GEORGE MORRIS CENTRE

*Canada's Independent Agri-Food Think Tank*

# International Review of Swine R&D in Alberta
## FINAL REPORT

Prepared for: The Alberta Agricultural Research Institute (AARI) and the Alberta Livestock Industry Development Fund (ALIDF)

Attention:
Freda Molenkamp
Alberta Agricultural Research Institute
9th Floor N., 10365 – 97 Street
Edmonton, AB T5J 3W7
(780) 422-6570
Freda.Molenkamp@gov.ab.ca

Prepared by:
Kevin Grier, Kate Stiefelmeyer, Al Mussell
George Morris Centre
225-150 Research Lane
Guelph, Ontario
N1G 4T2
Telephone: 519-822-3929 ext 202
Fax: 519-837-8721
Contact email: kevin@georgemorris.org

Date: October 6, 2006

# Executive Summary

The purpose of the project is to assess the value and role of the Swine Reproduction and Breeding Herd Management Program (Swine Reproduction), the value and role of the Swine Nutrition Program, and to provide insight into what a future Swine R&D Program should focus on for Alberta in the Western Canadian context.

In order to address this purpose, the AARI and ALIDF have determined that the following objectives must be met:

1. Assess the historical impact that the Programs have had on the Alberta, Western Canadian, and international swine industries
2. Assess the current impact that the Programs have had on the Alberta, Western Canadian, and international swine industries
3. Assess the future impact that the Programs will and can have on the Alberta, Western Canadian, and international swine industries (and other possible future industries)
4. Assess the most vital areas of research and development (R&D) focus for a future Swine Program over the next ten years, based on the current and future industry opportunities and challenges
5. Determine the most effective role that a future Swine R&D Program can play in the Western Canadian context, especially in relation to existing resources and infrastructure in Western Canada
6. Conduct an assessment of other similar programs around the world and briefly assess the impact they have had on their respective industries
7. Identify the future requirements/components of a successful swine R&D Program (including budget, staffing, governance model, partnerships/collaborations, level of scientific excellence, etc) for Alberta in the Western Canadian context

**The Programs Described and Evaluated**

The Swine Reproduction and Development Program (SRDP) builds upon two main areas of pork research. One is swine nutrition, under the leadership of Dr. R. Ball, and the other is swine reproduction and breeding herd management, guided by Dr. G. Foxcroft. Both of these lead researchers are in collaboration with other SRDP researchers. Dr. Ball is an expert in the study of amino acid requirements and metabolism. Dr. Foxcroft is a Canada Research Chair in Swine Reproduction Physiology and has expertise in the application of basic research to improving the efficiency of breeding herd management.

These two main programs occur at the University's Swine Research and Technology Center (SRTC). The Center is committed to research, training and technology transfer for the pork industry. The SRTC consolidates swine operations at the Edmonton Research Stations, providing an integrated site for swine research on nutrition, reproduction, environmental management and medical research.

The research of both Foxcroft and Ball is focused, almost exclusively, on economic returns to swine production. In particular, it is focused on reduced costs of production and increased returns, which result from the following:

- better feed conversion and daily rates of gain
- more effective usage of feedstuffs
- lower death loss
- greater numbers of pigs per litter
- improved growth rates
- more effective breeding herd management and selection
- increased value of culls

The research programs established and built by Foxcroft and Ball have been successful from a number of important perspectives. Essentially, the impacts of the two programs were to establish the University of Alberta as a world leader in swine nutrition and swine reproductive technology. From academia through the private sector, both Foxcroft and Ball are highly regarded and well respected leaders and contributors to the scientific component of the swine industry. The research resulting from these two programs has provided the industry, particularly producers in Alberta, with financial benefits very conservatively estimated in the hundreds of millions of dollars. The research has also supplied other academics around the world with standards and guidance for their own research initiatives. The work of the two programs at the University of Alberta also created advances that allow leading companies in the feed, genetics and nutrition sectors to better serve the producer sector across Canada.

