CAPI
THE CANADIAN AGRI-FOOD POLICY INSTITUTE

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At a Digital Crossroads: 5 Actions Canada needs for progress in Digital Agri-Food

A *Research* Report prepared for CAPI in collaboration with EMILI by Lauren Martin, Elisabeta Lika, Kyle Volpi Hiebert, and Anjolaoluwa Bamgbala

Research Report

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The Canadian Agri-Food Policy Institute's mission is to lead policy development, collaborate with partners and advance policy solutions within agriculture and food

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To ensure the validity and quality of its work, CAPI requires all *Research* Reports to go through a peer review process. CAPI thanks the peer reviewers for their comments on an earlier draft of this report.

DIGITAL AGRI-FOOD IN CANADA

FROM INNOVATION TO ADOPTION AT SCALE.

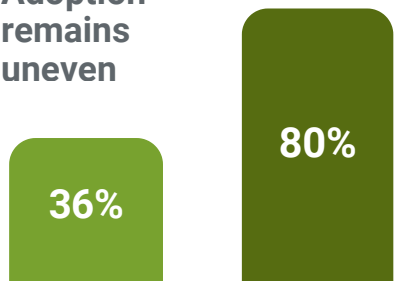
The future of agri-food will be digital, whether the sector is ready or not.

Canada's challenge is no longer identifying the barriers. It is creating the conditions for adoption at scale.

An uncertain operating environment is raising the stakes

- Climate pressure
- Market volatility
- Labour constraints
- Geopolitical uncertainty
- Rapid technological change

Adoption remains uneven



Smaller farms
<2000 acres

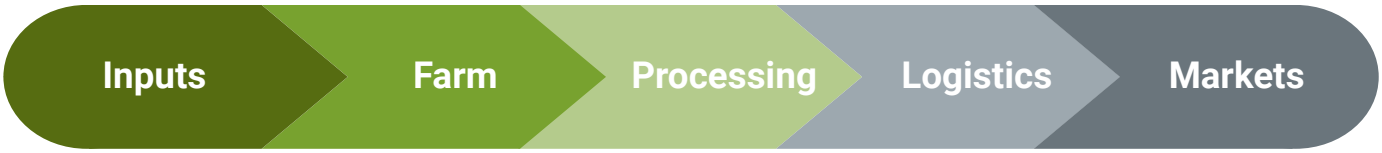
Large farms
>5000 acres

Why adoption still feels risky

- High upfront cost
- Integration complexity
- Uncertain ROI
- Data trust concerns
- Operational risk

Digital transformation does not stop at the farm gate

A digitized production sector feeding into bottlenecks does not strengthen competitiveness. It shifts pressure elsewhere in the system.



What has shifted

The enabling environment is shifting

$4.1B **invested** in Canadian agri-food tech from 2014-2024

$263M Canadian agri-food tech **funding** in 2024

Infrastructure, AI capacity, governance momentum, & a maturing innovation ecosystem are beginning to **reduce structural barriers.**

What needs to change

1. Prove what works
2. Fund scaling
3. Make regulation predictable
4. Build trust in data
5. Treat digital as systemic

Canada is full of smart ideas—it just needs the right setup to help them grow, scale, and actually stick.

Note from CAPI

Canadian agri-food is operating in an increasingly volatile environment. Global market dynamics, climate pressure, labour shortages, geopolitical instability, and rapid technological change are all shaping how decisions get made across the sector. For producers and firms alike, uncertainty is not fleeting, it is becoming the norm.

This context informs CAPI's study of the digitization of the sector. Digital capability is increasingly tied to productivity, resilience, and competitiveness. Yet adoption remains uneven. Canada has strong research capacity, promising technology firms, and a growing agri-food innovation ecosystem; however, adoption at commercial scale and system-wide integration continues to lag.

In 2025, CAPI and EMILI undertook a first comprehensive assessment of digital agriculture in Canada. That report established the baseline. It showed clearly that adoption is uneven and that the barriers are well known: connectivity gaps, uncertain returns on investment, skills limitations, data governance concerns, and fragmented pathways from innovation to use.

This report builds from that foundation and takes the next step. Rather than restating the challenge, it identifies the key barriers and sets out actions to address them. It also widens the lens, moving beyond the farm-gate. Gains in primary production will only translate into stronger performance if they are matched by increased digital capacity in processing and throughout the supply chain.

The five takeaways in this report are grounded in action. Canada is not short on ideas; the priority now is disciplined execution and implementation.

Key Takeaways

1. **Digital transformation is inevitable, regardless of system readiness.** Digital tools are no longer optional; they are becoming foundational to productivity, resilience, traceability, and competitiveness. The choice facing Canada is whether to actively shape and accelerate this transition, or risk falling behind peers who move more decisively.
2. **Gaps in digital adoption are widening.** Canada has no shortage of digital tools, promising firms, or early-stage activity, but uptake remains concentrated among larger and better-resourced operations. Without deliberate action, smaller farms and food manufacturers will continue to lose ground to their competition, limiting sector-wide productivity and resilience.
3. **The opportunity is bigger than the farm gate.** Digital transformation in agri-food cannot be understood only through an on-farm lens. Processing, logistics, traceability, manufacturing, and supply chain coordination all shape whether digital gains are captured or lost. If those parts of the system do not keep pace, pressure simply moves downstream.
4. **Canada's digital agriculture ecosystem is growing in size and activity, but it remains fragmented and poorly connected**. Various initiatives within Canada's food system are building positive momentum across AI, connectivity, data governance, and capital, yet these efforts continue to operate in silos. Digital transformation depends on coordination across actors who rarely engage directly—academia and industry, startups and government—but there are limited mechanisms to convene them. Without these shared spaces, scaling remains difficult to navigate and misaligned with adoption goals and desired outcomes.
5. **Scaling requires coordinated action.** Moving from pilots to widespread adoption requires deliberate action in several key areas: reducing risk through validation and testing sites, addressing growth-stage capital gaps, improving regulatory predictability, establishing clearer data governance, and strengthening system-wide coordination.

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Purpose, scope, and phase II direction

In 2026, global and regional uncertainty is no longer sporadic. It has become an entrenched feature of the operating environment for the Canadian agri-food industry. Geopolitical volatility, market disruption, climate pressure, labour constraints, and rapid technological change are reshaping decisions across the supply chain, from farm inputs to further processing. The expectation that conditions will stabilize has given way to more practical questions: how well positioned is Canada to adapt to emergent risks and compete within a global marketplace drifting towards protectionism? And where can digital capabilities reduce risk and improve performance across the system?

In 2025, CAPI and EMILI undertook a first comprehensive examination of digital agriculture in Canada. That work established a baseline. It documented Canada's uneven adoption profile and highlighted the oft-repeated structural constraints, including connectivity limitations, uncertain returns on investment, data governance and technology trust concerns, skills and advisory gaps, and fragmented pathways for technologies to scale. The resulting report was designed to identify the challenges and to bring coherence to a conversation that was often scattered across regions, subsectors, and policy portfolios.

This report is the next phase. It builds directly on that baseline, while also shifting the emphasis from diagnosis to action. The objective is to articulate five tangible priorities that can enable measurable progress on digital adoption in Canada. The intent is not to produce an exhaustive catalogue of initiatives. It is to identify a small set of key actions, that reflect how adoption and scaling decisions occur in commercial settings and under real-world operating constraints.

