QUEBEC
COMMITEE ON RESEARCH,
DEVELOPMENT AND KNOWLEDGE TRANSFER
IN THE SWINE INDUSTRY

GUIDE ON RESEARCH PRIORITIES IN THE SWINE SECTOR – HORIZON 2024

Quebec Committee on Research, Development and Knowledge Transfer in the Swine Industry

Publication/update: March 2023 by the Centre de développement du porc du Québec inc. (CDPQ)

TABLE OF CONTENTS

GUIDE ON RESEARCH PRIORITIES IN THE SWINE SECTOR – HORIZON 2024

PREAMBLE

This Guide, which was first published in June 2019, was updated in March 2023 to consider the consultations carried out during the year 2022. Overall, those consulted agree that the priorities stated remain valid. However, for the "Buildings, equipment and environment" and "Genetics and reproduction" areas, some clarifications or adjustments led to a revision of the statements.

As part of the Quebec swine industry's 2015–2020 Strategic Plan, a Forum on Research, Development and Knowledge Transfer (RDT) was held. The objectives of this forum were to promote exchanges on research priorities and to identify means to be implemented or structural changes to be considered to ensure better coordination of RDT activities in the swine sector. This forum followed the formation of the Committee on Research, Development and Knowledge Transfer in the Swine Industry, known as the RDT Committee. This committee is coordinated by the CDPQ.

By producing this document identifying research and development (R&D) priorities in the swine sector, the committee members responded to an expressed need to properly target current R&D issues and needs in order to maximize the scope of the projects carried out, as well as collaborations between industry partners and researchers and active research stakeholders. This document is intended as a guide for stakeholders involved in swine sector research priorities for a 0–5 year time horizon.

The RDT Committee has chosen to focus on six specific areas:

- Food and nutrition
- Buildings, equipment and environment
- Economy and management
- Genetics and reproduction
- Meat quality
- Health

In total, more than 80 people participated in focus groups for these six areas to identify the R&D priorities presented in this document. The names of these experts appear in the section for each of the areas, as well as those of the people who were able to participate in the updating process.

Researchers should see this document as an expression of the needs considered a priority by the industry. They should address this need when developing projects or working collaboratively with other partners.

Program managers will use this document as a reference to measure the level of relevance and support of the swine industry when analyzing applications for financial assistance for projects.

CAVEATS

Animal welfare theme

There was no consultation specifically on the theme of animal welfare, as it was considered that this dimension should be addressed horizontally in projects affecting the six areas presented.

Economy and management

Although this field is presented individually with its own R&D requirements, the concept of economy is also part of all the research fields identified, since the economic impact dimension of the solutions envisaged should normally be documented in the various projects carried out.

Use and content of the document

This document should be considered as a tool to guide R&D in order to address current issues in the swine industry. It should not be considered an action plan with a timetable intended to guide the initiatives and actions of researchers and stakeholders active in R&D. In addition, the list of research themes presented here is neither exhaustive nor exclusive of the research that can be conducted in the areas covered. The focus groups conducted a prioritization exercise to select the research themes considered to be the highest priority among a large number of topics discussed.

COMPOSITION OF THE RDT COMMITTEE

NOM	ORGANISATION
Marie-Pierre Létourneau-Montminy, Président	Université Laval
Tony Savard	AAC
Renée Caron	CDPQ
Frédéric Fortin	CDPQ
Janie Lévesque	CRSAD
Dan Bussières	Groupe CÉRÈS
Carl Gagnon	Faculty of Veterinary Medicine
Stéphane Godbout	IRDA
Raphaël Bertinotti	Les Éleveurs de porcs du Québec
Yvan Fréchette	Les Éleveurs de porcs du Québec
Louis-Antoine Gagné	MAPAQ
Francis Simard	Nutreco
Éric Pouliot	Olymel
Daniel Godbout	PIC
Jacquelin Labrecque	Ro-Main

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

SHUR-GAIN
trouw nutrition
une entreprise de Nutreco

Université de Montréal

UNIVERSITÉ LAVAL

1.1 Intestinal health in piglets

Background

Stress due to weaning often results in reduced performance and in diarrhoea that requires the use of antibiotics, a practice that the industry wishes to minimize. It is therefore important to promote good intestinal health in piglets. This requires better understanding of the dynamics and dietary strategies that can influence intestinal health, as well as the ability to validate their impact on animal performance. Many studies are currently focused on the microbiota (the bacteria present in the digestive tract, particularly in the lower part). Some studies have shown that there may be a link between the microbiota and the development of the intestinal mucosa and the immune system. However, both bad and good bacteria compete for nutrients. Their interrelationships are complex, and more studies are needed to fully understand their mechanisms of action.

In the face of possible restrictive standards for the use of zinc in animal feed, this issue must also be addressed as a priority in order to find alternative additives or other solutions. Zinc (Zn) is an essential trace element for swine that has a significant impact on their zootechnical performance. In particular, it is essential for the integrity of the intestinal mucosa and is involved in immune response. Although the recommended level of Zn in the diets of weanlings is 100 mg/kg (NRC, 2012), pharmacological levels (up to 3,000 mg/kg) have been used as an antimicrobial to help prevent diarrhea and improve the health of the intestinal mucosa and as a growth factor in the post-weaning period. This practice of using zinc oxide, although effective, leads to significant releases of Zn in livestock manure. To reduce dietary Zn intake and comply with possible new standards while preserving positive effects on growth and intestinal mucosa, studies are needed to better understand zinc's mechanism of action and propose new strategies.