**Future Direction**

Looking to the future, the industry in Alberta must recognize the following basic factors:

- Alberta producer check off money for research programs will become increasingly scarce. Furthermore, those producers that remain in the industry will be much larger and more focused than ever on the allocation of check-off and research dollar expenditures.
- Access to export markets is crucial. Key barriers to entry will include animal health issues, as well as animal welfare and consumer safety issues, both real and imagined.
- In domestic markets, as with export markets, consumer safety and product differentiation will be important from a marketing as well as market demand perspective.
- Within both export and domestic markets the need for competitively produced and priced pork products will continue to be the most important market driver.
- The drive for alternative fuels has both positive and negative ramifications for feed costs. On the positive side, there could be increased access to cheaper bio-fuel based byproducts. On the negative side, this increased demand could increase the cost of feed grains.

Based on George Morris Centre understanding of industry priorities and challenges, the listing below provides guidance regarding some of the swine research priorities of the future:

- There is a need for research into feed grain productivity, quality and yields. This is necessary in order to address the growing lack of productivity on the prairies, relative to competing regions in the US.

- The potential negative impacts of swine disease and health challenges are obvious. Research into causes and prevention of swine health challenges is a very important priority now and in the future.
- There is a need for research into alternatives to antibiotics. Consumers, domestically and internationally, are demonstrating an aversion to meat from livestock treated with antibiotics. It is thought necessary to develop antibiotic alternatives in order to ensure continued export access and domestic market development.
- As of now, it is too early to tell whether alternative fuels are going to be harmful or beneficial regarding feed grains costs. This is a future issue, however, and the pork industry needs to understand how to utilize and benefit from the by-products of this feed sector.
- There is a need to focus on improved reproduction and nutrition productivity. There are no two issues more important to swine competitiveness than increased nutrition efficiency and improved breeding herd productivity. Both of these areas address cost reduction and revenue enhancement and both issues will always be important. There will always be a need to focus on swine nutrition and reproductive technologies if there are going to be serious efforts made in productivity and competitiveness.

Before considering future actions, however, the funding bodies and Alberta Agriculture, Food and Rural Development need to address a basic question: Should Alberta be a player in the world of swine research and development? In other words, is it advantageous for Alberta to support and maintain such a capability?

The consideration of this question, strictly on the basis of industry size and current growth trends (which have been flat), suggests a response that could easily be: "Why bother!" Clearly it can be argued that the research needed to benefit Alberta production can and will occur elsewhere. Thus, the province's producers would simply adopt and adapt research findings as they emerge. Further, if one were to ask whether there are truly nutrition and reproduction issues specific to Alberta, these too may be difficult to identify. Thus, from a purely practical and perhaps even mercenary perspective, a positive response to the most fundamental question posed above may find little support.

However, the role of swine research and development within Alberta should be considered from a broader strategic perspective and the province's potential as a major producer and exporter of agri-food products. Clearly, a signal (such as reduced or discontinued funding) to curtail swine research sends a very clear message that swine production is not an area of strategic interest to the province of Alberta.

Despite current competitiveness concerns, specifically in the area of feed grains, Alberta is well suited for livestock production. It has a large land base (hence very low livestock densities), the ability to produce large quantities of feed grain, and a limited human population thus reducing the risks of conflict between producers and non-farm residents. Furthermore, more than one-half of Alberta's agri-food processing and production is directly related to livestock and livestock products. Clearly, the growth and health of the province's agri-food industry is inextricably tied to a healthy livestock sector.

A positive response to the question then leads to additional questions:

1. What areas of swine research make a meaningful and relevant contribution and are, perhaps, even in a lead position?
2. How can Alberta maximize return on research investments while minimizing duplication?

These questions are addressed by recognizing the following points:

1. Recognize the international nature of the swine industry and the scope of swine research and development. This characteristic demands a singularity of focus and a clear commitment to building research strengths in selected areas. The approach of trying to be all things to all people is simply a formula for mediocrity leading to little or no success.

2. Recognize the inherent tension between the practical short-term interests of producers and the long term, at times seemingly uncertain, or perhaps even obscure objectives of basic research. This tension is a fundamental dynamic of the industry, and the challenge for research funding providers and the swine industry is to transform this dynamic into a creative force rather than a conflicting one.