A second trend emerging for Canada's agri-food industry in 2026 is around scope. Digital transformation does not stop at the farm gate. On-farm adoption remains foundational, but it is only one component of a larger, interconnected system. Productivity gains at the farm level are insufficient if they are not matched by corresponding digital capacity advancements in processing, logistics, traceability, and downstream supply chains. A digitally enabled production sector feeding into capacity-constrained value-added segments does not strengthen competitiveness. It shifts pressure elsewhere in the system, perhaps creating new and novel weaknesses.

Indeed, digital adoption in value-added segments faces many of the same constraints seen on farms—yet with additional layers of complexity: traceability requirements, multi-firm data sharing, system interoperability across facilities, workforce transition, and regulatory compliance. In many cases, the value of digital tools depends not only on whether they work within a single operation, but on whether systems can connect across operational stages or locations in a secure, trusted, and commercially viable way. Adoption decisions made

in one context increasingly depend on the digital maturity and alignment of tools, actors and capabilities elsewhere.

This second phase of the analysis of digital agriculture in Canada thus intentionally broadened the scope from a primary production lens to the full agri-food value chain and prioritized voices operating in, or directly adjacent to, the market. The analysis draws on 13 targeted interviews spanning producers, agri-food firms, technology providers, trade and advisory organizations, investors, and government officials. These conversations were complemented by ongoing engagement with project partners and insights gathered through sector dialogues and events. Together, these inputs ensure that the five priority actions are grounded in lived commercial and operational realities and focused on what is realistic, non-duplicative, and capable of moving the needle.

Has the environment shifted since 2025?

A heightened sense of urgency but adoption patterns remain uneven

Last year's analysis focused specifically on primary agriculture, where data showed that on-farm adoption of digital tools remains uneven. Evidence pointed to a persistent structural divide: large farms (over 5,000 acres) report adoption or planned adoption rates near 80%, while smaller operations (under 2,000 acres) sit closer to 36%. No new comparable national farm-level survey has materially altered that picture.

The same constraints identified in 2025 also continue to shape farm-level decision-making by producers: rural connectivity gaps, high upfront capital costs, integration complexity, uneven returns on investment, and unresolved concerns around data ownership and governance, interoperability and the right to repair. Their persistence points to a clear diagnosis. It is not a shortage of proven digital tools available on the market to producers that is suppressing adoption rates. Rather, the need to collaboratively deliver conditions that make adoption low-risk, economically rational, and operationally workable across enterprises.

Yet behind these figures lies a more fundamental challenge: an overly cautious mindset that cuts across the entire system. Agri-food is, by nature, a risk-averse sector. Returns on investment are difficult to quantify, and every farm or firm is different. When a technology decision fails, the operational consequences can be lasting—even crippling. These hesitations are grounded in the realities of farm business management. Even where the operation is not directly tied to the farm, in the broader food industry, the same careful culture is dominant, and for good reasons. But this has its downsides. For one, when risk-aversion becomes the default frame through which digital agri-food policies, programs and incentives are evaluated, the conversation stalls before it begins.

Digital agriculture cannot be considered optional. Without digitization, Canada's agri-food system risks falling behind global peers and will struggle to meet its own productivity, sustainability, and competitiveness targets. Resilience in a volatile global environment increasingly depends on the ability to use data to optimize decision-making, allocate resources efficiently and adapt to emergent risks—and harness new opportunities—in real time. There is no alternative path to a resilient, high-performing sector.

This report does not dismiss adoption concerns but rather will use them to define a roadmap for action.

Other sectors have navigated comparable barriers and found pathways through deliberate policy design, peer learning, and ecosystem coordination—the agri-food sector is not so unique that it cannot similarly progress. Shifting the collective mindset to embrace bolder actions means recognizing that the challenges are real and that solutions exist, that progress is possible, and that the unrealized potential is substantial. This shift is not just something asked of industry. It is equally required of political leaders who set priorities, program designers who define eligibility, investors when choosing to invest or not in Canada, and ecosystem actors who shape the conditions for adoption. Without that broader reorientation, even well-designed interventions risk underperforming in a system that is not ready to use them.

Data governance has moved closer to the centre of national economic discussion as well. Clear rules around ownership, interoperability, jurisdiction, and control over data are increasingly understood as prerequisites for achieving user trust at scale. Artificial intelligence and advanced analytics have also become core components of competitiveness strategy, supported by federal investments in AI capacity, domestic cloud infrastructure, and rural broadband. These are not abstract policy trends; they shape the operating conditions under which digital tools—in agri-food, but also other sectors—will either function or fail.

Importantly, the newest generation of digital tools is more data-intensive and infrastructure-dependent than earlier precision technologies. That means improvements in connectivity, computing access, and data governance can translate directly into better adoption outcomes. The agtech adoption gap is real. But the enabling environment is strengthening—infrastructure investment, governance momentum, capital flows, and a maturing innovation ecosystem are beginning to reduce structural barriers.

Still, improving on-farm adoption rates is necessary but insufficient on its own to successfully transition Canada's agri-food sector—a pillar of the national economy and regional identities—to where it needs to be to maintain competitiveness and resilience in the twenty-first century. In addition to increased climate risks and demographic changes, macroeconomic volatility and global trade disruptions have sharpened the urgency to enhance productivity growth and drive innovation. In this context, the broader digital innovation and policy environment surrounding agri-food has moved meaningfully since 2025, and in ways that are more consequential than incremental year-over-year changes to digital tool adoption rates.

This has created a credible window to accelerate digitization across the agri-food system, but only if the mindset shift needed to act on that urgency takes hold at every level, from the farm gate to the cabinet table.

Outcome and actions

ACTION 1: Invest in a coordinated national network of commercial validation infrastructure to de-risk adoption.

Prioritize funding for commercial-scale validation infrastructure that proves real-world performance, reduces adoption risk, and accelerates uptake across diverse farming and processing environments. Integrate these test-sites to ensure national coordination and data-sharing.

The decision to adopt a new digital tool is ultimately an investment decision for producers and processors alike. And, in the current operating environment, these decisions carry significant risks—both real and perceived. Trade disruptions, weather variability, labour scarcity, input price swings, and tighter credit markets compress margins and heighten scrutiny around every expenditure. The mere fact that a digital tool can do something does not make it worth investing the time, effort and capital into acquiring it and integrating it into an existing business. Instead, adoption only comes when there is credible reduction in risk for a producer involved in acquiring a new tool and they can concretely understand the measurable return in benefit it will provide for their operations. If the expected return on a new product or service does not clearly outweigh the cost, disruption, and learning curve involved, adoption does not occur, regardless of how impressive its innovation promise may be.

For example, drones are emerging as an increasingly valuable tool in agriculture for how they enable faster data collection and introduce new methods for field management, including perimeter surveillance, rapid field surveying, and thermal scanning. Yet their uptake is limited by a farmers' willingness to purchase a unit, practice with it and become certified to fly it in their local jurisdiction. Plus, they might then need to take additional steps to convert that data into a format usable within their own information management system. Repairs and maintenance requirements must also be taken into consideration, especially in rural areas where such services might not be readily available.

"If you're a farmer in Bruce County, getting to him is hard. He's busy, he doesn't have a tech department. He does look for innovations, but they have to be proven before he'll adopt. So he'll want to see that the neighbour did it…a lot of these agtech companies don't have distribution channels like seeds or fertilizer, so they have to go direct and it's like: "I don't know you, I don't know your company, you're trying to sell me something I don't understand, plus I'm busy, plus it's expensive."

