

HORIZON 2030

GUIDE ON RESEARCH PRIORITIES IN THE SWINE SECTOR

RESEARCH,
DEVELOPMENT AND KNOWLEDGE TRANSFER
COMMITTEE FOR THE QUEBEC PORK INDUSTRY

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GUIDE ON RESEARCH PRIORITIES IN THE SWINE SECTOR – HORIZON 2030 -

PREAMBLE

This Guide serves as a reference document for all stakeholders involved in Quebec swine research. It structures research, development and transfer (RDT) priorities around six strategic areas for the 2025-2030 period :

- Feed and Nutrition
- Buildings, Equipment and Environment
- Economics and Management
- Genetics and Reproduction
- Meat Quality
- Health

Context and Development

This Guide was developed under the responsibility of the RDT Committee of the swine sector, created following the Forum on Research, Development and Transfer organized as part of Quebec's 2015–2020 Swine Sector Strategic Plan. The Forum aimed to foster exchanges on research priorities and identify ways to improve coordination of RDT activities in the swine sector. Coordination of the RDT Committee was entrusted to the CDPQ.

First published in June 2019, this Guide was updated in March 2023 for the "Buildings, Equipment and Environment" and "Genetics and Reproduction" sections. This new version responds to a clearly expressed need to precisely target current RDT issues and needs, maximize the impact of completed projects, and strengthen collaboration among industry partners, researchers and research stakeholders.

Consultation Process

Nearly 80 experts participated in consultation groups organized for each of the six domains to identify the RDT priorities presented in this document. Their names appear at the end of each thematic section, reflecting the breadth and diversity of the expertise mobilized.

How to Use This Guide

For researchers: This document expresses the priority needs identified by the Quebec swine sector and should guide the development of research projects and collaborations with industry partners.

For program managers: This guide serves as a reference to evaluate the relevance and level of swine sector support when reviewing funding applications for research projects.

CAVEATS

Animal Welfare

No specific consultation was conducted on animal welfare, as this dimension is considered cross-cutting across all domains presented. Animal welfare issues must therefore be integrated horizontally into all research projects, regardless of their specialty.

Economics and Management

The economic dimension permeates all identified research areas. Although the "Economics and Management" domain is addressed individually with its own priorities, systematic evaluation of the economic impact of proposed solutions is an essential element of all projects. This approach ensures that developed innovations remain viable and accessible for Quebec producers.

Artificial Intelligence and Data Management

Advances in artificial intelligence now touch every sector, including swine production. While AI is not a research priority in itself, it represents a strategic tool for addressing the multiple challenges facing the sector. However, expert groups emphasized that access to quality data is an indispensable prerequisite for effective R&D projects, particularly for AI applications. The swine sector must therefore equip itself with high-performance information sharing and data pooling tools to maintain its leadership in swine research and create an innovation-friendly ecosystem.

Knowledge Transfer and Adoption of Results

The valorization and transfer of research results to end users are major challenges often underestimated in R&D projects. The real impact of research can only be measured by its effective adoption and contribution to improving sector practices.

To accelerate this uptake, particular attention must be paid to :

- creating tools and methods that facilitate understanding and application of results by producers and their advisors;
- developing continuous training for sector stakeholders;
- establishing structured exchange networks between researchers and practitioners.

Innovation and Sustainable Development

The swine sector continually pursues improvement, notably through optimization of inputs used in production. Research efforts must remain aligned with the sector's objectives and targeted productivity levels, within a perspective of sustainable economic, social and environmental development of the Quebec sector.

About This Guide

This guide is an orientation tool for research in the face of current challenges in the swine sector. It should not be interpreted as a prescriptive action plan with binding timelines for researchers and R&D stakeholders. The list of research themes presented results from a rigorous prioritization exercise conducted by consultation groups. It is neither exhaustive nor exclusive: other relevant research can and should be conducted in the areas covered. The themes selected represent those deemed most priority among all topics discussed during consultations.

COMPOSITION OF THE RDT COMMITTEE

The list of members and organizations below reflects the RDT committee composition as of July 2025

NAME	ORGANIZATION
Marie-Pierre Létourneau-Montminy, Présidente	Université Laval
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Dan Bussières	Groupe Cérès
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Raphaël Bertinotti	Les Éleveurs de porcs du Québec (EPQ)
Yvan Fréchette	Les Éleveurs de porcs du Québec (EPQ)
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Éric Pouliot	Olymel
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Daniel Ramage	Swine Innovation Porc (SIP)



Agriculture et Agroalimentaire Canada

Agriculture and Agri-Food Canada

Québec

CDPQ Centre de développement du porc du Québec inc.

CRSAD Centre de recherche en sciences animales de Deschambault

GROUPE CÉRÈS INC

irda Institut de recherche et de développement en agroenvironnement

Les Éleveurs de porcs du Québec

OLYMEL On nourrit le monde

PIC

RO-MAIN Prenez les devants

Swine Innovation Porc

trouw nutrition une entreprise de Nutreco

SHUR-GAIN

Université de Montréal

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FEED AND NUTRITION



1. FEED AND NUTRITION

1.1 Improving piglet gut health

Background

Weaning stress often results in performance declines and diarrhea requiring antibiotic use, a practice the sector seeks to minimize. It is therefore important to promote good piglet gut health. To achieve this, it is necessary to better understand the dynamics and dietary strategies that can influence it, and to be able to validate their impact on animal performance.

Many studies currently focus on the microbiome — bacteria present in the digestive tract, particularly in the posterior section. Some studies show a potential link between the microbiome and the development of the intestinal mucosa and the immune system. However, harmful bacteria and beneficial bacteria alike compete for nutrients. Their interactions are complex, and more studies are needed to fully understand their mechanisms of action.