Priority research themes

- Understand the mechanism of action of zinc and find alternatives to zinc as a modulator of intestinal health in post-weaning piglets;

- Better understand the parameters that modulate intestinal health and in particular the biomarkers that measure it, such as the intestinal microbiota, and their link with animal growth performance.

1.2 Reduction in antibiotic use in piglets

Background

Antibiotics have long been used as a preventive measure to control the impact of weaning stress, which causes diarrhea and lowered performance, among other things. However, their use is increasingly restricted to prevent antibiotic resistance. It is imperative to find alternative food and nutrition strategies. Various solutions must be explored, such as the search for alternative additives, the more precise validation of nutritional needs in order to meet them with less excess, and the development of alternative management strategies to reduce the stress associated with weaning (e.g. partial weaning, later weaning, etc.). The projects to address this issue must be carried out in a commercial context.

Priority research theme

- Review current feeding, nutrition and management practices to reduce antibiotic use in post-weaning piglets.

1.3 Reduction in mortality from birth to weaning

Background

The economic losses linked to mortality from birth to weaning are significant for farrowing farms. With the increase in litter size resulting in less uniform piglet weights at birth, the first days of a piglet's life are critical. The search for strategies to reduce this mortality is important. Sows play a major role in this regard, since it is mainly their milk production that will influence the growth rate of piglets. Thus, optimizing the feeding of lactating sows is essential, as it will affect the composition of their milk and therefore the vitality of the piglets and the rate of mortality from birth to weaning.

Priority research themes

- Validate feeding strategies (piglets and sows) that can reduce mortality from birth to weaning;

- Better understand the impacts of sow feeding on colostrum and milk quality and validate strategies that can influence it.

1.4 Feeding of post-weaning piglets to stimulate consumption

Background

A quick start to consumption after weaning is a key element in achieving good performance and avoiding health problems. However, some piglets have difficulty consuming quickly, and the causes are not well known. It is therefore important to address this issue by trying to better understand what influences the onset of consumption after weaning and to establish what feeding strategies would be appropriate to address it.

Priority research theme

- Better understand the factors that influence the onset of consumption following weaning and establish strategies to address this issue.

1.5 Feeding of replacement gilts and sows

Background

Currently on farms, gilts and sows are fed two feeds, one for the gestation period and the other for the lactation period. The nutritional compositions of these foods are constant during each of these periods and for all sows. However, several studies have shown that sows' nutritional needs vary according to their gestation or lactation stage, as well as according to their individual characteristics such as weight, body condition, litter size, etc. The lack of alignment between sows' needs and diets, particularly in young and still-growing sows, causes large fluctuations in body reserves, which affects their reproductive performance and longevity.

Moreover, considering that new regulations require breeders to manage their sows in groups during the gestation period, the relevance of adjusting feed management or nutritional needs raises questions.

Priority research themes

- Develop feeding strategies for gestating and lactating gilts to optimize their subsequent reproductive performance, longevity and especially milk production;
- Validate the impact of precision feeding during gestation on the reproductive performance and longevity of sows, with particular attention to gilts;
- Validate the impact of group management of gestating sows on nutritional needs and feed management;
- Better understand the needs of growing gilts in order to maximize their performance potential (e.g. breeding performance, milk production, longevity, etc.)

1.6 Control of toxins in pork ingredients and feed

Background

Toxins found in animal feed have major economic impacts as they negatively affect animals' performance and health. Pork is particularly sensitive to this. Although there is currently a great deal of information in the literature on toxins in livestock feed and ingredients, particularly mycotoxins, it is still difficult to predict their toxicity and establish strategies to counter their adverse effects, given the complexity of the factors associated with this issue.

Priority research themes

- Better understand the effects of toxins in pigs' feed on the animals and evaluate strategies to counter them;

- Develop a strategy to better communicate with plant sector stakeholders to avoid or reduce the presence of toxins in animal feed (work upstream rather than only downstream).

1.7 Reducing the environmental footprint of pork production

Background

Reducing the environmental footprint of swine farms is important in terms of environmental impact, but also for social acceptability. The concepts of this reduction are essential for the sustainable development of swine farms. The environment is an increasingly important societal value and, in the face of consumers, it is essential to take measures to reduce the environmental impact of production, whether through new livestock systems (free-range, organic, etc.), innovations regarding facilities (manure processing equipment, etc.), or feeding strategies.

Priority research theme

- Establish feeding strategies to reduce the environmental footprint of swine farms.

Expert groups consulted to identify priorities

NAME	ORGANIZATION
Simon Huard, agr	ADM Animal Nutrition
Chantal Farmer, Ph.D.	Agriculture and Agri-Food Canada
Jacques Matte, Ph.D.	Agriculture and Agri-Food Canada
Martin Lessard, Ph.D.	Agriculture and Agri-Food Canada
Candido Pomar, Ph.D.	Agriculture and Agri-Food Canada
Aurélie Moulin, M.Sc., agr	Agri-Marché
Krystina Dumont, M.Sc., agr	Aliment Breton
Yvan Lacroix, BBA	AQINAC
Marie Despars, agr	Cargill
Laetitia Cloutier, M.Sc., agr	CDPQ
Sylvain Tremblay, agr	DCL nutrition + santé animale
Richard Bilodeau, M.Sc., agr	F. Ménard
Ludovic Lahaye, Ph.D.	Jefo
Dan Bussières, agr	Groupe Cérès Inc.
Jean-Philippe Martineau, M.Sc., agr	Groupe Cérès Inc.
Martine Pelletier-Grenier, agr	Groupe Cérès Inc.
Pierre Lessard, M.Sc., agr	Olymel
Ivan Girard, Ph.D.	Probiotech
Renald Mercier, agr	Shur-Gain/Trouw Nutrition
Francis Simard, M.Sc., agr	Shur-Gain/Trouw Nutrition
Michel Vignola, M.Sc., agr	Shur-Gain/Trouw Nutrition
Frédéric Guay, Ph.D.	Université Laval
Marie-Pierre Létourneau-Montminy, Ph.D.	Université Laval

AQINAC = Association québécoise des industries de nutrition animale et céréalière
CDPQ = Centre de développement du porc du Québec inc.