Joe Dales, RHA Ventures

The 2025 CAPI-EMILI report and subsequent research demonstrated that producers generally move past the awareness stage of the adoption cycle fairly easily. They know about the tools available to them. But where the friction arises is around integration—when a technology requires workflow redesign, data interoperability across systems, and sustained interpretive capacity or skills that may not exist in the enterprise. At that point, the risk of disrupting the status quo that is already working "well enough" often outweighs the anticipated gain, especially when margins are thin and the evidence for return on investment is thin too.

Established technology providers, such as legacy manufacturers, with proven track records and existing customer relationships can navigate this calculus more easily. They have the resources to demonstrate performance at scale and have the commercial durability to support a product through early adoption. Smaller or newer tech startups often cannot. They may have technically sound solutions, but without validated performance data and credible real-world evidence, they struggle to clear the trust threshold that adoption requires. Many do not even survive long enough to bring their idea to market.

To bridge the gap between established technology providers and smaller firms, shared validation infrastructure is essential. Dedicated commercial-scale test environments allow technologies to be evaluated under realistic conditions, with findings that clients and investors can rely on, reducing the burden on individual firms to prove their value from scratch. Also vital is how this process reduces the risk to customers who gain confidence in their adoption decision by seeing a given technology work in a setting similar to their own. Otherwise, they would be absorbing all of that uncertainty themselves. Canada is investing more deliberately in building this de-risking infrastructure; however, more could be done.

"I don't believe we have an adoption gap but rather an execution gap. Farmers aren't risk-adverse; they're rational. What's missing is trusted, real-world validation. We need producer-led challenges that guide innovators to solve real problems, and solutions that are proven across multiple farmers not just one-off pilots."

Lindsay Smylie, AgSphere

EMILI's Innovation Farms, operating as a network of commercial-scale test sites in Manitoba, represents one of the clearest examples of this approach. The original Innovation Farms site, a 5,500-acre fully instrumented seed farm near Winnipeg, provides innovators from industry and academia with access to leading-edge equipment, technology, and real production conditions. In July 2025, Farm Credit Canada (FCC) and EMILI expanded the network with a 8,500-acre potato and irrigated-crop operation in MacGregor, Manitoba, testing sensor-based storage monitoring, field-scale crop surveillance, and agronomic software platforms in conditions that reflect what commercial producers face. Similarly, Innovation Farms Ontario—a four-partner network supported by FCC and centred around a 2,000-acre commercial site near Bothwell, Ontario—also conducts research and testing of new technologies, specializing in automation and robotics. And at Olds College in Alberta, one hour north of Calgary, the institution's applied research division, operated by faculty and students, partners with producer sites and industry on testing, validation and demonstration of agtech tools in commercial settings as well.

The Canadian Agri-food Automation and Intelligence Network (CAAIN) functions as a national backbone for smart farm infrastructure and automation-focused innovation, funded by ISED's Strategic Innovation Fund. Its programming is organized around three pillars (robotics and automation, data-driven decision-making, and smart farms) and it funds collaborative projects that connect innovators, producers, and research institutions in settings where technology can be validated and demonstrated to farmers evaluating real-world return on investment. CAAIN's model is explicitly designed to reduce the perceived risk of adoption by allowing producers to observe performance in conditions close to their own before committing capital.

The Canadian Food Innovation Network (CFIN) operates in the food processing and manufacturing space. Beyond its funding programs, CFIN creates experimental sandboxes where food businesses can test new innovations in an operational environment without taking their day-to-day production offline, a meaningful distinction for processing facilities where downtime has direct commercial consequences. Its Innovation Booster program provides rapid, flexible support to SMEs working through commercialization barriers, and to date CFIN has awarded over $21.5 million to 104 Canadian food-tech projects, matched by $24.6 million in industry co-investment, generating an estimated $90 million in economic impact and attracting over $82 million in follow-up investment.

"In food and beverage processing in Canada, there are about 7,000 active players; the middle-sized company segment (those with 100 to 499 employees) is comprised of less than 600 companies. They make up 8.1% of the total number of manufacturers and generate around $19B in GDP but 70% of that amount comes from exporting. To succeed in new trading environments, they will benefit from becoming more productive and Canada will benefit from them scaling."

Dana McCauley, CFIN

Taken together, these developments represent something more than a collection of individual programs. They reflect a maturing approach to the innovation-to-adoption pathway, supported by provincial and federal programming, which acknowledges that building tools is not sufficient if those tools cannot be tested, validated, and trusted at commercial scale. The gap between a promising pilot and a routinely adopted technology has long been one of the places where Canadian agri-food tech value has lacked.

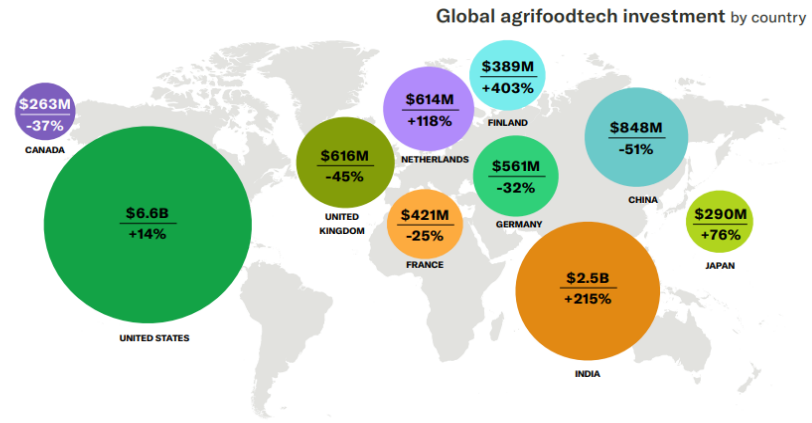
ACTION 2: Deploy dedicated growth-stage capital for agri-food innovation

Design and deploy growth-stage financing tools that reflect longer development timelines, capital intensity, and validation requirements in agri-food.

As the broader agri-tech innovation ecosystem continues to expand, Canadian firms and multinationals alike are advancing practical tools into the field. This ranges from precision robotics such as Upside Robotics, Haggarty Robotics, and integrated digital platforms like BASF Digital Farming to food manufacturing and data platforms like Mode40—and much more. Artificial intelligence has likewise moved from experimental pilots toward operational deployment, reshaping decision-making within individual enterprises and across supply chains. The digitization of agri-food is here; the opportunities are being seized. And yet there remains a constraint on capital availability for the vast majority of Canada's IP to scale at home.

A national ecosystem scan estimates that $4.1 billion was invested in Canadian agrifood tech between 2014 and 2024 and reports an 8.4% compound annual growth rate. However, AgFunder's 2025 global investment report shows that Canadian agrifood tech funding fell to $263 million across 65 deals in 2024, a pullback driven by a global shift toward profitability and a systemic venture capital gap that leaves Canada heavily reliant on public grants. While innovation activity remains high, the combination of limited private scale-up capital and unresolved structural issues has significantly slowed the flow of investment into Canada.

2024 agrifoodtech funding by country



Global rankings changed in 2024 compared to 2023. The US kept its top spot, but India rose from fourth to second place while China fell from second to third after a dramatic 51% drop in funding year-over-year.