Various solutions are worth exploring, including the search for alternative additives, more precise validation of nutritional needs to meet them while generating fewer surpluses, and the development of alternative management strategies to reduce weaning stress (e.g., partial weaning, later weaning, early socialization). A rapid feed intake onset following weaning is a key factor for good performance and avoiding health problems. Some piglets, however, have difficulty starting to eat quickly, and the causes are not well understood. It is therefore important to also address this issue by trying to better understand what influences feed intake onset following weaning and identify dietary strategies to remedy it.

Pharmacological levels of zinc (Zn, up to 3,000 mg/kg), an essential trace element for pigs with a significant impact on zootechnical performance, have been used as an antimicrobial to help prevent diarrhea, improve intestinal mucosa health, and as a growth promoter in the post-weaning period. The recommended Zn level in weaned piglet rations is 100 mg/kg (NRC, 2012). Zinc is necessary for the integrity of the intestinal mucosa and is involved in immune response. While effective, this zinc oxide practice leads to significant Zn discharges in livestock effluents. Restrictive standards are forthcoming in 2027 (as was the case in Europe in 2022) to reduce zinc use in animal feed. This requires resolving this issue as a priority to find alternative additives or other solutions. To reduce dietary Zn intake and comply with new standards (around 300 mg/kg) while preserving

positive effects on growth and intestinal mucosa, studies are needed to better understand zinc's mechanism of action and propose new strategies.

Finally, economic losses related to birth-to-weaning mortality are significant, particularly for farrow-to-finish operations. With increased litter size causing less uniform piglet birth weights, the first days of life are critical. Finding strategies to reduce this mortality is important.

Priority research themes

- Understand the mechanism of action of zinc and find alternatives to zinc as a gut health modulator in post-weaning piglets;
- Better understand the parameters that modulate gut health and, in particular, the biomarkers that measure it, such as the intestinal microbiome, and their relationship to growth performance;
- Examine current feeding, nutrition and management practices to reduce antibiotic use in post-weaning piglets;
- Validate strategies that can reduce piglet stress at and after weaning;
- Better understand the factors that influence feed intake after weaning and establish strategies to optimize it;
- Validate feeding strategies that can reduce birth-to-weaning mortality in piglets;
- Validate feeding strategies that can reduce the incidence and severity of post-weaning diarrhea;
- Find mitigation strategies for Porcine Reproductive and Respiratory Syndrome (PRRS) and better understand the gut-lung axis.

1.2. Improving productivity and longevity of breeding animals

Background

Sow mortality is a very concerning issue that harms sector competitiveness given the significant investment of time and money made on these animals. The sow's role in birth-to-weaning mortality is major, since it is primarily her milk production that influences piglet growth rate. Thus, optimizing lactating sow nutrition is essential, as it affects milk composition and therefore piglet vitality and birth-to-weaning mortality rates.

Currently, gilts and sows in production farms are fed two feeds: one for the gestation period and one for the lactation period. The respective nutritional composition of these feeds is constant throughout each period and for all sows. However, multiple studies have shown that sows' nutritional needs vary according to their stage of gestation or lactation, as well as individual characteristics such as weight, body condition, litter size, etc. The mismatch between feed intake and sow requirements, particularly in young, still-growing sows, causes large fluctuations in body reserves that affect reproductive performance and longevity. Furthermore, considering that new regulations require producers to manage their sows in groups during gestation, the relevance of adjusting feeding management or nutritional needs adds additional challenges.

Alternative feeding strategies to better match needs must be implemented, such as transition feeding between gestation and lactation, and precision feeding.

Priority research themes

- Better understand gilt nutritional needs;
- Develop gilt feeding strategies during gestation and lactation to optimize reproductive performance, longevity and, above all, milk production;
- Validate the impact of precision feeding during gestation and lactation;
- Validate the impact of group housing of gestating sows on nutritional needs and feeding management;
- Examine nutritional needs at early gestation;
- Examine dietary strategies during the gestation-to-lactation transition phase;
- Examine the effect of feeding on semen quality in AI boars;
- Examine feeding strategies for boars in artificial insemination centres to improve sow fertility;
- Understand and document sow mortality in Canada.

1.3. Reducing environmental impact and adapting to climate change

Background

Improving the environmental performance of swine operations responds to a dual challenge: ecological impact and consumer confidence. These dimensions are naturally part of a sustainable development approach. Sensitized to these issues, producers and consumers recognize the importance of adopting responsible practices. Several levers exist: moving toward innovative systems, investing in effluent treatment technologies and optimizing dietary strategies. At the same time, economic sustainability of operations remains a fundamental objective for ensuring sector longevity.

Complementarity between human and animal nutrition represents a strategic opportunity. Valorization of co-products and by-products offers promising solutions to optimize resources. However, their dietary integration presents significant technical challenges related to their composition and nutritional stability. Toxins, particularly mycotoxins, can affect animal performance and farm profitability, making specialized expertise essential. Although knowledge of these contaminants has accumulated, their prediction and management remain complex due to the multiple variables involved. The sector must continue to invest in research and risk-management solutions.

Priority research themes

- Develop dietary strategies to reduce the environmental footprint;
- Evaluate the nutritional value of ingredients, particularly by-products;
- Better understand the effects of toxins in pig feed and evaluate mitigation strategies;
- Study nutritional strategies to cope with heat stress;
- Develop feeding strategies for alternative production systems (e.g., liquid feeding, organic feeding).