2. BUILDINGS, EQUIPMENT AND ENVIRONMENT

2.1 Modernization of infrastructure and equipment

Background

Aging infrastructure and the scarcity of skilled labour are currently concerning challenges for owners and managers of swine sector companies. The average age of swine buildings is over 20 years, with the majority of infrastructure built in the 1990s during the industry's period of rapid expansion. A major modernization of livestock structures is therefore required, in addition to the current challenges related to productivity improvement objectives. This need for modernization also applies to environmental control systems in livestock farms. The integration of new technologies should be planned for during the designing of new buildings. In addition, current knowledge would make it possible to construct buildings that are more energy efficient, thereby substantially reducing heating costs.

Priority research themes

- Develop precision farming technologies while promoting data sharing, automation and robotization of production processes;
- Improve the energy efficiency of farms, reduce the use of non-renewable energy and develop tools to model the effect of the integration of different techniques on production cost;
- Develop models of swine buildings promoting eco-construction, including equipment, as well as durable and high-performance materials, to optimize construction and maintenance costs, improve biosecurity and promote integration into the lanscape;
- Develop a smart environmental control strategy based on the real needs of the animals in order to optimize swine comfort and health.

2.2 Animal health and welfare

Background

The environmental conditions for swine farming have a major impact on the health of herds, and therefore their productivity. They also influence consumer perceptions of how we raise animals and therefore play a significant role in our efforts to improve the social acceptability of the swine sector. It is also important to consider emerging issues, such as the challenges associated with the desire to reduce antibiotic use in livestock, the impact of climate change, and new animal welfare requirements.

Priority research themes

- Improve tools for better detection of disease within herds to reduce antibiotic use;

- Develop production systems adapted to the latest animal welfare standards, new consumer requirements and climate change, with a view to "naturalness" of the animal's living environment (e.g. large group, natural light, comfort, etc.)

- Improve management and biosecurity practices to prevent health threats throughout the swine industry (i.e. breeding stock selection, maternity, nursery and feeding, transportation [animals and inputs], food production, artificial insemination centres, manure spreading, etc.).

2.3 Environmental impact

Background

Stakeholders in the swine sector are concerned with reducing the environmental impact of swine farming and protecting the health of their herds, workers and rural communities. The sector has always been proactive in terms of management and actions relating to environmental protection, but the current context requires new efforts. For example, manure is an excellent fertilizer that must be used on agricultural land, and reconciling its advantages and disadvantages will require further efforts.

Sustainable water use would also improve environmental performance. In addition, recent studies have shown that the compilation and analysis of data on water consumption on livestock farms could be enhanced, both to optimize water use and to improve monitoring of animal performance and health.

Priority research themes

- Effectively make use of animal manure according to its agronomic properties and qualities. In particular a reasoned management in two phases maximizing the recovery of nutrients and the circularity of co-products;

- Improve air quality in buildings and reduce emissions into the environment (e.g. gases, odours and bioaerosols);

- Optimize water management in livestock farms, both in terms of quality and quantity, and optimize the use of data on animal water consumption;

- Develop emission factors inventories allowing life cycle analyzes to quantify the gain made by the introduction of new practices and technologies on farm;

- Make modeling tools available to assess the economic impacts of integrating different reducing practices and technologies

Expert groups consulted to identify priorities

NAME	ORGANIZATION
Francis Pouliot, Eng., M.Sc.	CDPQ
Sébastien Turcotte, agr	CDPQ
Yan Martel-Kennes, agr, M.Sc.	CRSAD
Pierre Baril, agr	CRSAD
Pierre Ruel, Eng.	CRSAD
Yves Choinière, Eng., M.Sc.	Consultants Lemay & Choinière Inc.
Rock Joncas, Eng., agr, M.Sc.	IRDA
Stéphane Godbout, Eng., agr, Ph.D.	IRDA
Mathieu Girard, Jr. Eng., Ph.D.	IRDA
Arianne Lévesque, Eng., M.Sc.	IRDA
Johann Palacios, Eng., M.Sc.	IRDA
Raphaël Bertinotti, Eng. ENITAB, M.B.A.	Les Éleveurs de porcs du Québec
Yvan Fréchette, TPA, pork producer	Les Éleveurs de porcs du Québec
Josée Reid, agr, M.Sc.	Les Éleveurs de porcs du Québec
Julie Moreau-Ricard, agr M.P.A.	Les Éleveurs de porcs du Québec
Sarah-Claude Vanlandeghem, Jr. Eng.	MAPAQ
Jacquelin Labrecque, Eng.	Ro-Main
Patrick Brassard, Jr. Eng., Ph.D.	Université de Toulouse
Lorie Hamelin, Eng., Ph.D.	Université de Toulouse
Sébastien Fournel, Eng., Ph.D.	Université Laval
Marie-Pierre Létourneau-Montminy, agr, Ph.D.	Université Laval

CDPQ = Centre de développement du porc du Québec inc.
CRSAD = Centre de recherche en sciences animales de Deschambault
IRDA = Research and Development Institute for the Agri-Environment
MAPAQ = Quebec Department of Agriculture, Fisheries and Food

3. ECONOMY AND MANAGEMENT

3.1 Competitiveness of the Quebec swine industry

Background

Canada is the third largest pork exporter in the world. More than 60% of Canadian pork and pork products is exported, with 45% coming from Quebec. Canada also imports pork from the United States, which is found in Quebec supermarkets. It is therefore essential that the Quebec swine industry be competitive, both nationally and internationally.

