

POLICY BRIEF · MARCH 2026

Accelerating Digital Technology Adoption in Ontario's Rainbow Trout Aquaculture Industry

Strategies, Barriers, and Opportunities for Sustainable Growth

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Ontario, Canada — Canada's Largest
Rainbow Trout Producing Province

DATE

March 2026

KEY POLICY MESSAGES

- Skilled workforce development and digital literacy are the most critical first-order interventions.
- A provincial data governance framework is urgently needed to address farmer trust and privacy concerns.
- Subsidies and financial incentives must be expanded and better targeted at small and medium-sized operations.
- Technology providers must be engaged as partners in adoption — not merely vendors — with accountability for ongoing support.
- Peer learning and demonstration programmes can shift attitudes and subjective norms at scale.

Ontario’s rainbow trout aquaculture sector — Canada’s largest, producing approximately 6,000 metric tonnes annually — stands at a critical inflection point. Mounting environmental pressures, rising production costs, and intensifying global competition make digital transformation not merely desirable but strategically necessary. Yet adoption of digital technologies, including Decision Support Systems (DSSs), Internet of Things (IoT) sensors, and AI-driven analytics, remains strikingly low across the industry.

Two landmark peer-reviewed studies conducted at the University of Guelph illuminate the barriers and pathways forward. Using Q methodology and the Theory of Planned Behaviour (TPB), the first study identified three distinct stakeholder discourses shaping technology adoption attitudes. The second applied a rigorous SWOT-AHP-TOWS framework to 19 industry actors, revealing that external opportunities — especially cost savings and time efficiencies — significantly outweigh current barriers when strategically leveraged.

Rainbow trout farming is the cornerstone of Ontario’s freshwater aquaculture sector. Net-pen operations in Georgian Bay and the North Channel of Lake Huron account for 96% of provincial production, supporting rural employment, Indigenous economic development, and a growing domestic and international market expanding at 4.6% per year.



Despite this economic significance, digital technology adoption has stagnated. Research collected in 2023–2024 confirms Ontario lags behind analogous sectors in precision livestock and crop agriculture. Water temperatures in Lake Huron’s Manitoulin Island region have been rising steadily — making real-time environmental monitoring and predictive analytics survival tools, not peripheral improvements.

1. MULTI-STAKEHOLDER PERSPECTIVES ON DIGITAL TECHNOLOGY ADOPTION

Using Q methodology and surveys of 23 industry actors — producers, researchers, input dealers, educators, and government officers — three coherent discourses emerged that cut across professional roles, underscoring the need for nuanced rather than sector-wide interventions.

<p>DISCOURSE 1</p> <p>Skilled Workforce and Data Governance</p> <p>Emphasis on need for specialised, well-trained staff. Concern over third-party data access, ownership rights, and absence of a legal framework governing data use.</p> <p>Key actors: Producers, input providers, educators</p>	<p>DISCOURSE 2</p> <p>Complexity and Personalised Support</p> <p>Barriers rooted in complexity and cost. Participants stress need for personalised extension services, pre-adoption trials, training, and post-installation support.</p> <p>Key actors: Producers, input providers, government officers</p>	<p>DISCOURSE 3</p> <p>Financial Assistance and Demonstrated Value</p> <p>Financial assistance and demonstrated ROI are the primary adoption drivers. Strong opposition to high costs for small and medium-sized farms.</p> <p>Key actors: Researchers, input dealers, producers</p>
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KEY INSIGHT — CROSS-DISCOURSE CONSENSUS

All three discourse groups agreed on four consensus positions: (1) adoption requires radical changes to current farming practices; (2) there is little social pressure to adopt technologies for waste management; (3) digital technologies will increase farmer workload; and (4) data management limits the perceived value of digital tools. These consensus points should anchor any sector-wide communication strategy.

2. SWOT-AHP-TOWS ANALYSIS OF DECISION SUPPORT SYSTEM ADOPTION

The second study applied the Analytic Hierarchy Process (AHP) to pairwise comparisons among 19 stakeholders, producing a clear quantitative hierarchy for strategic action.