Experts consulted for research priority identification — Feed and Nutrition

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AAFC = Agriculture and Agri-Food Canada
AQINAC = Quebec Animal Nutrition and Cereal Industry Association
CDPQ = Centre de développement du porc du Québec inc.

BUILDINGS, EQUIPMENT AND ENVIRONMENT



2. BUILDINGS, EQUIPMENT AND ENVIRONMENT

2.1. Infrastructure and Equipment Modernization

Background

Aging infrastructure and a shortage of qualified labour are pressing challenges for swine sector business owners and managers. The average age of swine buildings exceeds 20 years, with the majority of infrastructure built in the 1990s during the industry's rapid expansion period. Major modernization of livestock structures is therefore required, in addition to current challenges related to productivity improvement objectives. This modernization need also applies to barn climate control systems. Integration of new technologies should be planned at the design stage of new buildings.

Priority research themes

- Develop or evaluate technologies favouring data sharing, precision livestock farming, process automation and robotization of production processes;
- Improve farm energy efficiency, reduce non-renewable energy use and develop tools to model the effect of integrating various energy-saving techniques on production costs;
- Optimize building configurations to improve animal flow, enhance animal welfare, reduce construction and maintenance costs, improve biosecurity, facilitate landscape integration and optimize manure management;
- Develop strategies based on animals' real needs to optimize climate control, pig comfort and health.

2.2. Animal health and welfare

Background

Barn climate conditions have a major impact on herd health and therefore productivity. They also influence public perception of how animals are raised and thus play a role in efforts to improve social acceptability of the swine sector. It is also important to consider

emerging issues, such as challenges associated with reducing antibiotic use in livestock, the impact of climate change, and new animal welfare requirements.

Priority research themes

- Develop new tools for better detection and monitoring of diseases within herds, and to make animals more resistant to diseases, to reduce antibiotic use and prevent transmission and spread of diseases;
- Develop production systems adapted to the latest animal welfare standards, new consumer requirements and climate change (e.g., heat stress);
- Develop new tools for alternative management and environmental enrichment aimed at improving health and welfare in farrowing, nursery and finishing;
- Study the impacts of light spectra and lighting duration, both natural and artificial, in the context of naturalizing the rearing environment;
- Improve biosecurity management practices to prevent health deterioration throughout the entire swine production chain (from selection of breeding animals through farrowing, nursery and finishing, animal transport and inputs, feed production, AI centres, washing, manure spreading and management of dead animals).

2.3. Environnemental impact

Background

Swine sector stakeholders are concerned about reducing the environmental impact of swine production and protecting the health of their herds, their workers and rural communities. The sector has always been proactive in terms of environmental protection regulations and actions, but the current context requires new efforts toward net greenhouse gas emission reductions. For example, liquid manure is an excellent fertilizer that must be valorized on agricultural land, and reconciling its advantages and disadvantages will require continued effort.

Furthermore, sustainable water use would improve the environmental balance. Recent studies demonstrate that compiling and analyzing water consumption data in swine

operations could be valorized both for optimizing water use and for improving animal performance and health monitoring.

Priority research themes

- Effectively manage animal manure based on its properties, agronomic qualities (fertilization potential valorization) and spreading techniques, to further optimize use of this organic fertilizer;
- Improve air quality inside buildings and reduce emissions into the environment (e.g., gases, odours and bioaerosols);
- Optimize water management in livestock operations, in terms of both quality and quantity, including various treatments (acid, additives, antibiotics) that may be administered through drinking water, and optimize use of animal water consumption data;
- Develop new on-farm practices to continue improving the environmental footprint in terms of greenhouse gases and eutrophication and acidification risks, by promoting integrated crop-livestock approaches, mobilizing expertise in plant and animal production as well as soil health;
- Quantify emission factors and costs associated with adopting innovative practices and technologies, to generate data for life cycle analyses (LCA) and economic assessment of the adoption of these practices.

Experts consulted for research priority identification — Buildings, Equipment and Environment

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CDPQ = Centre de développement du porc du Québec inc.
IRDA = Institut de recherche et de développement en agroenvironnement
MAPAQ = Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec



ECONOMICS AND MANAGEMENT

3. ECONOMICS AND MANAGEMENT

3.1. Optimizing competitiveness of the swine sector

Background

In Quebec, approximately two-thirds of pork produced and processed is destined for export. In 2024, Quebec's share of global pork trade reached 5%, highlighting the crucial importance of maintaining competitiveness of its swine sector in domestic and international markets. Evaluating this competitiveness requires analyzing overall productivity by considering all resources used (labour, capital, raw materials, etc.) rather than limiting the analysis to partial indicators typically used. The proposed approach decomposes productivity into three key dimensions: economies of scale, technological progress and managerial efficiency. This method allows precise identification of improvement levers and deepens understanding of performance sources, thereby revealing optimization opportunities throughout the swine production chain.

Priority research themes

- Identify and validate the key factors likely to significantly optimize profitability, from farm to processing;
- Analyze and quantify the elements distinguishing the most financially successful farms.

3.2. Economic impact of swine diseases

Background

Endemic and emerging swine diseases, such as African Swine Fever, represent a major economic threat to the swine sector. Rigorous assessment of their potential costs is essential to guide prevention strategies.

Understanding and anticipating these financial impacts, as well as identifying priority mitigation measures, are crucial for ensuring the resilience and sustainability of Quebec swine enterprises. A proactive approach to health risk management not only limits direct losses but also preserves the sector's competitive position in export markets.

Maintaining herd health occurs in a context where antibiotic use in pig production is being reduced. This requires a delicate balance since maintaining herd health remains essential

to prevent economic losses related to disease. Rigorous health control and alternative practices therefore become indispensable to limit financial and animal health risks.