COUNTRY	$ TOTAL	$ CHANGE	DEALS
United States	6.6B	14%	468
India	2.5B	215%	218
China	848M	-51%	169
United Kingdom	616M	-45%	113
Netherlands	614M	118%	35

COUNTRY	$ TOTAL	$ CHANGE	DEALS
Germany	561M	-32%	56
France	421M	-25%	70
Finland	389M	403%	18
Japan	290M	76%	89
Canada	263M	-37%	65

RBC's recent work highlights that agri-food accounts for only about 2% of federal government backed growth, venture and infrastructure funds, and about 4% of total growth funds invested in Canada over the past five years. CFIN finds that about 30% of food-tech investment rounds still depend on public grants, a far higher share than in the U.S. or U.K., and that scaling capital becomes particularly scarce at later stages.

"Based on research CFIN did in late 2024, we saw that Canadian foodtech companies were fairly on par with the UK and US for catalytic investment and Series A investment. Investors were willing to give founders small amounts of money. But when it came to raising Series B and Series C funds, Canada really fell off. Investors' actions seem to say, 'great, you've got proof of concept, go grow your business' and then come back when the pension funds are ready to talk to you.' I believe the most important place to put funding right now is into scaling."

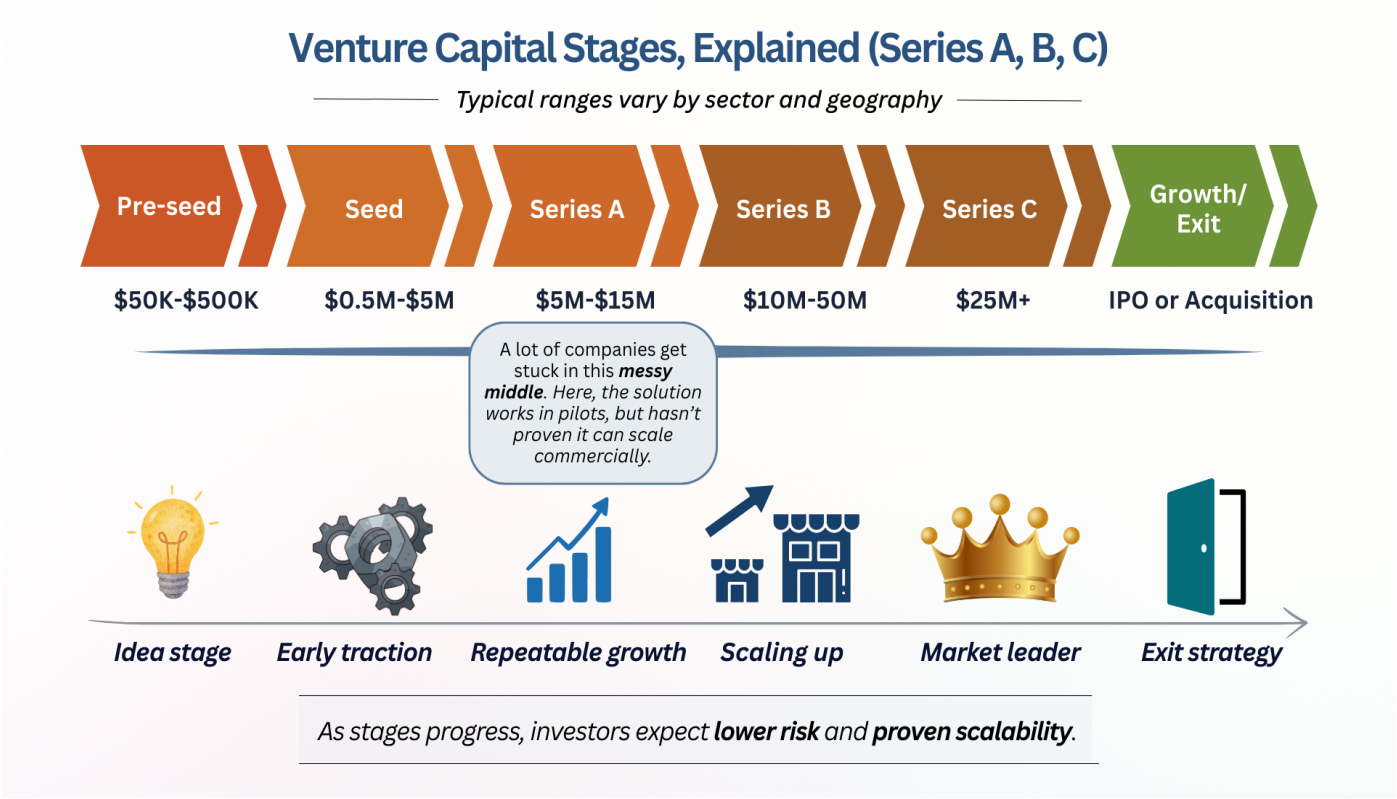
Dana McCauley, CFIN

"On the deal side of things, we do okay in the deals, but the volume of the dollars… are just not to the same scale that we see in other places… when we looked at the dollar value, it's kind of a 23-to-1."

Craig Klemmer, FCC

Ultimately, Canada generates strong intellectual property and early-stage research, but value frequently dissipates before innovations transition from proof-of-concept to de-risked, investable products. As RBC states, one challenge is the limited availability of growth capital in Canada for companies seeking rounds of funding north of $15M. The lack of growth capital invested in Canadian agri-food and agtech has resulted in startups being undercapitalized or seeking foreign capital, constraining their ability to build traction in the Canadian market and grow into mature companies.

This is the stage where technologies require multi-year field trials and integration testing across diverse operating conditions which generate validated return-on-investment data. Meanwhile their creators need mentorship and help with regulatory navigation and business model refinement. Altogether, it is expensive, time-consuming, and rarely suited to traditional research funding or early-stage venture capital.



A central reason for the investment gap is the limited understanding of the agri-food and agtech sectors within the broader investment community. Many generalist investors struggle to see the opportunities within them because they personally lack deep sector expertise, and capital thus tends to flow instead toward more familiar, less complex domains. As RBC's *Seeding Scale* report documents, Canada has a relatively small number of dedicated agri-food venture and growth funds. With only a handful of vehicles exclusively focused on this space, it leaves shallow pools of capital for mid-stage growth. Meanwhile, broad government growth capital funds, such as the Canada Growth Fund and related initiatives, rarely deploy into agri-food because traditional investment criteria do not map well to the sector's scale, timelines, and asset intensity.

These structural constraints mean that promising Canadian companies often look outside the country for growth capital, slowing domestic scaling and weakening Canada's ability to retain high-potential ventures and talent.

The result is predictable. Promising agri-food technologies stall at pilot stage, seek foreign capital and relocation to scale, or fail before generating the performance evidence required to unlock adoption at home. Canada excels at invention; it is less consistent at financing validation and commercialization at scale.

> *"It's hard to uptake some of this technology when it's not proven. And I've found in my experience, some of it may have been slightly misleading on the readiness level that it was at. So, there's that challenge too. And to take on some of these things at more risk, especially for a smaller farm, it can be challenging… It causes more work for you before the immediate returns."*
>
> *Michael Del Ciancio, DC Farms*

"This country is "This country is so strong in IP creation to prototype. We have every kind of program imaginable… we foster and encourage the idea… The strategy isn't to create long-term sustainable companies. We create our own problem because we encourage [too many ideas] that are not industry driven."