The competitiveness of the Quebec swine industry depends on several factors, including the cost of pork production. In the past, improving productivity within companies was the main factor in improving the cost of production. Thus, the productivity gap between the least and most productive companies corresponded to the profit margin gap between these two groups. Recently, however, the productivity gap has narrowed, while the profit margin gap remains high. One of the explanatory variables would be the differences observed in the way companies are managed.

Also, the cost of feed, which is the largest expenditure item on a swine farm, varies from one establishment to another despite similar technical performance. It is important to understand the factors that influence these differences.

Priority research themes

- Identify and validate important elements that would significantly improve the cost of production;
- Identify and quantify the elements that distinguish the top-performing farms (financially) from the average farm.

3.2 Economic issues related to endemic diseases

Background

In Quebec, some collective pathogen control initiatives are implemented in different areas of the province. However, little information is available on the success factors characterizing an area and its companies in cases where control of one or more pathogens is effective (economically speaking). In order to achieve continuous improvement in the control of production costs and the effective management of diseases, it is important to identify success factors.

Priority research theme

- Conduct cost-benefit analyses (CBAs) or cost-effectiveness analyses (CEAs) of collective pathogen control initiatives to identify success factors and make recommendations to the industry as a whole.

3.3 Economic issues related to emerging diseases

Background

The threat of the introduction of emerging diseases into North America is ever-present (e.g. African swine fever, foot-and-mouth disease, etc.), and the economic stakes associated with the arrival of such diseases in our territory are many and not well known. In addition, one of the most important issues is certainly risk management in response to the appearance of one or more emerging diseases.

Priority research theme

- Evaluate different scenarios on the economic impacts of emerging diseases in Canada and Quebec and evaluate various risk management tools.

3.4 Economic impact of reduced antibiotic use

Background

The swine industry has positioned itself on the importance of reducing the use of antibiotics in swine farming. These changes in farming methods have not only an economic impact that must be considered, but also repercussions for corporate management or governance practices.

Priority research themes

- Assess the economic impact of reducing antibiotic use in swine farms, the best management practices to support this transition, and the factors that contribute to the success or failure of the implementation of resulting new farming methods.

3.5 Need for investment in swine buildings in Quebec

Background

Quebec pork companies must catch up with regard to investments in building renovations and the modernization of livestock infrastructure. Such investments are necessary to improve business competitiveness and labour efficiency, but also to adapt to new animal welfare standards and anticipate the needs associated with climate change, at least those that can reasonably be foreseen. A variety of investment incentives are available to producers. The development of tools to help producers make the best choices in relation to anticipated market revenues and the costs involved would prove to be a strategic framework to ensure the competitiveness of companies.

Priority research themes

- Compare the standards and conditions for establishing construction projects between Quebec and other Canadian provinces, as well as the costs associated with them;

- Analyze the impact of anticipated regulatory changes (e.g. regarding animal welfare standards, environmental standards, construction standards, etc.);

- Develop a reference guide and tools to help producers make decisions about their construction projects (new buildings or renovations), with consideration for animal welfare standards, adaptations to be anticipated due to climate change, related construction costs and expected changes in technical performance depending on the type of construction chosen;

- Determine, based on current construction costs (maternity, nursery and feeding), the required income per swine or per 100 kg or per piglet produced (maternity) for planned investments, as well as the amortization period for the capital required.

3.6 Impacts of climate change on swine production in Quebec

Background

Climate change can cause modifications to swine farming conditions in Quebec, potentially impacting swine performance and production costs for pork companies. For example, the latest heat waves have had an impact on swine feeding and mortality. This can also impact the energy efficiency of farms. It is necessary to study the financial impact of this phenomenon, both at the farm level and for the swine sector as a whole, and to assess whether there are any possible repercussions that could affect the competitive position of the Quebec swine sector in relation to foreign competitors.

Priority research themes

- Analyze the impact of temperature variability and frequency of extreme weather events on production and analyze the cost-benefit analysis of proposed adaptation solutions.

3.7 New business models

Background

Rearing methods and business models are changing. Increasing numbers of producers are specializing in one stage of the rearing chain, such as maternity or finishing. In addition, other producers wish to raise pigs in autonomous networks. These changes in the structure of swine farming impact the profit margins of companies, and questions are raised about the various possible model(s).

Priority research theme

- Analyze and assess the various existing and emerging business models.

3.8 Market risk management strategies and revenue protection

Background

The use of profit margin protection strategies by futures markets is gaining in popularity. In addition, the swine sector has developed the Market Risk Management System (SGRM) to facilitate access to US futures markets for producers.

Priority research themes

- Facilitate access to futures markets by improving the supply of existing tools and advisory services;

- Strengthen the capacity of advisors to assess the impact of different profit margin protection strategies through the development of guides or simple tools that integrate livestock producers' production cost data in order to ensure optimal returns for livestock producers.