Priority research themes

- Conduct cost-benefit analyses (CBA) or cost-effectiveness analyses (CEA) of collective disease control initiatives to identify success factors and formulate strategic recommendations for the entire sector;
- Model various scenarios of emerging disease introduction in Canada and Quebec, and evaluate the effectiveness of available risk management tools across the entire sector;
- Evaluate (update) the collective cost of the main endemic diseases affecting Quebec's swine sector, notably PRRS and swine influenza;
- Evaluate the economic and health effectiveness of alternative practices to preventive antibiotics in Quebec swine operations, comparing their short- and long-term costs and benefits.

3.3. Infrastructure investment strategies

Background

Infrastructure costs in Quebec significantly exceed those in the United States, creating a major competitive disadvantage for Quebec swine producers. This situation forces producers to favour renovation of aging facilities rather than new construction, thus limiting efficiency gains and farm modernization.

The gap between construction costs and producers' financial capacity constitutes a barrier to necessary investments. This financial constraint compromises not only the long-term profitability of enterprises, but also their capacity to adapt to new regulatory requirements and climate change challenges. Renovation costs are also very high relative to sector profitability. Market uncertainty makes producers reluctant and lenders hesitant to invest in a sector that has been significantly battered since the pandemic. As a result, the farrowing facilities of many swine enterprises are not yet adapted to the animal welfare standards that have been mandatory since July 1, 2024 under the current Code of Practice, a transition the industry has committed to completing by January 1, 2029 (sows must be in groups by January 2028).

Priority research themes

- Compare construction standards, approval processes and establishment conditions for construction projects between Quebec, other Canadian provinces and comparable regions, as well as associated costs;

- Evaluate the financial and operational impact of anticipated regulatory changes, particularly regarding animal welfare standards, environmental standards and construction standards;

- Design a reference guide and decision-support tools to assist producers and their advisors in infrastructure projects, including comparative analysis of new construction versus renovation options, integration of animal welfare standards, climate change adaptation and optimization of technical performance;

- Establish profitability thresholds by production type (farrowing, nursery and finishing), determining the minimum revenues required per unit produced to ensure viability of planned investments and their optimal amortization periods.

3.4. Climate adaptation and circular economy

Background

Climate change presents growing challenges for the Quebec swine sector. Water management is becoming critical with increasingly severe heat waves that can lead to water shortages. At the same time, these heat waves lead to heat stress issues on farms and complicate transport of pigs to slaughterhouses, resulting in additional costs and animal welfare risks.

However, this climate transition opens up promising economic opportunities. Valorization of co-products from a circular economy perspective and access to the carbon market through offset credits represent revenue diversification levers that are still largely unexplored. The Quebec swine sector must define its strategy for integrating these new economic tools to transform climate constraints into competitive advantages.

Priority research themes

- Quantify the impact of temperature variability and frequency of extreme climate events on technical and economic performance, and evaluate the profitability of proposed adaptation strategies;

- Analyze the agronomic and economic value of circular economy projects, including valorization of effluents, co-products and integration into bioenergy supply chains.

3.5. Market risk management strategies

Background

Available financial instruments, such as futures markets and bank products based on slaughter delivery indices, offer protection mechanisms against price fluctuations, but their optimal use remains complex for many producers.

The diversity of value chain actors — from feed mills to processors, including slaughterhouses — generates distinct risk profiles requiring tailored strategies. The effectiveness of these tools depends largely on advisors' ability to assess the returns of various hedging strategies and adapt them to the specific economic realities of each operation. An integrated risk management approach, combining sector analysis and practical tools, is essential to optimize sector profitability and competitiveness.

Priority research themes

- Conduct a detailed SWOT analysis (strengths, weaknesses, opportunities, threats) for each industry segment to identify vulnerabilities and specific improvement levers;
- Objectively evaluate the effectiveness and accessibility of the various risk management tools available on the market, taking into account costs, complexity of use and potential benefits;
- Develop practical guides and decision-support tools for advisors, integrating individual production cost data and allowing objective evaluation of margin protection strategies based on operation profiles.

3.6. Standardized Economic Indicators and Benchmarking Data

Background

The growing diversification of swine enterprises complicates comparative performance analysis (benchmarking) and interpretation of production costs. Analyzing production

costs requires crossing economic and technical data, which is challenging with small samples. This situation limits producers' ability to benchmark against their peers and identify where to focus improvement efforts.

The lack of standardized reference data on production costs is a major obstacle to developing a benchmarking culture in the sector. Without a standardized system for collecting, analyzing and sharing economic data, producers are deprived of the benchmarks needed to optimize their performance. Establishing an integrated economic data system is a strategic challenge for the sector. This system would enable continuous benchmarking, replacing one-time studies with dynamic monitoring segmented by production type. It would also facilitate controlled researcher access to real producer data, through partnerships and privacy-respecting consent processes, opening the way to more relevant and field-grounded research.

Priority research themes

- Design a secure economic data pooling process ensuring informed producer consent and confidentiality of sensitive information;
- Define standardized economic indicators and establish a sustainable structure ensuring their continuous updating and evolution with sector needs;
- Conduct sector benchmarking studies providing comparative analyses and personalized improvement recommendations.

3.7. Succession and Business Transfer Financing

Background

Swine enterprise transfers face financial challenges threatening sector sustainability. The growing gap between the capitalized value of operations and the financial capacity of potential successors creates a vicious cycle where outgoing producers must make substantial financial sacrifices to ensure transmission. This situation compromises not only the retirement income of exiting producers, but also discourages new entrepreneurs from entering the sector.