Cameron Bergen, Mode40

This capital gap is not simply a funding shortfall. It is a structural misalignment between how innovation is financed and how agricultural technologies mature.

In a sector where adoption depends on proof of real-world performance and durable customer trust, insufficient scale-up capital directly constrains domestic competitiveness.

ACTION 3: Create predictable, time-bound regulatory pathways for agri-food innovation

Set defined timelines and provide upfront regulatory direction to enable faster, more predictable commercialization decisions and to keep commercialization in Canada.

Regulatory burden is a consistent theme in agri-food discussions, yet when digital agri-food actors are asked for specifics, few can identify concrete examples of regulations that limit digital technologies. In many cases, digital tools exist in a pre-regulatory space. There are discrete exceptions, for instance, pesticide application—although Health Canada recently proposed a new policy to allow spray drone use of pest control products already registered for aerial application—or innovations at the biological level, but for most digital tools, regulation is not an immediate barrier.

The challenge lies in perception. Canada is widely seen as a small country with a heavy regulatory overlay, which can create a chilling effect on investment. Investors and innovators weigh potential regulatory hurdles alongside cost, disruption, and ROI. If the unknown risk of compliance is not signaled or clarified early, adoption and investment decisions are deferred or moved abroad. Clear, early, and consistent regulatory guidance is a signal of intent: Canada is open for business and capable of supporting innovation.

Canada's regulatory framework for agri-food safety is robust, but timelines for decisions often misalign with the ROI horizons that capital demands. Unlike sectors such as automotive or robotics, agri-food innovations carry unique food safety, pest management, and health considerations—scrutiny is essential. Yet when regulatory processes lag behind, or are inconsistent with peer countries, would-be investors naturally look elsewhere.

Regulatory certainty and efficiency is, therefore, a lever of competitiveness. Inconsistent or slow timelines across jurisdictions risk a self-fulfilling cycle: technologies are tested in Canada but commercialized abroad, capital follows, and Canada risks becoming a strong test bed with weaker ability to capture and scale value domestically.

"We have such high-quality standards in Canada, the regulatory environment is a global strength but if our approval timeline outlasts our innovators' cashflow runway, we lose everything. We'll lose the company, the capital and the competitive advantage."

Lindsay Smylie, AgSphere

ACTION 4: Develop a national agricultural data governance framework

Establish clear, practical rules that define rights and responsibilities for data access and use, supported by common language and standards.

A consistent theme across our interviews, reinforced by analysis of the experience of other competing jurisdictions more advanced in embracing digital agriculture, is that unclear or inconsistent governance arrangements can materially impede adoption of digital tools. When agribusinesses cannot anticipate or understand how their data will be accessed, shared, or monetized, hesitation often follows. Trust, transparency, and predictability in data governance were repeatedly identified as prerequisites for broader digital uptake in Canada's agriculture and agri-food sector.

That said, concerns were not universal. Food and beverage manufacturing respondents did not cite data governance as a significant barrier to digital adoption, suggesting there is a distinction between these subsectors. Similarly, not all agtech interviewees reported resistance from producers. Where technology providers demonstrated clear, tangible value in exchange for data, producers were generally willing participants.

"From day one, farmers have paid for our technology… Honestly, the farmer cares about the data privacy when they don't get enough value in return. The farmers we're working with are comfortable sharing their data, because they get value for the data they share immediately, they get enough in return."

Jana Tian, Upside Robotics

Complicating the issue is the inconsistent terminology used across the ecosystem. Concepts such as data sovereignty, data governance, data rights, and right to repair are frequently invoked, often interchangeably, despite referring to distinct legal and policy constructs.

This imprecision contributes to confusion among producers and, in some cases, reinforces mistrust. For clarity, this report adopts the OECD's definition of data governance as "the frameworks, policies, and institutional arrangements that determine how data is accessed, shared, protected, and used."

"Data ownership is misleading terminology because… legally, how do you define data ownership? The company has the data and provides a copy to farmers who can download it but only aggregated data… Talk about data rights rather than ownership… What choices do I have as a farmer? If I terminate my contract, will the company still keep my farm data? Most agreements state that data is kept 'in an anonymized format'-what does anonymization even mean in the context of a farm?"

Rozita Dara, Director of AI4Food, School of Computer Science, U of Guelph

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Data Interoperability

While not always raised explicitly by producers, interoperability shapes whether digital tools can function together across equipment, platform, and stages of the value chain. Without it, data remains siloed, systems do not connect, and the practical value of digital investments is significantly reduced. Firms and farms have a limited capacity to maintain several competing systems at once; when technologies don't speak to one another, it presents a barrier to adoption. Interoperability is a foundational condition for adoption at scale. There are signs of movement in this space, including industry-led efforts to develop common standards and enable data exchange across systems, but progress remains uneven and fragmented.

Given its role in enabling integration, reducing switching costs, and supporting trust in how data flows, interoperability warrants more explicit attention alongside governance as part of the conditions required for widespread digital adoption.

Ultimately, our research points to the need for a clearer data governance framework—one that reduces mistrust, defines the roles and responsibilities of vendors and users, and ensures a more balanced sharing of value.

"We need a new business model to make sure everyone gets benefit from it… I 100% agree with the perception that farm data holds significant value. But the effort that a firm has to put into the data to make it useable, is also a substantial investment for the organization."

Rozita Dara, Director of AI4Food, School of Computer Science, U of Guelph

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Canada remains early in its agricultural data governance maturity. There is no legal definition of agricultural or farm-generated data in statute and no dedicated legislative framework for agricultural data rights. While voluntary industry standards and codes of practice are being developed, there are no binding standards governing how agtech providers handle, share, or commercialize data generated on farms. Foundational issues remain undecided.

By contrast, several jurisdictions elsewhere have taken varied but concrete steps to clarify governance of farm-generated data. Approaches range from voluntary codes of practice designed to generate trust, to regulatory frameworks establishing baseline obligations for data access and use and federated infrastructure initiatives that enable secure and interoperable data exchange.

No single model resolves all tensions, but each offers practical insight for Canada's evolving policy environment.

The table below summarizes five case studies, outlining their key features and principal takeaways for Canada that we recommend offer important lessons for establishing a coherent data governance framework here.

Given that governance concerns were more consistently raised in relation to farm-generated data, the international analysis below focuses on agricultural data governance in primary production.

Country	Instrument	Type	Key feature	Main limitation	What Canada can take from it
EU	Code of Conduct (2018) + Data Act (2025)	Voluntary and then binding	Binding right for farmers to access and share device-generated data	Seven-gap between voluntary and binding; low farmer awareness of the code	Design a voluntary code with an explicit pathway to binding standards
Australia	Farm Data Code	Voluntary + certification	Certification mechanism; control-not-ownership framing; positioned as adoption enabler	Voluntary uptake uneven; aggregation problem not fully addressed	Focus on control (access, use, revocation) and not legal ownership; Build in a certification signal at the point of technology adoption
Nether-lands	JoinData Cooperative	Farmer-governed infrastructure	Farmer-owned intermediary managing consent and data exchange at scale	Depends on pre-existing cooperative culture and institutional anchors	Seed a farmer-governed data structure building on existing cooperatives
United States	ADT Core Principles	Voluntary industry principles	AI training disclosure requirement; anti-competitive use prohibition	No enforcement; self-reported compliance; contracts remain skewed toward providers	Include explicit AI training and data aggregation disclosure requirements
New Zealand	Farm Data Code of Practice	Voluntary + accreditation	Early mover; accreditation tools included	Has not evolved significantly; limited uptake beyond early adopters	An early start matters, but governance frameworks that do not evolve in response to a changing technology landscape become progressively less relevant to the problems farmers actually face.