3. Understand that focused research capacity, in and of itself, creates opportunity. Without capacity (principle investigators, technicians, facilities and equipment), nothing can happen. This observation flows from the principle that success builds success and ideas create new ideas.

4. Commit to building and deepening those areas in which strength, reputation and results have already been established. Alberta has already had the good fortune of having built capability in the areas of amino acid metabolism and reproductive physiology. Clearly, this capability revolves around the leadership of two key individuals. Now is the time to broaden the leadership and build the strength of these programs.

5. Commit to a research priority selection process that is iterative in nature. This requires a structured process that solicits direct input from practical production concerns versus the pure research interests of the scientific community.

6. Commit to facilitating a more formalized national swine R&D roundtable to collaborate, establish priorities and allocate research to centres best suited based on strengths. The time has come for industry organizations and research institutions within Canada to develop a more strategic approach to swine research.

   This roundtable process should involve an administrative function involving provincial pork bodies as well as the Canadian Pork Council. The administrative function would be responsible for keeping a national accounting of pork research funding and projects as well as project results. This would assist the process of priority setting, and potential collaboration, as well as helping to ensure that duplication is kept to a minimum. Furthermore, this national framework would also help establish funding responsibilities. In particular, the national roundtable could place accountabilities on different

beneficiaries of research as well as governments. It could set guidelines for funding basic and applied research.

7. Use the national roundtable experience to begin the establishment of an international roundtable including US, Netherlands, Denmark, China, and Brazil. It follows that if Canada can successfully establish a national swine research and development roundtable, it can play a key role in facilitating an international roundtable. In both cases, the Banff Pork Seminar is an ideal setting to begin both national and international processes.

8. Seek and facilitate the formation of national and international sources of funding. The international nature of swine research and development requires that Alberta no longer proceed in a 'go it alone' manner. The establishment of a national swine research & development roundtable coupled with clear centres of expertise will clearly assist this process.

Fundamentally, with regard to the framework for future research, this paper is effectively arguing in favor of the status quo, but with an important caveat. That caveat is that the swine industry needs to provide its own research structure and priorities. This will help assure government funding bodies such as AARI and ALIDF, as well as the Agriculture Funding Consortium, that the industry is working on top priorities and that Alberta has a valid and constructive role within that structure. That is to say, this endeavor is saying that the industry and funding providers in Alberta should keep moving forward. The move forward would be toward increasing the swine research funding structure and framework to ensure higher levels of comfort for funding providers and higher levels of achievement for the industry.

Another key point to note is that while national priorities and frameworks are very important, they do not take away the competitive marketplace of ideas that Alberta has wisely developed with regard to funding. Instead, the framework will give reassurance to the funding bodies that the competitive marketplace is indeed well focused on swine industry priorities.

# Table of Contents

# 1.0 Introduction, Purpose and Objectives

## 1.1 Introduction

The Alberta Agricultural Research Institute (AARI) was established by the Alberta Science and Research Authority Act. The Institute funds numerous projects each year that play a role in attempting to advance Alberta's position in the agriculture and food sector across the world. Its mission is to enhance the economic contributions of the Alberta agricultural and food industry through support for research, development and technology transfer.

The Alberta Livestock Industry Development Fund (ALIDF) was initiated in 2001 to support research and development projects that contribute to an environmentally and socially responsive livestock industry. ALIDF is a multi-commodity livestock organization which funds projects that aeffect: environmental sustainability, food safety and quality assurance, animal welfare, value-added development, and education and communication.

Government and private industry have long recognized the benefits, returns and economic impacts resulting from agricultural research and development. While that is generally agreed, both government and private industry have also needed to develop processes and mechanisms to demonstrate the return on the R&D investment dollar. For their part, producer associations, who are often direct financial supporters of agricultural R&D, also wish to track the returns to their funds. Beyond those basic cost and benefit goals, there is also the need to generate information to support strategic decision-making with regard to agricultural R&D policies, priorities, and resource allocation. The basic question or problem is how to allocate limited research funds and obtain the maximum possible return on R&D investment.