The goal is to preserve know-how, maintain productive capacity and ensure generational renewal essential to the vitality of the Quebec swine sector. Exploring innovative financing solutions or introducing patient capital are promising avenues to facilitate these transfers and ensure enterprise sustainability.

Priority research theme

- Develop and evaluate financing solutions and innovative transmission models to facilitate swine enterprise transfers, including analysis of patient capital mechanisms, intergenerational partnerships and public support tools adapted to sector realities.

3.8. Workforce and sectoral economic resilience

Background

In recent years, the Quebec swine industry has faced significant challenges related to workforce availability and retention. The shortage of qualified workers, accentuated by an aging population, competition from other sectors and the prolonged effects of the pandemic, has placed considerable pressure on the entire sector, from livestock production to processing. This situation has forced many businesses to review their practices, invest in automation and redouble efforts to attract local or international labour.

More specifically, temporary foreign workers (TFW) constitute a fundamental economic pillar of the Quebec swine sector, contributing critically to production and processing operations. Their presence meets structural workforce needs that the local market cannot fill, particularly in contexts of generalized worker shortages. It is crucial to measure the economic impact of TFWs on swine enterprises. Government policies regarding TFWs can significantly affect the sector. An in-depth analysis would allow better understanding of their contribution and formulation of recommendations for workforce policies that support sector competitiveness.

Priority research themes

- Quantify the economic impact of temporary foreign workers on financial performance, productivity and competitiveness of swine enterprises, analyzing their direct contribution and sectoral multiplier effects;

- Develop risk mitigation strategies related to labour shortages or reduced access to foreign workers, including automation, work process reorganization, training partnerships and local workforce attraction mechanisms.

Experts consulted for research priority identification — Economics and Management

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AAFC = Agriculture and Agri-Food Canada
CDPQ = Centre de développement du porc du Québec inc.
CECPA = Centre d'études sur les coûts de production en agriculture
CMCA = Centre multi-conseils agricoles
IRDA = Institut de recherche et de développement en agroenvironnement
MAPAQ = Ministère de l'agriculture, des pêcheries et de l'alimentation du Québec



GENETICS AND REPRODUCTION

4. GENETICS AND REPRODUCTION

4.1. Reproductive traits and sow longevity

Background

Genetic improvement has considerably increased sow prolificacy, but litter size at weaning has not kept pace. Weaning litter size depends on sow fertility, embryo survival and birth-to-weaning mortality, which remains particularly high in swine production, even in high-performing herds. This situation generates major animal welfare, labour valorization and profitability challenges. Critical aspects to develop include sow mammary development, colostrum quantity and quality, teat number and quality, uniformity of piglet birth weight, sow feed intake and efficiency during lactation, weaned piglet weight, and sensitivity to heat stress.

The increase in sow productivity is negatively correlated with their reproductive lifespan. Furthermore, sow mortality rates appear to be increasing and culling rates remain high. It therefore becomes essential to better understand the various risk factors leading to mortality or premature culling and to develop strategies to improve sow longevity.

Priority research themes

- Analyze the impact of the reproductive tract microbiome on fertility and reproductive success;
- Reduce embryonic and birth-to-weaning mortality through combined optimization of genetic and/or non-genetic factors to improve profitability, sustainability and animal welfare in farrowing operations;
- Study the impact of selection on piglet survival;
- Develop automated sow monitoring technologies adapted to labour and expertise constraints, and massive data analysis methods for early detection of problems leading to culling;
- Deepen knowledge on causes of premature sow culling (prolapse, heat stress, pathologies);
- Identify genetic or environmental factors favouring reproductive longevity of commercial sows (management, group dynamics during gestation, body condition, behaviour, feet and legs) and their retention in the herd.

4.2. Reproductive technologies and techniques

Background

Sow fertilization and gestation rates, as well as birth litter sizes, are among the determining parameters of farm profitability. Semen quality and insemination techniques directly influence fertilization rates. It is essential to continue deepening knowledge of semen quality criteria and the factors influencing quality and preservation capacity (boar age, health, heat stress, housing conditions, nutrition, chromosomal abnormalities, genetic factors).

Developing techniques to reduce the number of spermatozoa per insemination dose without affecting fertilization rates is of capital importance. These innovations include improving diluents and semen conditioning methods, as well as optimizing artificial insemination protocols and improving semen deposition techniques to maximize reproductive efficiency.

The constant evolution of insemination methods also aims to reduce sow stress while maintaining optimal reproductive performance. Embryo transfer is also a valuable technique for sharing genetics between breeders while reducing disease transmission risks between herds, and enriching knowledge of embryonic physiology and factors influencing foetal development. Optimization of long-term germplasm conservation techniques (spermatozoa and embryos) must continue to be explored to preserve genetic material.

Priority research themes

- Improve semen quality and preservation by deepening knowledge of genetic and environmental factors;
- Refine semen quality evaluation methods;
- Develop and optimize partnerships and data exchanges with artificial insemination centres to effectively address priority semen quality challenges in the sector;
- Refine insemination techniques to reduce boar inventory, thereby decreasing environmental impact and labour requirements;
- Improve embryo transfer techniques and deepen knowledge of ovulation rate, foetal development and optimal age for quality oocyte production;

- Evaluate the impact of boar feeding on semen production and quality;
- Optimize conservation techniques to preserve genetic material long-term;
- Explore the use of artificial intelligence to determine the best germplasms to use for artificial insemination or cryopreservation.

