvesting
→ Potential veterinary drug residues not mitigated by prior interventions.

•Most hazards were controllable through **Good Aquaculture Practices (GAP)** and **Prerequisite Programs (PRPs)** like water quality management, source traceability, and sanitation.

Overview of Post Harvest Losses from the Food Safety Perspective

•Artisanal fish farming in PNG faces major challenges in post-harvest food safety primarily due to inadequate infrastructure, particularly the absence of cold chain systems such as ice plants, cold storage, and refrigerated transport. These deficiencies, coupled with poor road access to farms located in remote inland areas, result in high levels of qualitative post-harvest loss, sometimes up to 40% of the catch.

• Farms distant from urban centres suffer lower market prices for fish due to delays and quality degradation during transit. A case study of ten farms shows price variability linked to distance, road conditions to market, and species, with trout commanding higher prices than tilapia.

Figure 7. A Tilapia farm and Hatchery in PNG.

Conclusion

In Papua New Guinea's remote highlands, smallholder GIFT tilapia and rainbow trout farms are an important source of protein for families, but under current practices with no reliable ice or refrigeration, post-harvest quality losses are high.

A generic HACCP analysis of these processes identified as key hazards algal toxins and veterinary drugs that may be introduced via feed and/or fingerlings at the receiving step and becoming significant again at harvest when veterinary drugs are used in production/grow out.

Improving transportation infrastructure and cold chain logistics is essential to preserving fish quality and ensuring fair market returns for artisanal aquaculture producers in PNG's remote highlands. Without these improvements, rural farmers will continue to face limited profitability and reduced contributions to national food security.

Recommendations

Concerted policy and infrastructure support are required.

- Investment in rural cold chain capacity – e.g., solar powered chillers or freezers to stabilise product quality.
- Farmer training on simple HACCP principles, hygienic handling and improved smoking or drying techniques.
- Regulatory support through integration of small-scale farms into national food safety regulations.
- Regulatory support through funding and supporting community fish processing centres - in line with PNG's food security strategy.
- Future research should include systematic measurement of quantitative losses in inland aquaculture.
- Future research should include field trials of HACCP based interventions.
- Most importantly, future research should include cost-benefit analysis of cold-chain investments to provide an evidence base for scalable improvements.

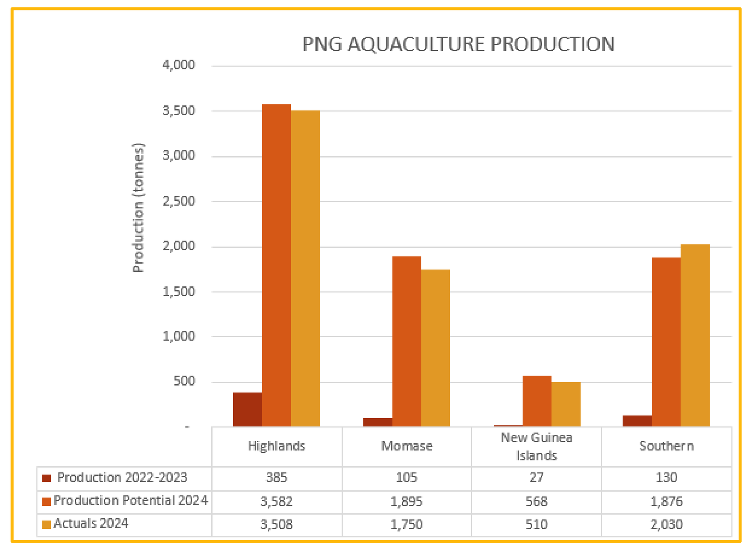

Figure 8.

Note: *Figure 8 shows the exponential increase in production volume driven by recent government focus on the sector, underscoring the urgency of implementing this report's recommendations.*

Acknowledgements

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