The European Union (EU)

Few jurisdictions offer as much practical insight as the EU, where nearly a decade of experience, and a transition from voluntary to mandatory frameworks, provides clear lessons for Canada.

The EU Code of Conduct on Agricultural Data Sharing, launched in April 2018 by a consortium of nine major agri-food industry associations, represented a serious, pioneering sector-led effort to clarify farm-level data governance. It articulated principles of transparency, consent, portability, and recognition of farmers as data originators with a legitimate role in controlling their data. Its primary value was conceptual: it created a shared vocabulary and reference framework for contracts and responsible practice across the ecosystem.

However, voluntary instruments without enforcement have structural limits. A 2024 assessment conducted across five EU member states, involving nearly 100 stakeholders, found limited awareness of the Code, minimal impact on contract terms, and little change to the underlying power asymmetry between individual farmers and dominant platform or equipment providers. The Code established norms, but it did not materially rebalance rights or outcomes.

That structural recalibration arrived with the EU Data Act, which came into force in September 2025. The Act grants users of connected devices, including farmers operating precision agriculture equipment, a legal right to access data generated by those products and to share it with third parties of their choosing. Manufacturers can no longer treat farm-generated data as exclusively their proprietary digital property. Unlike the Code, the Data Act does not depend on voluntary compliance; it establishes enforceable baseline entitlements that apply irrespective of contractual language.

Australia

The Australian Farm Data Code, first published by the National Farmers' Federation (NFF) in 2020 and substantially revised in 2023, made a deliberate conceptual choice by framing the governance challenge around user control rather than ownership. Legal ownership of agricultural data remains contested in property law across most jurisdictions and attempting to resolve that question through a voluntary code risks a counterproductive stalemate.

The Australian model instead focuses on what is operationally meaningful to producers who can access their data, for what purposes, for how long, and under what conditions that access can be withdrawn. The second edition of the Australian Farm Data Code thereby introduced a certification mechanism, allowing agtech providers to apply for NFF certification for specific products or services. This policy design feature is particularly relevant to adoption. In practice, most producers do not scrutinize technology contracts in detail, and many lack the legal or technical capacity to interpret them fully. A certification mark functions as a clear, credible signal at the point of purchase, reducing transaction costs without requiring producers to become data governance experts.

> Australia's approach is perhaps the closest international analogue to what Canada might realistically develop in the near term, given comparable sector structure and institutional capacity.

Importantly, the NFF did not position the Code as a defensive instrument, but as an adoption enabler. The explicit argument is that trust in data governance is foundational to unlocking digital productivity gains, not a parallel regulatory exercise. That approach inherently has greater coalition-building value: it provides agtech firms, financiers, and public programs with a shared strategic rationale for supporting the Code beyond compliance alone.

The Netherlands

The Dutch experience offers a different kind of lesson, less about what rules to write than about what institutional structures can shift the underlying power dynamics that voluntary codes and even legislation alone struggle to address.

JoinData, established in 2017, is a farmer-governed agricultural data cooperative that serves as a trusted intermediary between farmers and firms, including input suppliers, machinery companies, processors, research institutions, that want access to farm data. Farmers who participate retain control. They decide which parties can access their data, for what purposes, for how long, and can revoke access at any point. JoinData handles the shared infrastructure of consent management, data exchange, and audit logging, allowing farmers to participate in a digital data economy without having to negotiate individually with each counterparty.

The arrangement delivers significant benefits: A single farmer negotiating data access terms with a major agricultural platform or machinery manufacturer has little to no leverage. A farmer-governed cooperative representing thousands of operations changes that dynamic fundamentally, without requiring government to regulate the platforms themselves.

United States

The U.S. has addressed farm data governance primarily through the Agricultural Data Transparency Core Principles, an industry-led voluntary framework updated in 2024. The principles establish that farmers own data originating from their operations and address consent, transparency, portability, and specific prohibitions, including restrictions on using farm data to speculate in commodity markets, which is a concrete protection against one of the more commercially consequential risks farmers face.

The 2024 update added a provision requiring disclosure of whether farm data is used to train AI or machine learning models. This is a forward-looking protection that Canada would do well to incorporate.

But the U.S. experience also illustrates the limitations of voluntary principles without either legislative backstop or structural countervailing mechanisms. Compliance is self-reported, enforcement does not exist, and farm data contracts continue to be weighted toward technology providers.

New Zealand

New Zealand was among the first countries to recognize that farm data relationships are unique and therefore need explicit governance mechanisms dedicated to their situation. The New Zealand Farm Data Code of Practice, developed in 2014 through direct consultation among farmers, technology providers, and government, established voluntary principles around transparency, portability, consent, and provider accountability. It also notably included an accreditation mechanism from the outset.

Technology providers could seek certification against the Code, giving farmers a practical signal about responsible data practices. In this respect, New Zealand anticipated a design choice that Australia did not formally adopt until its second Code edition in 2023.

The Code's primary value was normative: it established shared language and expectations before data conflicts became entrenched, and it demonstrated that a small, agriculture-dependent country could move on this agenda without waiting for global regulatory convergence. However, New Zealand has failed to sustain early progress. The Code has not evolved significantly since 2014, uptake among providers remains limited, and the absence of a clear pathway toward stronger or binding standards meant that early momentum has not compounded over time.

ACTION 5: Establish a coordinated, system-wide approach to digital agriculture

Coordinate policy, research, capital, and extension services so innovation translates into sector-wide productivity gains.

Digitizing the agri-food sector is not just about tools on the farm, it is about reimagining the very nature of farming in the twenty-first century. Increasingly this depends on developing greater capacities in related areas off the farm. Research, funding, commercialization, extension services, data infrastructure, and processing capacity are all interdependent. Innovation in one area, without alignment across the system, simply shifts pressure elsewhere and limits the impact of progress.

Our conversations with experts highlighted multiple pinch points in the Canadian context that hinder greater resilience and competitiveness of Canadian agriculture, despite the wide availability of proven digital tools and a vibrant domestic agtech ecosystem: strong intellectual property (IP) and early research that is not commercialized; gaps in capital for firms to scale-up; aging or non-existent infrastructure; insufficient extension and support services for producers; and uneven data mobilization and technology uptake. Each of these is significant on its own, but taken together, they define whether digital agri-food can deliver productivity gains across the sector.

It bears repeating that progress on commercializing IP or on-farm adoption of digital tools alone is insufficient. Without adequate processing capacity, reliable logistics, and integrated supply chains, higher productivity does not translate into stronger economic outcomes. The system must work in concert, which means addressing multiple priorities simultaneously—a complex but necessary reality for meaningful adoption and impact.

Convening inclusive spaces that bring together innovators, funders, researchers, and private-sector actors with diverse perspectives are therefore critical to enabling this coordination. By connecting different nodes of the ecosystem, Canada can ensure that digital technologies are tested, scaled, and deployed in ways that generate value at every stage of the agri-food system.

Finally, it is critical to recognize that other priorities identified by the agri-food sector such as addressing aging infrastructure, strengthening transportation corridors, diversifying trade and reducing regulatory barriers are integral to a functioning agri-food system. Modernizing these core elements are just as important as digitizing agri-food operations as more cutting-edge activities.