4.3. Genetic progress and epigenetic modulation : impact on performances and adapting practices

Background

Increasing slaughter weights, constant genetic progress and epigenetic advances require continuous adaptation of production practices and better understanding of complex relationships between weight gain, feed efficiency, body composition, carcass yield and quality. Genetic progress, continuously accelerating thanks to new selection methods, requires permanent readjustments in management and equipment to maintain optimal performance in commercial production. Epigenetics studies environmental influence on gene expression (reversible, transmissible and adaptive modifications) without altering the DNA sequence. The literature demonstrates the effects of epigenetic programming, particularly on embryonic development, disease resistance and meat quality. Applying treatments to breeding animals to favourably influence offspring performance presents considerable untapped potential, notably through development of management or parental feeding practices that favourably affect epigenetic programming of offspring.

Priority research themes

- Study the impact of genetic, epigenetic and environmental factors on pig performance in nursery/finishing, on carcass composition and meat quality;
- Develop methods for estimating nutritional needs in nursery, finishing and gestation adapted to the accelerated pace of genetic progress;
- Design epigenetic programming practices using the environment to modulate expression of certain genes (e.g., maternal nutrition, foetal development, immune programming).

4.4. Disease resilience and adaptability

Background

Improving the health of sows and growing pigs, by strengthening their resilience, resistance or robustness to disease, is a major challenge for the swine sector. Currently, genetic selection is carried out in nucleus herds with very high health status, with genetics then disseminated to commercial herds with lower health status.

This pyramidal structure has the disadvantage that natural selection for certain pathogens present on commercial farms is not conducted in nucleus herds. The ultimate goal is general resilience to all diseases, although certain pathologies such as PRRS and post-weaning diarrhea remain particularly problematic, which will reduce antibiotic use and minimize antimicrobial resistance.

Priority research themes

- Improve disease resilience through better understanding of genetic factors and their interactions with environment, nutrition, health and management;
- Analyze health statuses and specific needs in the Quebec context and explore genomic and epigenetic solutions.

4.5. Genetic selection, social behaviour and welfare in swine production

Background

Production systems are evolving to address animal welfare challenges: group management of sows during gestation, elimination of piglet tail docking, addition of enrichment objects for finishing pigs. Recent research reveals that selection for optimal growth impairs pig social behaviour (increases stress and aggression), creating challenges in commercial production, particularly during mixing of finishing pig groups or gestating sows, probably due to the increased nutritional needs of animals with superior genetics.

Priority research themes

- Optimize social behaviour of group-housed sows and nursery and finishing pigs (reduce conflicts and aggression) through selection or learning of social skills through adapted management;
- Develop behavioural indicators for sows and finishing pigs and analyze their links with zootechnical performance and environmental factors;

- Evaluate the impact of genetic progress and increasing slaughter weight on final product quality.

4.6. Digital data and artificial intelligence

Background

Development and implementation of new technologies generates a considerable amount of data requiring new means of valorization and optimal exploitation. It therefore becomes essential to develop tools for acquisition, sharing and analysis of massive data for practical application in genetics and reproduction. This field includes machine learning, a field of study of artificial intelligence. Emerging technologies enable collection and processing of vast quantities of information while addressing various workforce shortage and training challenges.

Priority research themes

- Develop innovative new technologies (automated heat detection, lactating sow monitoring) to optimize reproductive success and pre-weaning survival in a constrained labour context;
- Design methods for analyzing massive animal performance data for practical application of digital technology and artificial intelligence in livestock farming, maximizing expression of genetic potential under specific farming conditions.

4.7. Social acceptability, ethical issues and advanced genetic selection

Background

Consumers have limited knowledge of the various methods of genetic improvement: classical genetic selection, genomic selection, advanced techniques (gene editing, CRISPR), genetically modified organisms (GMO) and transgenes. It remains essential to continue developing these tools to create new genetic improvement opportunities.

At the same time, it is important to better understand consumers and the social acceptability factors that will determine the medium-term application potential of these methods. Advanced genetic selection offering multiple improvement opportunities with favourable social acceptability potential, it becomes relevant to study the social parameters and ethical concerns surrounding this innovative tool and its applications.

Priority research themes

- Understand and identify social acceptability factors for the use of advanced genetic selection;
- Develop genetic lines that respond to consumer concerns through advanced genetic selection.

Experts consulted for research priority identification — Genetics and Reproduction

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MEAT QUALITY

5. MEAT QUALITY

5.1. Technology, AI and anomaly detection

Background

Technological advances offer new possibilities for improving anomaly detection in abattoirs. Their cost can be expected to continue declining, and their development and ease of use to continue growing, notably thanks to artificial intelligence. These technologies could well meet needs that are currently difficult to fill, and whose automation would, among other things, increase precision, reduce economic losses or assist quality control and assurance teams.

Priority research themes

- Detection of abscesses on carcasses to avoid subsequent contamination;
- Immunocastration — rapid, accurate and affordable detection of off-odours from boar carcasses;
- Automated inspection of viscera and other organs to detect issues (e.g., adhesions);
- Automated identification and quantification of skin lesions in relation to their causes.

5.2. Quality assessment tools

Background

Precise evaluation of carcass and cut quality is essential for optimizing the value chain. Development of reliable and accessible tools would allow better product valorization and more informed decision-making at each stage of production, processing and marketing. Technologies are rapidly evolving, and it is essential that they be adapted to the needs of the Canadian swine industry to remain a leader in the field. Upcoming approaches will need to allow estimation of both the weight and composition of cuts, as well as their quality.

Priority research themes

- Non-invasive evaluation of carcass composition — weight and cut composition;
- Automated evaluation of quality parameters.