STRENGTHS

- Seamless integration with existing farm management systems
- Easy data entry — reduces manual workload
- User-friendly web dashboards
- Robust support for day-to-day operations

WEAKNESSES

- Limited customisation for farm-specific needs
- Data security and privacy vulnerabilities
- Requires trained human resources to operate
- Ongoing system monitoring burden

OPPORTUNITIES

- Government subsidies available for digital tool adoption
- Integration across diverse farm operations
- Significant efficiency and productivity cost savings
- Time savings through task automation

THREATS

- Cybersecurity risks: hacking, breaches, malware
- Growing data privacy concerns and farmer distrust
- High implementation costs and supply shortages
- Intensified market competition from widespread uptake

The AHP produced an unambiguous result: **Opportunities (weight: 0.566)** substantially outweighed Strengths (0.243), Weaknesses (0.123), and Threats (0.068). The dominant opportunity — efficiency and productivity cost savings (weight: 0.253) — was more than three times any individual weakness or threat factor.

CRITICAL FINDING — TOWS STRATEGY RANKING

Among all sixteen SWOT-derived strategies, ‘Automating Operations to Save Time and Enhance Productivity’ (SO2) ranked first, followed by SO4 and SO1. SO strategies collectively outperformed WO, ST, and WT strategies by more than 2:1, indicating the highest-return path is leveraging existing strengths against available opportunities.

Synthesising both studies, four primary barriers to digital technology adoption in Ontario rainbow trout aquaculture emerge:



Workforce Capacity

Inadequate digital and technical literacy among farm operators, compounding the difficulty of finding skilled human resources capable of operating and maintaining advanced systems.



Data Governance Vacuum

No provincial legal framework exists for data ownership, third-party data use, or privacy protection — generating significant distrust among producers.

\$ Financial and Cost Barriers

High upfront costs for hardware, software, and training are perceived as prohibitive for small and medium-sized operations. Subsidies are seen as insufficient or inaccessible.



Perceived Value Deficit

Producers require peer evidence, demonstration sites, and documented ROI before committing. Proof of concept in the Ontario rainbow trout context remains insufficient.

Secondary barriers include limited DSS customisation for species-specific needs, increasing regulatory complexity and cybersecurity threats, and the transitional workload burden during implementation periods.

05 Strategic Recommendations

The following recommendations are sequenced by priority according to the AHP-weighted TOWS analysis. They are directed at the Ontario Ministry of Agriculture, Food and Agribusiness (OMAFRA), the Ontario Aquaculture Association, and technology providers operating in the sector.

P	STRATEGIC ACTION	LEAD ACTORS	IMPACT
1	Develop and fund targeted digital literacy and training programmes for farm operators, covering core technologies (IoT, data analytics, AI) and data governance.	OMAFRA, Ontario Aquaculture Assoc., Technology Providers	High
2	Establish a provincial data governance framework — clear ownership rights, privacy protections, and third-party use regulations — specific to aquaculture digital data.	Ontario Govt., Industry Assoc., Legal Bodies	High
3	Expand and streamline access to subsidies and cost-sharing programmes for DSS and digital technology adoption, prioritising small and medium-sized operations.	OMAFRA, Agriculture Canada, Ontario Trout Farmers Assoc.	High
4	Require technology providers to develop farm-specific customisation, standardised onboarding, and mandatory post-installation technical support protocols.	Technology Companies, Industry Assoc., Government	Med-High
5	Create and disseminate a repository of Canadian aquaculture DSS success stories and peer-to-peer demonstration events to build evidence of value.	Universities, OMAFRA, Extension Services	Medium
6	Invest in cybersecurity infrastructure for on-farm digital systems, including subsidised access to encryption tools, security audits, and threat response protocols.	Government, Technology Providers, Cybersecurity Partners	Medium

Short-Term · 0–18 Months

- ▶ **Training Gap Assessment**
Commission a provincial audit of digital technology training resources and identify gaps in aquaculture-specific coverage.
- ▶ **Data Governance Task Force**
Convene a cross-sector task force to draft model agreement frameworks covering ownership, privacy, and third-party use.
- ▶ **Subsidy Review**
Review and expand cost-sharing programmes to include explicit DSS and IoT eligibility for aquaculture operators.