Further to their respective mandates, AARI and ALIDF invited proposals to conduct an international review of the Swine Research and Development Programs at the University of Alberta. There are two specific programs under review: the Swine Reproduction and Breeding Herd Management Program, and the Swine Nutrition Program. This review will also provide insight into the swine R&D programs that Alberta may require in the future. Alberta Pork is also an active participant in this review, given that it has been a strong financial supporter of the swine research programs at the University of Alberta.

Each aspect of the review will be conducted within a Western Canadian context, acknowledging other research programs in the West. This is important because the University of Manitoba is developing a major new multi-disciplinary agriculture research structure that will place significant holistic solutions emphasis on swine management and production systems in Western Canada. In addition, the Prairie Swine Centre in Saskatoon is very active as a non-profit research and technology corporation. It is making a contribution to the swine industry by providing research, education and technology transfer directed at pork production.

Currently at the University of Alberta, Professor Ronald Ball is the lead Swine Nutrition Program researcher and Professor George Foxcroft is the lead Swine Reproduction and Breeding Herd Management Programs researcher. Both are faculty members at the University's Department of Agricultural, Food and Nutritional Science. Dr. Foxcroft and his research team

are investigating physiological aspects of sow and gilt reproduction and are looking for quick, effective ways to assess boar fertility and semen quality. Dr. Ball is committed to finding ways to reduce feed costs through an improved understanding of amino acid requirements for health and growth of pigs and is also developing rapid tests to determine the amino acid composition of feedstuffs.

## 1.2 Purpose and Objectives

The purpose of the project is to assess the value and role of the Swine Reproduction and Breeding Herd Management Program, (Swine Reproduction) the value and role of the Swine Nutrition Program, and to provide insight as to what a future Swine R&D Program should focus on for Alberta in the Western Canadian context.

In order to address this purpose, the AARI and ALIDF have determined that the following objectives must be met:

1. Assess the historical impact that the Programs have had on the Alberta, Western Canadian, and international swine industries
2. Assess the current impact that the Programs have had on the Alberta, Western Canadian, and international swine industries
3. Assess the future impact that the Programs will and can have on the Alberta, Western Canadian, and international swine industries (and other possible future industries)
4. Assess the most vital areas of research and development (R&D) focus for a future Swine Program over the next ten years based on the current and future industry opportunities and challenges
5. Determine the most effective role that a future Swine R&D Program can perform in the Western Canadian context, especially in relation to existing resources and infrastructure in Western Canada
6. Conduct an assessment of other similar programs around the world and briefly assess the impact they have had on their respective industries
7. Identify the future requirements/components of a successful swine R&D Program (including budget, staffing, governance model, partnerships/collaborations, level of scientific excellence, etc) for Alberta in the Western Canadian context

## 1.3 Research Perspective

The AARI website notes that there are three main groupings of returns on the investment in agricultural research: economic benefits; consumer gains, and indirect benefits. Specifically AARI notes the following “rewards from agricultural research and development”:

- Economic Benefits
  - reduced average costs of production
  - increased returns from higher yields
  - improved quality of products
  - improved disease and insect resistance
  - new uses for agricultural products
- Consumer Gains

  - more abundant supplies of food
  - improved food quality and safety
  - lower costs
- Additional Indirect Benefits
  - greater employment
  - thriving rural communities
  - increased exports
  - improved rural infrastructure
  - environmental sustainability

While the benefits and rewards to research may appear to be generally clear or even obvious, there remains the economic challenge of measurement. This is a challenge because often the rewards are intangible, indirect or a result of a number of factors combined. Furthermore, there is no one economic standard for measurement and reporting. As a result, there has been a relatively large volume of economic literature that examines the different methodologies associated with measuring the returns from agricultural research. In fact, the economics of agricultural research has evolved to become an important discipline within the agricultural economics profession.