The role of government? Public policy as an enabler of scaled digital agriculture adoption

If the adoption challenge is systemic, the next question is whether Canada's policy environment creates the enabling conditions that allow producers, firms, technology providers, and investors to move from pilots to routine, scalable use. As referenced earlier in the report, since 2025, attention to digital enablers has increased. Yet the overall approach remains uneven. Digital agriculture is rarely treated as a core, cross-cutting priority with clear objectives, shared definitions, and measurable outcomes. Instead, support appears through a mix of broader innovation, infrastructure, and sectoral programming such as Canada's Connectivity Strategy and time-limited initiatives that vary across departments and levels of government.

Public funding for the enabling environment around digital agriculture currently flows through three main channels, according to the federal program mapping conducted for this report (FY 2022-23 to FY 2024-25):

1. **Agriculture-Targeted Programming:** This is mainly delivered by AAFC, often through the federal-provincial Sustainable Canadian Agriculture Partnership (SCAP), which is the central framework for many cost-shared programs with provinces and territories. Digitalization of the sector and spurring innovation are not consistently positioned as overarching objectives.
2. **Cross-Sector Innovation and Scale-Up Programming:** Agriculture competes alongside other sectors for funding from agencies such as NRC, RDAs, ISED and federal research funders.
3. **Climate and Nature Portfolios:** Agriculture projects may qualify if they align with outcomes such as mitigation, adaptation, and nature-based solutions (e.g., ECCC).

The largest share of recorded annual program spending in the inventory is held within cross-sector portfolios[1].

Greater detail of the government funding map can be found in Appendix 1.

This should not be read as an exhaustive inventory of all public or publicly backed support. Rather, it is a map of the main federal program pathways identified through this report. What this mapping suggests is not a simple absence of public support, but a more structural problem of fragmentation. Much of the identifiable funding sits outside agriculture-specific channels, which means firms and producers often must navigate multiple departments, program logistics, and eligibility frameworks to piece together support. In that context, the constraint is often not whether programs and public support exist, but whether the overall system is clear, suitable, and coordinated enough to support movement from pilot activity to scalable adoption.

The role of government is not to duplicate what markets already do well or to centralize innovation decisions. It is to intervene where adoption depends on enabling conditions that markets alone are unlikely to supply at sufficient scale or consistency.

Viewed through that lens, public policy aligns directly with the five actions identified in this report.

1. **Invest in a coordinated national network of commercial validation infrastructure to de-risk adoption.**

Adoption accelerates when performance is credible. Shared test sites and validation environments reduce risk for both innovators and producers by generating trusted, real-world evidence of how technologies perform across different regions and production systems. Because this infrastructure creates system-wide benefits and lowers barriers to entry, it is unlikely to emerge at sufficient scale through market forces alone.

[1] For cross-sector and climate/nature programs, reported financials generally represent program totals in portfolios where agriculture is eligible, not agriculture-only allocations unless explicitly specified.

Governments have a critical role to play in strengthening and connecting this ecosystem by:

- Supporting the expansion of commercial-scale validation environments across diverse regions and production systems;
- Helping to connect existing centres (e.g., test farms, innovation hubs, and applied research sites) into a more integrated national network;
- Supporting common approaches to performance measurement, so results are credible, comparable, and useful for producers and investors; and
- Ensuring access for early-stage companies, ensuring smaller firms can test and validate technologies without prohibitive cost or complexity.

2. Deploy dedicated growth-stage capital for agri-food innovation

Canada's persistent gap between proof-of-concept and commercial scale cannot be addressed by public funding alone, private capital must play a leading role. However, investment decisions are shaped by regulatory predictability, policy coherence, and the availability of appropriate financing tools. Where these are misaligned with the realities of agri-food innovation, capital remains cautious and scaling stalls.

Governments can play a catalytic role by:

- Deploying targeted funding instruments that crowd in private capital, particularly at the Series B and C stages While initiatives like FCC Capital are successfully mobilizing capital across the innovation continuum, they are not specifically designed to address the structural shortage of growth-stage capital. Targeted instruments focused on Series B and C financing remain necessary to ensure Canadian firms can scale domestically rather than seeking capital abroad.
- Aligning agriculture, innovation, and competitiveness policies to create a coherent investment signal;
- Reducing regulatory and program complexity that can delay or deter investment decisions; and
- Supporting the development of sector-specialized investment vehicles, including blended finance models tailored to agri-food.

3. Create predictable, time-bound regulatory pathways for agri-food innovation

Regulatory timelines that outlast a firm's capital runway can directly suppress investment and delay commercialization. While Canada's regulatory system is a strength, unpredictability and slow timelines risk pushing innovation and capital to other jurisdictions. Improving clarity and timeliness is essential to maintaining competitiveness.

Governments must:

- Establish clear service standards and timelines for approvals, aligned with investment and commercialization cycles;
- Provide early-stage regulatory guidance so innovators understand requirements upfront ("no wrong door" approach);
- Improve coordination across departments and jurisdictions to reduce inconsistency and inefficiency; and
- Create dedicated pathways for emerging technologies, allowing for faster, controlled market entry where appropriate. For example, where technologies have been approved in other like-jurisdictions.

4. Develop a national agricultural data governance framework

Digital adoption increasingly depends on trusted data relationships. Yet Canada lacks a dedicated agri-food data governance framework, and inconsistent terminology continues to create hesitation. Building trust at scale requires clear, consistent, and predictable rules.

Governments have a role to:

- Clarify terminology and establish a common language across the agri-food ecosystem
- Set expectations for data access, use, portability, and third-party sharing (defining rights and responsibilities)
- Support the development of codes and certification mechanisms to build trust
- Define a clear pathway toward stronger, enforceable standards, if needed, over time

5. Digitization is Systemic

Connectivity, advisory capacity, research, processing, logistics, and regulatory design are interdependent. When these pieces lack coordination, transaction costs rise and scaling slows. Government's role is fundamentally one of coordination:

Government's role is to:

- Align portfolios that affect digital agriculture;
- Ensuring infrastructure investments support digital use cases; and
- Designing programs that are legible across jurisdictions.

Overarchingly: A Targeted Role

Markets will build tools. Producers will decide whether to adopt. Investors will allocate capital. Government cannot replace these functions. But where adoption depends on shared infrastructure, predictable rules, and cross-jurisdictional coherence, public policy has a distinct and limited role to play. That discipline will determine whether Canada's digital agriculture opportunity compounds or stalls.

Conclusion

Canada's agri-food sector stands at a pivotal moment. Digital tools and emerging technologies offer a path to greater productivity, resilience, and global competitiveness, but adoption remains uneven and constrained by structural, financial, and governance barriers. This report identifies five interdependent actions that, taken together, create the conditions for scalable adoption: de-risking innovation through coordinated validation infrastructure, bridging growth-stage capital gaps, establishing predictable regulatory pathways, clarifying agricultural data governance, and fostering system-wide coordination across the value chain.

Progress will not occur through isolated initiatives or market forces alone. Success requires a deliberate, integrated approach where public policy, private investment, and ecosystem actors work in concert.

By aligning incentives, providing credible validation, and strengthening trust in both technology and data, Canada can unlock the latent potential of its agri-food innovation ecosystem. The opportunity is clear: the decisions made today will determine whether Canada becomes a global leader in digital agriculture or risks falling behind peers who move faster to integrate technology, capital, and policy into a cohesive system.