Expert groups consulted to identify priorities

NAME	ORGANIZATION
Geneviève Berthiaume, B.Sc.A.	CDPQ
Louis-Carl Bordeleau, M.A.	CDPQ
Michel Morin, agr	CECPA
Martin Boutin, agr	CMCA and GCAQ
Benoît Turgeon, agr	GCA
Luc Belzile, M.Sc.	IRDA
Denise Godonou, Eng., M.Sc.	IRDA
Jingran Li, M.Sc.	IRDA
Jean Tanguay, agr	La COOP/OLYMEL
Denis Champagne, agr	Les consultants Denis Champagne
Vincent Cloutier, agr	Les Éleveurs de porcs du Québec
Raphaël Mbombo Mwendela, M.Sc.	Les Éleveurs de porcs du Québec

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
GCAQ = Les groupes conseils agricoles du Québec
IRDA = Research and Development Institute for the Agri-Environment

4. GENETICS AND REPRODUCTION

4.1 Behaviour of sows and feeder pigs

Background

Livestock systems are evolving to address various issues, such as animal welfare. Examples include group management of sows during gestation, the abolition of piglet tail cutting and the addition of enrichment items for feeder pigs. In recent years, research has shown that selection for swine with improved growth is not favourable for improving behaviour between swine (reducing stress and aggression between individuals), which is becoming a problem in commercial production, especially when mixing swine pens or lots. In this context and with a view to improving animal welfare, genetic selection is preferred for improving sow behaviour in order to facilitate group management or the management of feeder pigs. There is also a need to develop measures to evaluate the behaviour of sows and feeder pigs and to develop genetic behavioural evaluation methods.

Priority research theme

- Improve genetics and the environment to optimize the social behavior of group-housed sows and feeder pigs (minimize conflicts/aggression between animals) and enhance its impact on the fertility, productivity and longevity of group-housed animals.

4.2 Growth and evolution curves of characteristics related to slaughter weight

Background

In the context of increasing slaughter weights, there is a need to better understand and assess the relationship between weight gain, feed efficiency, deposition of (lean) muscle and fat, carcass yield and quality, and variability between individuals.

Priority research theme

- Develop growth and evolution curves for economically-important traits related to the increase in slaughter weight.

4.3 Sow longevity/reproductive life

Background

The increase in sow productivity is negatively correlated with reproductive life (the number of days in production). In addition, it appears that the sow mortality rate is increasing and culling rates are relatively high. Thus, it would be important to better understand the different risk factors leading to early culling or mortality and to develop ways to improve sow longevity through genetic selection.

Priority research theme

- Improve sow longevity through a better combination of genetic and environmental factors by identifying factors leading to increased mortality rates in commercial sows (prolapses, plumbs, etc.) and by developing automated technologies allowing better monitoring of animals in a context of limited manpower and expertise.

4.4 Disease resilience

Background

Improving the health of growing pigs and sows, whether through their resilience, resistance or disease resistance, is a major challenge for the swine sector. Currently, genetic selection is carried out in nucleus herds with very high health status. The genetics from the selected animals are transmitted to commercial herds, which have a lower health status. This pyramid-shaped production scheme has the disadvantage that natural selection for certain pathogens present on commercial farms is not carried out in nucleus herds. Ultimately, the goal is to achieve overall resilience to all diseases, although currently some diseases such as PRRS and post-weaning diarrhea are more problematic. It is therefore essential to identify how to improve genetic selection for disease resilience and develop selection methods to achieve this more effectively (e.g. marker or genomic selection, new phenotypes, etc.).

Priority research theme

- Improve resilience to disease through a better understanding of genetic factors and their interactions with other factors (e.g. environment, diet, health, management, etc.)

4.5 Genetic anomalies

Background

Frequencies of genetic abnormalities should be monitored more closely when the number of genetic sources is limited, or in the case of purebred swine populations with high selection pressure. In addition, animal welfare and health are major issues in the swine sector. The development of anonymous epidemiological databases to identify problems is important in order to monitor the temporal evolution of the different anomalies and to obtain reliable references on their rates within populations. In addition, it is necessary to understand the contribution or effect of genetics in relation to the animals' environment and to identify the genetic mechanisms involved (genetic markers, copy number variation, transcriptomics, DNA methylation, etc.) in order to reduce the incidence of anomalies.

Priority research theme

- Reduce the frequency of genetic abnormalities observed in swine populations (e.g. sudden deaths, scrotal hernias, umbilical hernias, etc.).

- Develop and promote partnerships and exchanges of information with artificial insemination centers to respond effectively to the main challenges in terms of genetic defects within the sector.

4.6 Mortality from birth to weaning

Background

The rate of mortality from birth to weaning is very high in swine production, especially in high-performance herds. This is becoming an issue both for animal welfare and for the development of labour and the profitability of livestock farming. More specific elements to be developed using genetic selection include sow mammary development, quantity and quality of colostrum produced, uniform birth weight of piglets, consumption and feed efficiency of lactating sows.

Priority research theme

- Reduce the pre-weaning mortality rate through a combination of genetic and non-genetic factors in order to optimize profitability, sustainability and animal welfare in the farrowing units.

4.7 Semen conservation and quality

Background

Sow fertilization and gestation rates and litter sizes at birth are among the most important parameters of livestock profitability. Techniques for screening for chromosomal abnormalities related to these parameters could be developed to detect them more quickly, accurately and reliably. In addition, the study of genetic variability between boars for semen quality parameters related to fertility would identify new traits to be selected. The development of databases based on data collected during homosperm insemination under commercial conditions would also be an approach to be explored in order to select the most fertile boars.