It is of interest to note that during the 1970's, agricultural economists tended to utilize analytic methods that focused on inputs saved in the production process. For example, economists would measure the volume of fertilizer utilized for a given crop yield compared to the amount of fertilizer which has been technologically changed as a result of research. Another example would be to measure the reduction in days to market and feed usage as a result of research enhanced nutrient formulations.

According to the 2001 Canadian Journal of Agricultural Economics paper entitled "Returns to Canadian Swine Research," the economic surplus approach has evolved to become the most common method used to analyze the returns.[1] This approach characterizes the benefits from research as the changes in consumers' and producers' surpluses that occur as commodity demand or supply curves shift in response to technological changes attributed to research. These producer and consumer surpluses relate to the increases in quantity and quality produced as a result of research. These economic surpluses are in fact the resulting benefits for both producers and consumers. From that point, benefit (the surpluses) and cost ratios can be estimated.

With regard to that 2001 "Returns to Canadian Swine Research" paper, its purpose was to present estimates of the returns to Canadian federal swine research. It considered research expenditures between 1974 and 1997. The estimates were obtained using Agriculture and Agri-Food Canada's Canadian Regional Agricultural Model (CRAM). The economist authors of the study found that overall, Canadian federal swine research expenditures were found to have generated high rates of return. The net present value of the results of the research was found to range from $7.6-12.1 billion in constant 1996 dollars. The benefit-cost ratio was found to range from 6.4 to 22.4. That is, for every dollar invested in swine research, the returns to that research amounted to between 6.4 and 22.4 dollars.

[1] Returns to Canadian Swine Research, Brinkman et al, Canadian Journal of Agricultural Economics, July 2001.

### 1.3.1 Perspective Summary

Past work investigating the broad value of swine research in Canada has shown significant benefits. This work was done by taking two different approaches. Under one approach, the value of productivity improvements obtained through research is estimated retrospectively in terms of the additional inputs that would have been required historically to obtain current period productivity. In this sense, the benefit of research is measured in the value of inputs saved. Under a second, more contemporary approach, the benefits of research in increasing productivity are interpreted and used to shift the aggregate supply function for the product. The increased productivity increases the product's quantity sold and decreases its price, which increases the surplus to consumers and shifts producers' surplus. The net effect of these surplus changes is interpreted as the benefit of the research. Using this latter approach, returns to investments in swine research in Canada have ranged from 50% to more recent estimates of 98-145%. Thus, at a sector level, swine research has a large and measurable net benefit.

## 1.4 Project Methodology

The returns to agricultural research and, in particular, swine research can be measured from a micro or a macro perspective. From a micro perspective the investigation of the benefits could look specifically at a particular research project and its results. Conversely the analysis could, as in the case of the 2001 swine research project, look in retrospect at the costs and benefits of a wide body of research on the entire swine industry.

For the purposes of this project, a hybrid approach with both micro and macro perspectives has been adopted. From a micro perspective, the analysis will utilize the Prairie Swine Centre/George Morris Centre swine enterprise simulation model to evaluate the cost savings and improvement in revenues achieved by applying the Alberta reproductive and nutrition research findings on a commercial farm. The George Morris Centre and the Prairie Swine Centre developed the enterprise model as a joint venture, in which the two parties share intellectual property. The model has undergone extensive work in design and testing. The model is capable of simulating the typical financial impact of changing growth rates, improved reproductive results or lowering feed cost. In essence the model is ideal for testing the results of the research undertaken at the University of Alberta with regard to swine reproduction and nutrition. From a macro perspective, the analysis will look at how the University of Alberta reproductive and nutrition research has contributed to and advanced national and international research in these areas and the broad-based benefits that have resulted.

There are three main methods in which this project has been conducted:

1. Interviews with academic and private industry participants
2. Economic Modeling
3. Assessment and analysis of research papers and scientific reports

This research paper will proceed by addressing the objectives of the project as focal points of the work effort. With that noted, the seven objectives will be combined into four broad work areas with specific tasks or tactics assigned to address each of the areas.