Medium-Term · 18 Mo–3 Yr

- ▶ **Digital Extension Services**
Pilot a structured digital extension programme delivered jointly by government advisors and technology companies.
- ▶ **Demonstration Farm Network**
Establish at least two demonstration farms in Georgian Bay and the North Channel to showcase DSS functionality and document measurable ROI.
- ▶ **Workforce Pipeline**
Collaborate with post-secondary institutions to embed aquaculture digital competencies into diploma and degree programmes.

Long-Term · 3+ Years

- ▶ **Legislative Action**
Enact provincial data governance legislation specific to aquaculture, with enforceable protections for producer data.
- ▶ **Sector Transformation Roadmap**
Develop a digital transformation roadmap with measurable targets, annual reporting, and accountability mechanisms.

Both studies are geographically restricted to Ontario and draw on relatively small samples — constraints that reflect the limited size of the provincial industry rather than methodological shortcomings. Future research priorities include:

Longitudinal studies tracking adoption attitudes over time as technology and subsidy landscapes evolve, providing dynamic rather than static policy intelligence.

Broader stakeholder representation in future SWOT-AHP exercises, particularly from operational managers, extension specialists, and Indigenous community aquaculture representatives.

Economic modelling of cost-benefit ratios at various operational scales to produce credible, concrete ROI projections for producers.

Cross-jurisdictional comparative research examining how analogous Canadian and international freshwater aquaculture sectors have overcome similar barriers.

Ontario's rainbow trout aquaculture sector possesses the infrastructure, market position, and entrepreneurial capacity to lead a digital transformation that could redefine freshwater aquaculture productivity in Canada. The opportunities — cost savings, efficiency gains, productivity improvements, and climate adaptation through real-time monitoring — vastly outweigh the barriers.

The barriers are not primarily technological. They are human, institutional, and financial: a workforce that needs upskilling; a regulatory environment that has not kept pace with data-intensive farming; and cost structures that disadvantage smaller producers. Targeted, evidence-informed policy interventions will unlock the sector's full potential.

FOR IMMEDIATE POLICY ACTION

- ▶ Fund a provincial Digital Aquaculture Training Initiative through the Ontario Agri-Food Innovation Alliance.
- ▶ Establish a Data Governance Task Force to draft model agreements for aquaculture digital data use.
- ▶ Audit and expand aquaculture-specific eligibility under existing technology adoption cost-sharing programmes.
- ▶ Partner with technology companies to mandate post-installation support as a condition of provincial procurement or endorsement.

This policy brief synthesises findings from the following peer-reviewed studies:

Chowdhury, A., Kabir, K.H., McQuire, M., & Bureau, D.P. (2025). The dynamics of digital technology adoption in rainbow trout aquaculture: Exploring multi-stakeholder perceptions in Ontario using Q methodology and the theory of planned behaviour. Aquaculture, 594, 741460.

Chowdhury, A., Kabir, K.H., & Zhooldideh, M. (2026). SWOT-AHP-TOWS analysis of decision support system adoption in the Ontario rainbow trout industry. Journal of Rural Studies, 123, 104040.

Both studies were supported by the Ontario Agri-Food Innovation Alliance Knowledge Translation and Transfer (KTT) Funding Program (UG-KTTR-2021-101228) and conducted at the School of Environmental Design and Rural Development, University of Guelph.

School of Environmental Design and Rural Development

University of Guelph · Ontario Agricultural College Policy Brief · March 2026 | KTT Program
UG-KTTR-2021-101228