5.3. Consumer expectations

Background

Consumer quality perception is a key factor in the success of meat products. Understanding their expectations, evaluation criteria and consumption habits would allow guidance of production, processing and marketing strategies. This is of particular importance as the Canadian swine industry seeks to diversify its products and expand its domestic market presence, with the goal of reducing dependence on imports, which have experienced significant variations in recent years due to factors such as trade conflicts and the COVID-19 pandemic.

Priority research themes

- Valorize current pork cuts and explore new cuts;
- Update the key parameters defining eating quality;
- Encourage consumer education (cooking, new cuts, food safety…) and determine the best approaches;
- Explore consumer appreciation criteria (organoleptic, nutritional and other) to respond to needs and demands expressed by different generations.

5.4. Shelf life and microbiological quality

Background

Quebec has a strong reputation in export markets for the quality of its pork products. To ensure this brand image is maintained, product shelf life in fresh form is necessary to meet demand from the most lucrative, but often distant, export markets. This also holds true for domestic markets to reduce food waste. Controlling the microbiome remains a major challenge to extend the shelf life of meat products while ensuring their safety. The specific ecosystem of each plant should also be considered. Exploring innovative,

potentially natural and ecological approaches (e.g., biocontrol) could allow this challenge to be met.

Priority research themes

- Develop innovative approaches to control desirable and undesirable microbial populations;
- Explore natural antimicrobials;
- Study the influence of the microbiome on meat safety and control strategies.

5.5. Animal husbandry

Background

Livestock practices have an impact on carcass and meat quality, whether related to nutrition, genetics, management practices or simply carcass weights, which have steadily increased over the years. The challenges that the swine industry faces and will face will undoubtedly bring changes that could impact carcass and cut quality. To maintain the reputation and, above all, the positioning of Canadian products, it is essential to use profitable production approaches that meet consumer expectations and achieve desired quality standards.

Priority research themes

- Develop dietary strategies adapted to target weights (seasonality) and desired quality;
- Study the impact of pig maturity (age), related to increasing growth rate, on carcass and meat quality;
- Optimize immunocastration use (timing between doses, adapted nutrition) to produce desired quality.

5.6. Pre-slaughter stress and product quality

Background

Pre-slaughter stress is undoubtedly a pivotal point for meat quality. Although research advances have improved procedures and limited sources of stress during steps preceding

slaughter, this factor remains an important concern for the industry and the public. The diversity of situations encountered and variability of individual reactions makes stress management complex, with each animal potentially responding differently to the same conditions.

Priority research themes

- Deepen understanding of pre-slaughter stress factors, taking into account individual variations, and determine whether there is a genetic signature of stress sensitivity;
- Evaluate optimal holding time as a function of transport duration;
- Refine knowledge about conditions and equipment (trucks, gathering pens, loading/unloading procedures, abattoir holding areas) that improve animal welfare during transport of pigs from farm to abattoir.

Experts consulted for research priority identification — Meat quality

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AAFC = Agriculture and Agri-Food Canada
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HEALTH



6. HEALTH

6.1. Virulence factors and pathogeny

Background

Porcine Reproductive and Respiratory Syndrome (PRRS) causes major economic losses in Quebec swine operations, estimated at $38 to $50 million per year. Swine influenza, an important zoonosis, could generate annual losses comparable to those of PRRS. Analysis of viral sequences, whether partial or complete, contributes to better understanding of the circulation and mutations of these viruses within the Quebec swine herd.

Furthermore, bacterial infections, notably those caused by *Streptococcus suis* and *Haemophilus parasuis*, are re-emerging with the reduction of antibiotic use, highlighting the urgent need for effective control solutions.

Digestive diseases, particularly those caused by *Salmonella* and *Escherichia coli*, also remain major concerns. Thorough characterization of these pathogens is important.

Thème de recherche priorisé

- Characterize pathogens and identify virulence factors (including in a co-infection context) as well as factors related to development of immunity against PRRS and influenza viruses, *Streptococcus suis*, *Haemophilus parasuis*, *Salmonella* and *Escherichia coli*.

6.2. Disease diagnostic methods

Background

It is necessary to develop tools and strengthen expertise to better interpret and utilize analytical results, notably to distinguish active from inactive viruses, bacterial strains, or to distinguish vaccination-induced immunity from that acquired through exposure to a wild strain. Beyond a laboratory diagnostic context, development of on-farm disease detection kits directly usable at the livestock site also constitutes a priority need. These advances would contribute to addressing several challenges, including reduction of antibiotic use.

In addition, it is essential to promote the use of behavioural and physiological pig data (for example: water consumption, feed intake, behaviours, body temperature,

biomarkers — at the individual or collective level) to enable automatic detection of health problems. Artificial intelligence and digital vision represent promising levers to address this challenge.

Priority research themes

- Develop, improve and reduce the costs of diagnostic and sampling methods, notably for PRRS, influenza, Porcine Epidemic Diarrhea (PED), Delta Coronavirus (PDCoV), Senecavirus A (SVA) and African Swine Fever;
- Develop methods for automated (early) detection of health problems.

6.3. Disease surveillance (detection and communication) : endemic and emerging diseases

Background

Surveillance of endemic and emerging diseases promotes understanding of disease circulation. It also enables implementation of collective and individual actions to prevent disease spread and thereby better control it. The importance and positive outcomes of this type of action are recognized.

Continued development and improvement of collection and analysis tools for disease surveillance in Quebec and Canada (and indeed North America) must integrate both on-farm and abattoir data. Digital vision tools coupled with AI have a role to play in collecting this data. Financing of these recurring disease surveillance actions at the federal, provincial and local levels must also be ensured.