Appendix 1: Mapping federal research and innovation funding eligible for agricultural projects

This report maps federal programs in Canada that fund, or are eligible to fund, agricultural research and innovation (R&I). Using a master inventory table of publicly reported program documentation (with source links), it summarizes each program's purpose, eligibility, funding mechanism, and annual fiscal-year financials for FY 2022–23 through FY 2024–25.

Programs are grouped into three funding pipes: (1) agriculture-targeted programs, (2) cross-sector innovation programs, and (3) climate/nature funds that can include agriculture.

Methodology

Programs were included if they directly target agriculture, make agriculture competitively eligible, or allow eligibility under climate/nature-focused proposals. Data were sourced from official program pages and departmental results reporting (e.g., DRRs and transfer payment tables) for AAFC, NRC, ISED, RDAs (REGI delivery agencies), ECCC, and federal research funders, with evidence links recorded in the inventory.

Financial data for FY 2022–23, FY 2023–24, and FY 2024–25 were recorded using the most comparable public "actual" totals, generally using the "Total program" line; FY 2024–25 reflects "actual" or "authorities used" depending on the source. The limitation is that for many Pipe 2 and Pipe 3 programs, figures reflect total program spend rather than agriculture-only allocations unless specified in the source.

Landscape and Definitions

The programs for agricultural and agri-food innovation are categorized into three pipelines based on their primary focus and the competitive environment.

Pipe 1: Focuses primarily on agriculture and agri-food innovation (typically led by AAFC).

Pipe 2: Includes cross-sector innovation and research programs where agriculture projects compete alongside those from other sectors (e.g., NRC, RDAs/REGI, ISED, tri-agency).

Pipe 3: Encompasses climate and nature programs. Agriculture projects are eligible when aligned with outcomes such as mitigation, adaptation, nature-based solutions, clean technology deployment, or enabling infrastructure.

Programs are coded by agriculture status as: Direct (ag), Eligible/competitive, or Eligible with framing.

Core program inventory and comparative table

Table 1 summarizes a representative set of federal programs relevant to agricultural research and innovation, showing department/agency, funding pipe, mechanism, agriculture status, FY 2024–25 actuals, and envelope/timing (where available).

Table 1

Program	Dept./ Agency	Pipe	Mechanism	Ag Status	FY 2024-25 Actual	Envelope/Timing
AgriScience Program	AAFC	1	Grant + Contribution	Direct (ag)	$28,418,920	$324.77M over 5 years (2023–2028)
AgriInnovate Program	AAFC	1	Contribution	Direct (ag)	$12,748,099	$95.4M over 5 years (2023–2028)
Agricultural Clean Technology Program	AAFC	1	Grant + Contribution	Direct (ag)	$105,936,797	$165.7M over 7 years (2021–2028)
Agricultural Climate Solutions	AAFC	1	Contribution	Direct (ag)	$121,915,602	Multi-stream; see master sheet
Sustainable Canadian Agricultural Partnership (PT-delivered cost-shared programs)	AAFC	1	Cost-shared transfer (FPT)	Direct (ag)	$275,752,424	$3.5B over 5 years, (2023–2028)
NRC IRAP	NRC	2	Contribution	Ag-eligible, competitive	$435,552,650	$500M over 5 years (2021–2026)
REGI ***REGI delivered by all RDAs; see master inventory for full list.	PrairiesCAN	2	Grant + Contribution	Ag-eligible, competitive	$177,975,284	Ongoing
Strategic Innovation Fund	ISED	2	Contribution	Ag-eligible, competitive	$1,703,467,211	Ongoing
NSERC Grants and Scholarships	NSERC	2	Grant	Ag-eligible	$1,100,448,230	Ongoing

Note: *For Pipe 2 (cross-sector) programs, financial figures generally reflect total program spending, not agriculture-only allocations, unless specified in the source.*

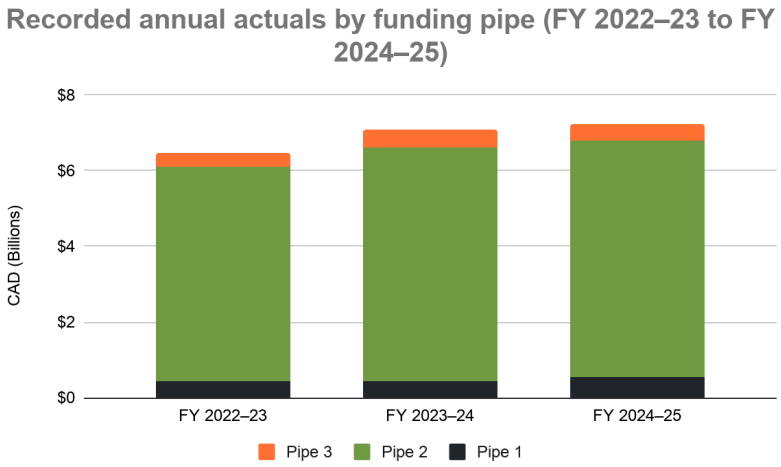
Source note: *Full inventory with program links and fiscal-year figures is documented in the master table.*

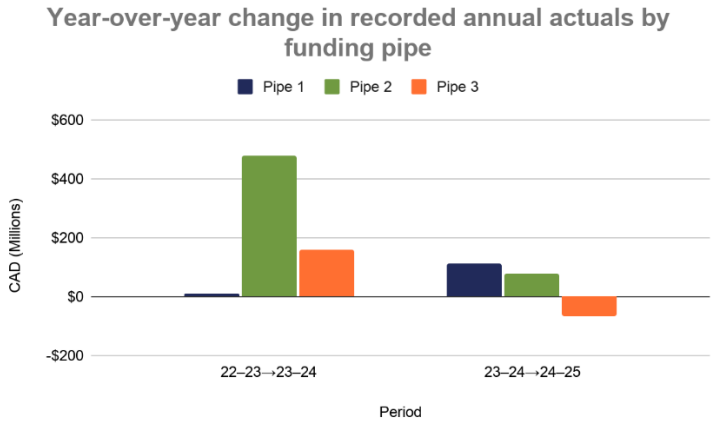
Quantitative estimates and funding trends

Across the programs included in this inventory, total recorded annual actuals were $6.45B (FY 2022–23), $7.10B (FY 2023–24), and $7.22B (FY 2024–25). Pipe 2 accounts for the majority of recorded totals (~86–88% each year), reflecting the scale of cross-sector innovation and research funding vehicles where agriculture projects compete.

The FY 2022–23 to FY 2023–24 increase is driven primarily by Pipe 2 (+$476.8M) and Pipe 3 (+$158.5M), while FY 2023–24 to FY 2024–25 growth is smaller and driven by Pipe 1 (+$112.1M) and Pipe 2 (+$77.8M), with Pipe 3 declining (−$66.2M).

Interpretation note: Pipe 2 and Pipe 3 figures typically represent total program spending and therefore indicate the scale of funding available to agriculture, not agriculture-only allocations unless specified in the source.





This map summarizes key federal programs eligible to fund agricultural R&I and highlights the relative scale of agriculture-targeted versus cross-sector funding. Program details and sources are documented in the master inventory table. Where agriculture competes within broader programs, agriculture-only attribution would require project-level analysis as a next step.