Priority research theme

- Improve semen conservation and quality through screening techniques for chromosomal abnormalities and a better understanding of genetic and environmental factors influencing the quality and suitability for storage of semen.

- Develop and promote partnerships and data exchanges with artificial insemination centers to respond effectively to the main challenges in terms of semen quality within the sector.

4.8 Semen reproduction and sexing techniques

Background

Semen sexing has the potential to improve the spread of genetics within swine populations and eliminate the need to castrate intact males through the production of females. It is therefore important to develop technologies for semen sexing as well as techniques to reduce the number of sperm per insemination dose without affecting fertilization rates. This last point is necessary because sexing the semen will reduce the number of sperm produced by the boar.

Embryo transfer is also a very useful technique for sharing or exchanging genetics between breeders to reduce the risk of disease transmission between herds. Thus, it would be important to improve embryo transfer techniques and to address the regulatory issues of products used for the decontamination of embryos during in vitro fertilization.

Priority research theme

- Improve insemination, embryo transfer and semen sexing techniques.

4.9 Methods of analysis of big data on animal performance

Background

The development and implementation of new technologies generate a large amount of data, which requires new means to fully make use of and exploit this information. It is therefore necessary to develop analysis tools to use big data for practical applications, such as genetic improvement. This research theme includes the field of machine learning, which is a field of study of artificial intelligence, -omics (genomics, transcriptomics, etc.) and epigenetics.

Priority research theme

- Develop methods for the analysis of big data on animal performance and genomics, for the purposes of practical applications of digital technology and artificial intelligence in farm, with the aim of making the best use of the genetic potential under pig farming conditions.

4.10 Genetic programming (epigenetics)

Background

Epigenetics is the study of the influence of environment on gene expression (reversible, transmissible, adaptive) without changing the nucleotide sequence of DNA. The literature clearly shows the effects of genetic (epigenetic) programming on embryonic development, among other things. To our knowledge, the only practical application to date in swine production is the use of the parental imprint effect of the IGF2 gene. The application of treatments to breeding animals to positively influence the performance of offspring has a real untapped potential. For example, developing parental feeding or management practices that positively affect the genetic programming of descendants.

Priority research theme

- Develop genetic programming (epigenetics) practices in order to use the environment to modulate the expression of certain genes (eg sow nutrition, fetal programming, immune programming, etc.)

4.11 Genetics and microbiome

Background

The microbiome (set of genes present in a microbiota) is associated with the health and performance of swine. Studies of microbiota (all microorganisms living in a given environment in a host or material) will allow the development of projects aimed at the practical application of this knowledge for genetic selection purposes. It is therefore important to have a better understanding of the relationship between genetics, microbiome and environment (P = G + M + E), as well as the transmissible component of the microbiome from sows to piglets. Studies on prebiotics and probiotics may also be of interest if there is an evaluation of their interaction with animals' genetics and a possibility of genetic selection.

Priority research theme

- Study the microbiome and its interactions with genetics and the environment for possible practical applications ((eg reduction in the use of antibiotics and zinc).

Expert group consulted to identify priorities

NAME	ORGANIZATION
Alexandre Cloutier, agr	Agri-Marché
Laurence Maignel, M.Sc.	CCSI
Frédéric Fortin, M.Sc., agr	CDPQ
Nick Coudé, M.Sc., agr	CIPQ
Éric Aubin	DNA Genetics
Richard Bilodeau, M.Sc., agr	F. Ménard
Christian Blais, agr	Gène-Alliance inc.
Dan Bussières, agr	Groupe Cérès inc.
Raphaël Bertinotti, Eng. ENITAB, M.B.A.	Les Éleveurs de porcs du Québec
Marquis Roy, agr	Olymel
Daniel Godbout, M.Sc.	PIC Canada
Claude Robert, Ph.D.	Université Laval

CCSI = Canadian Centre for Swine Improvement Inc.
CIPQ = Centre d'insémination porcine du Québec inc.
CDPQ = Centre de développement du porc du Québec inc.

5. MEAT QUALITY

5.1 Impact of disease on the quality of produced meat

Background

The various animal tissues, including muscle and adipose tissue, have the ability to adapt morphologically, physiologically and metabolically to various stimuli, a capacity called plasticity. Among the stimuli, the energy balance undoubtedly plays a central role and is in turn influenced by the quality of inputs and the scale of expenditures. In this context, it is likely that diseases will have an impact on the physicochemical properties of these tissues and consequently on the quality of the meat produced. Knowledge about the impact of diseases on the technical and economic performance of swine production is constantly increasing, but little research has been done on the impact on meat products. It is therefore becoming important to understand the impact of diseases on the physicochemical characteristics of meat and the mechanisms involved.

Priority research theme

- Assess the impacts of different diseases on the physicochemical characteristics of meat and shed light on the mechanisms involved.

5.2 Boar taint and meat quality

Background

Animal welfare standards and consumer demands for animal welfare are constantly increasing. Among the practices criticized in swine production are the castration of piglets and the methods used. Several European countries have already put forward stricter standards, even requiring the abandonment of physical castration. However, the boar taint that can develop and be found in meat is a major problem for meat quality, particularly for an exporting country such as Canada that is known for the quality of its products. Various alternatives exist, and others remain to be developed. In any case, it is important to validate their effectiveness and establish reliable control methods adapted to the realities of farms and factories.