Finally, it is strategically important to find ways to break down barriers that impede data pooling among stakeholders involved in disease management, notably, but not exclusively, sequencing data for bacteria and viruses responsible for swine diseases.

Priority research themes

- Enhance and optimize collection, sharing and analysis tools for data necessary for surveillance of PRRS, influenza and emerging diseases such as PED, PDCoV and ASF, as well as re-emerging bacteria, notably due to restrictions in antibiotic use;
- Develop and enhance tools necessary for timely communication of information to persons involved in managing these diseases;

- Develop a process that would ensure stable funding for surveillance activities.

6.4. Epidemiology: Infectious Diseases and Other Health Conditions

Background

To monitor and limit economic losses related to health problems, it is essential to create a representative portrait of the proportion of animals or herds affected. It is also essential to evaluate the relative importance of the various risk factors influencing these problems. Regarding infectious diseases, it is appropriate to document and quantify the factors favouring their transmission between animals and herds. These include livestock practices, transport, manure spreading and regional exposure (e.g., proximity to neighbouring herds).

For other non-infectious health conditions (e.g., hernias, prolapses, lameness), other types of risk factors must be taken into account.

Priority research themes

- Determine the prevalence of infectious diseases and study associated risk factors and transmission modes to identify methods for reducing their impacts;
- Determine the prevalence of non-infectious health conditions (e.g., hernias, prolapses, lameness) and analyze associated risk factors to identify methods for reducing their impacts.

6.5. Prevention, bio-containment and control

Background

Pathogen transmission represents a major economic challenge for the industry. To strengthen the effectiveness of prevention and control actions, it is essential to develop new tools, particularly in vaccination and biosecurity.

This includes exploring innovative technologies for vaccine manufacturing and administration (e.g., aerosols, mixtures), lifting regulatory barriers to the use of (1) autogenous vaccines and (2) solutions proven internationally (e.g., adjuvants authorized in the European Union).

Furthermore, rigorous application of biosecurity measures, both on-farm and during transport, remains a challenge. Integration of procedures within enterprises is often

suboptimal, highlighting the importance of strengthening implementation of good practices.

Logistical strategies, eradication plans adapted to farm type, and use of control groups (GDC, Reseau, CLÉ) are essential levers for preventing, controlling and eradicating diseases. Exploitation of available data — notably from traceability, the Provincial Health Watch (VSP), virus and bacteria sequencing — requires high-performance analysis and decision-support tools. Better information circulation among stakeholders is also crucial.

Finally, improving washing, drying and disinfection methods, particularly for transport trucks (while validating the medium-to-long-term impact on trailer longevity), is indispensable. These costly and time-consuming operations must be optimized through faster, more effective and economical solutions, accompanied by validation methods and rapid tests adapted to field conditions.

Priority research themes

- Conduct research favouring vaccine development, including :
    - Technological innovation (mRNA/DNA platforms, viral vectors, nanoparticles)
    - Improved immunological understanding (adjuvants, mucosal and systemic immunity, computational modeling, chemical synthesis)
    - Expanded therapeutic targets (universal vaccines, monoclonal antibodies, against infectious and non-infectious diseases)
    - Optimized vaccine manufacturing and administration processes

- Reduce barriers to rapid vaccine development;

- Evaluate and improve prevention, control and eradication measures, at the individual and collective level, including cost/benefit aspects;

- Document and develop biocontainment methods specific to each disease;

- Optimize facilities, tools and procedures for better integration of biosecurity measures on-farm and during transport;

- Develop decision-support tools, notably through automation and artificial intelligence, for disease prevention and control;

- Disseminate best practices for washing, drying and disinfection of transport vehicles;

- Establish effective information circulation mechanisms among stakeholders involved in disease prevention and management.

6.6. Welfare and resilience

Background

Canadian swine producers attach great importance to the welfare of their animals. The Canadian swine sector was among the first to adopt a Code of Practice for the Care and Handling of farm animals. Beyond ethical considerations and social acceptability concepts, animal welfare plays a crucial role in pig resilience, thereby contributing to overall herd health and performance.

Priority research themes

- Study the impact of animal welfare conditions on physiological, behavioural and immune resilience of pigs facing environmental and health stressors;
- Develop and validate objective and practical swine welfare indicators based on behavioural, physiological and health measures directly observable in animals or biomarkers;
- Develop and adapt CO_2 gas or gas mixture euthanasia technologies at an affordable cost for producers, compliant with animal welfare requirements for on-farm use.

6.7. Judicious antibiotic use and antimicrobial résistance

Background

Judicious antibiotic use is essential to limit the development of antimicrobial resistance, in both animals and humans. It also contributes to strengthening social acceptability of livestock practices. For example, antibiotic administration via drinking water allows more targeted treatment and reduces quantities used, unlike administration through feed, which results in greater antibiotic use.

To support treatment decisions, it is crucial to develop digital tools for collecting and analyzing antibiotic use data, and to ensure their recurring funding.

Furthermore, several studies indicate that optimizing piglet microbiome and improving production methods (including nutrition and feed additives) could significantly reduce antimicrobial use. These avenues therefore merit exploration through research.

Priority research themes

- Promote judicious antibiotic use by acting on overall herd health improvement, continuous training of producers and stakeholders, quantitative use monitoring and production of comparative reports (benchmarking);
- Measure the effects of treatments or alternative approaches to antimicrobials on zootechnical performance, production costs, microbiome modifications, emergence of resistance, re-emergence of pathogens and resilience to infectious diseases;
- Design and validate new strategies to guide antibiotic use in prevention and management of targeted issues (e.g., lameness, hernias).

Experts consulted for research priority identification - Health

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