Priority research theme

- Identify or develop alternatives to castration to control boar taint, as well as detection methods to validate their effectiveness and control carcass quality.

5.3 Antibiotic reduction and carcass and meat quality

Background

In the current context of reduced antibiotic use in animal production, it is essential to understand the potential impacts on carcass and meat quality. It is important to determine whether this reduction will result in an increase in the condemnation of certain parts of the carcasses (e.g.

more frequent abscesses) or will allow certain species of undesirable bacteria to proliferate and potentially affect the shelf life of the products. The potential economic impacts are major and, depending on the answers to these questions, alternative strategies will be needed to ensure that zootechnical performance, carcass value and product quality are maintained.

Priority research theme

- Determine the impact of reduced antibiotic use on carcass and meat quality and develop alternative approaches.

5.4 Pre-slaughter stress and product quality

Background

Pre-slaughter stress is undoubtedly a key issue for meat quality. Over the years, research has improved pre-slaughter practices to reduce stress. Nevertheless, even today, pre-slaughter stress remains a major issue, since a multitude of steps are potentially stressful and responses vary from one individual to another. In addition to continuing research to reduce stressors, this aspect of variable stress response merits more research, particularly to determine whether there is a genetic component large enough to allow selection within the population.

Priority research theme

- Better understand stress factors, including individual variations, and determine if there is a genetic signature for stress sensitivity.

5.5 Microbiota and meat safety

Background

In recent years, an increasing number of fields of biology have become interested in the microbiota, i.e. the bacterial populations that surround us. The intestinal microbiota represents a major field of research for improving animal performance, as well as the safety of meat. Meat is an ideal growth medium for many bacteria, and although slaughter processes are designed to reduce contamination and microbial load, there is still a certain amount of bacteria. Fortunately, these are very often harmless and can even be beneficial by inhibiting the growth of unwanted species. In this context, it is becoming important to better understand the intestinal microbiota and its impact on product safety in order to implement control strategies.

Priority research theme

- Understand the influence of the intestinal microbiota on meat safety and develop control strategies.

5.6 New technologies for evaluating carcass and meat quality

Background

Swine are graded primarily by carcass weight and muscle and fat thickness measured using a Destron probe. Although these measurements provide valuable information and have improved the quality of carcasses, they are not always indicative of the real value of the different cuts. The pork industry needs reliable, accurate and affordable technologies to determine the values of different cuts and thus continue to improve its products. This is all the more true in the current context where spare parts for the probes used are no longer available. The technologies could also be used to measure or estimate other important parameters related to meat quality and thus support its continuous improvement, a hallmark of the Canadian product.

Priority research theme

- Propose technologies to assess the composition, quality and economic value of cuts and carcasses for different budgets.

5.7 Product safety and quality

Background

Quebec has a strong reputation in export markets for the quality of its pork products. In order to ensure that this brand image is maintained, the shelf life of fresh products must be improved and increased to promote their exports to lucrative, but often very distant, markets. Several factors, including the physicochemical quality of the product (pH, humidity, etc.), the working environment or storage temperature, influence the development and proliferation of microorganisms responsible for the deterioration of products and their shelf life. It is therefore important to continue research on solutions to improve the shelf life of fresh pork products.

Priority research theme

- Find solutions to improve the shelf life of meat products and cuts to meet the requirements of different markets.

Expert group consulted to identify priorities

NAME	ORGANIZATION
Claude Gariépy, Ph.D.	Agriculture and Agri-Food Canada
Marie-Pierre Fortier, Ph.D. Cand.	CDPQ
Dan Bussières, agr	Groupe Cérès inc.
Eric Pouliot, Ph.D.	Olymel
Michel Vignola, agr	Trouw Nutrition
Linda Saucier, Ph.D., agr	Université Laval

CDPQ = Centre de développement du porc du Québec inc.

6. HEALTH

6.1 Characterization and pathogenesis

Background

Porcine reproductive and respiratory syndrome (PRRS) causes significant losses in Quebec swine farms, averaging between $38 M and $50 M annually. Comparison of PRRS virus sequences (partial ORF5, or complete) allows us to advance our knowledge of the circulation and mutations of this virus in Quebec's swine population.

Influenza, a zoonotic disease, could also result in annual losses as significant as those of the PRRS. New sequencing techniques for this virus would advance our knowledge of the circulation and mutations of this virus in Quebec's swine population.

Finally, *Streptococcus suis* infection is another zoonotic disease that affects even herds with high health status. There is a real need for the development of an effective vaccine against this bacterium, especially since it re-emerges in swine farming systems without antibiotics.

Priority research theme

- Characterize pathogens and identify virulence factors as well as factors related to the development of immunity against PRRS virus, influenza and *Streptococcus suis*.

6.2 Disease diagnosis methods

Background

New techniques for the complete sequencing of the swine genome make it possible to envisage more precise diagnosis of diseases. There is also a need to develop tools and expertise to better understand how to interpret and use the results of analyses obtained, including differentiating between active and inactive viruses, or vaccine immunity versus wild strain immunity. On-farm or near-farm disease detection kits are also required. This need addresses many issues, including the need to reduce on-farm antibiotic use.

It is also important to promote the use of behavioural and physiological measurement data from swine (e.g. water consumption, food intake, behaviour, body temperature – individual or group measurements) to enable earlier detection of health problems. Artificial intelligence can help to address this challenge.

Priority research themes

- Develop and improve diagnostic and sampling methods for PRRS, influenza, porcine epidemic diarrhea and African swine fever viruses;
- Develop methods for early detection of health problems.

6.3 (Collective) surveillance: Endemic and emerging diseases

Background

Surveillance of endemic and emerging diseases promotes the implementation of collective and individual actions to prevent the spread of diseases and better control them. The importance and positive impact of this type of action is recognized. Collection and analysis tools for disease surveillance must continue to be developed and improved. Funding for these recurring disease surveillance activities must also be provided at the federal, provincial and local levels.

Priority research theme

- Develop collection and analysis tools for surveillance of PRRS, influenza and emerging diseases and ensure stable funding.

6.4 Epidemiology: Infectious and non-infectious diseases

Background

For the purpose of effective disease surveillance and control, it is necessary to draw up portraits representing the proportions of animals and/or farms affected by various diseases. In addition, it is essential to properly assess the relative importance of various factors such as husbandry practices, transport, manure spreading, regional (neighbouring) exposure and others on the prevalence of infectious and non-infectious diseases, as well as on the transmission of pathogens between animals and between farms.

Priority research theme

- Assess the prevalence of risk factors and modes of transmission of infectious and non-infectious diseases (e.g. hernias, umbilical hernias and prolapse).

6.5 Prevention and control

Background

The transmission of pathogens has a very significant economic impact on the industry. We must develop new tools to be more effective in our prevention and control actions. For example, prevention and control can be achieved through vaccination and biosecurity programs. It is necessary to explore new technologies for the manufacture of vaccines and adjuvants, as well as for vaccine delivery (e.g. aerosols, mixtures, etc.). It is also important to ensure that regulations facilitate the use of auto-vaccines, new vaccination tools and tools available in other countries.

Good biosecurity measures on farms and during animal transport must also be developed. Implementation of existing measures, both on the farm and during animal transport, also needs to be improved. In particular, the integration of procedures within companies is not always

optimal, so it is necessary to continue to make progress in the implementation of good biosafety practices.

Transportation management strategies (logistics), disease eradication strategies based on farm type, and the use of control groups (GDC, Network, CLÉ, etc.) are essential for disease prevention, control and eradication. A great deal of data is available and it is essential for developing analysis and decision-making tools to create more added value with the information collected, particularly with traceability (movements of swine) and province-wide swine health monitoring (VSP) data.

Clean premises and improved washing methods, especially for trucks, are essential to prevent disease. These operations are time-consuming and impact the cost of production. The development of faster, more effective and less expensive methods is important, as well as the development of rapid testing and strategy validation methods to determine the effectiveness of washing and disinfection, particularly according to environmental conditions.

Priority research themes

- Develop vaccines, especially for diseases of economic importance;
- Develop and assess measures to prevent, control and eradicate diseases, both at the farm level and collectively;
- Improve facilities, tools and procedures to facilitate the integration and application of biosecurity measures on the farm and during transport;
- Develop decision support tools for disease prevention and control, based on available data;
- Identify possible improvements to increase the efficiency of washing and disinfection methods for transport vehicles.

6.6 Welfare and behaviour

Background

Producers are concerned about improving their breeding practices and the welfare of their animals. The search for appropriate methods of euthanasia addresses this concern.

Priority research themes

- To have the technique of euthanasia by electrocution with a low voltage (110 Volts) recognized for swine over 68 kg;
- Explore other methods of euthanasia, including those using gas.

6.7 Wise use of antibiotics

Background

The wise use of antibiotics is required to counter the development of antibiotic resistance in animals and humans, but also to promote social acceptability. In particular, antibiotics can be used in water, allowing for more targeted treatment, rather than in feed, which requires the use of larger quantities of antibiotics over a longer period of time. In order to facilitate decision-making in relation to animal treatment, it is also necessary to develop and ensure recurrent funding for tools for the electronic collection and analysis of data on antibiotic use.

Also, several studies show that it would be beneficial for the reduction of antimicrobial use to optimize piglet microbiota and rearing methods. Research on these aspects must therefore also be carried out.

Priority research themes

- Promote the wise use of antibiotics, in particular by training producers and stakeholders and monitoring the quantities used;
- Assess the impact on performance, production cost, changes in microbiota and presence of resistance, treatments or methods alternative to antimicrobial use and develop new ones.

Expert group consulted to identify priorities

NAME	ORGANIZATION
Martin Choinière, DVM	AQINAC
Daniel Richard, M.Sc.	AQINAC
Christian Klopfenstein, Ph.D., DVM	CDPQ
Sylvain Messier, DVM	Demeter Services Vétérinaires inc.
Sylvie D'Allaire, DVM	Faculty of Veterinary Medicine
Carl A. Gagnon, Ph.D., DVM	Faculty of Veterinary Medicine
Gilles Bergeron, agr, pork producer	Les Éleveurs de porcs du Québec
Raphaël Bertinotti, Eng. ENITAB, DVM	Les Éleveurs de porcs du Québec
Yvan Fréchette, TPA, pork producer	Les Éleveurs de porcs du Québec
Josée Reid, agr, M.Sc.	Les Éleveurs de porcs du Québec
Caroline Wolfe, pork producer	Les Éleveurs de porcs du Québec
Claudia Gagné Fortin, DVM	MAPAQ
François Cardinal, M.Sc., DVM	TRIPLE V
Stéphane Laberge, agr	RSB

AQINAC = Association québécoise des industries de nutrition animale et céréalière
CDPQ = Centre de développement du porc du Québec inc.
RSB = Réseau Santé Beauce