1. Current and historic costs of the Research Programs.
2. Current and historic impact that the Programs have had on the Alberta, Western Canadian, and international swine industry
3. Jurisdictional Review of Other Swine Research Programs
4. Future Alberta Swine Research Program Focus and Opportunities

# 2.0 Description of University of Alberta Swine Research Programs

## 2.1 Overview of the Programs[2]

The University of Alberta's Department of Agricultural, Food and Nutrition Science (AFNS) research activities include animal nutrition, physiology, animal breeding, molecular genetics, genomics, ethology, biotechnology, wildlife productivity and management. The research extends across commodities including: beef and dairy cattle, swine, poultry, bison, deer, and elk. The focus of livestock research in the AFNS is on issues of importance to the agri-food industry: food safety, food quality, production efficiency and sustainability, and environmental health.

The AFNS livestock research team is comprised of internationally recognized scientists with expertise in a wide range of disciplines across commodities in the areas of:

- Animal nutrition and metabolism,
- Animal physiology,
- Animal genetics, and
- Animal welfare (ethology and animal housing).

Their expertise supports technology platforms developed within the AFNS such as:

- Nutrient analysis,
- Endocrine/metabolic analysis,
- Genomics/proteomics, and
- Meat/muscle biochemistry.

### 2.1.1 Swine Reproduction and Development Program

The Swine Reproduction and Development Program (SRDP) builds upon two main areas of pork research. One research area is swine nutrition under the leadership of Dr. R. Ball and the other is swine reproduction and breeding herd management guided by Dr. G. Foxcroft. Both of these lead researchers are in collaboration with other SRDP researchers. Dr. Ball is an expert in the study of amino acid requirements and metabolism. Dr. Foxcroft is a Canada Research Chair in Swine Reproduction Physiologywith has expertise in application of basic research to improving the efficiency of breeding herd management.

The two main programs occur at the University's Swine Research and Technology Center (SRTC). The Center is committed to research, training and technology transfer for the pork industry. The SRTC consolidates swine operations at the Edmonton Research Stations, which provides an integrated site for swine research on nutrition, reproduction, environmental management and medical research.

The following are some of the accomplishments that the SRTC has cited[3]:

[2] AFNS Website, Research page http://www.afns.ualberta.ca/Research/Index.asp?page=Animal%20Science

- It is internationally recognized for research in reproduction and nutrition
- The Centre's trainees are leading industry and research positions across Canada - 30 MSc/PhD students in last 5 years
- Industry funds nearly half the current research activities

The research priorities of the swine nutrition program are as follows:

- Determine amino acid requirements
- Evaluate feedstuffs
- Develop new nutritional methods
- Improve pig health by diet
- Use pig nutrition research as a means of learning more about human nutrition

The research priorities of the swine reproduction program are as follows:

- Improve sow fertility
- Improve gilt management
- Develop new reproductive technologies
- Improve understanding of reproductive mechanisms

The following Courses are taught by researchers working at the SRTC

- Animal Reproduction, taught by Dr. Foxcroft
- Swine Production, taught by Dr. Ball

Perspective on Programs

The word program is basically defined as a plan or system under which action may be take toward a goal.[4] In that regard the two programs in question are focused on swine nutrition and reproduction with a series of projects or actions designed to achieve long term and short term goals. Beyond that, however, the programs are relatively informal in nature. They are funded based on a competitive process and on the reputations of the researchers themselves. The two programs in question work together in shared facilities but the overall objectives and projects are very different. If there is any "cross-fertilization" or collaboration it would be based on an as needed, informal basis. The same is true with the other program areas and research areas of AFNS. The scientists are colleagues with a mutual respect for the research objectives but there is no formal processes in which the entire swine research projects areas actually work together. In fact there is no particular reason why they should, other than in areas of overlap or mutual need. Simply put, the fact that they are all swine programs does not mean that there are overriding benefits or rational for working together.

Finally, within a specific research area, collaboration within and across institutions is not common or widespread. There are several reasons for this but the first is that the scientists are all competitors for the same limited pool of grant money. Furthermore, leading research scientists typically argue that any research program needs a small focus to be successful. That is because trying to do a little bit of everything is a recipe for mediocrity.

[3] Swine Research and Technology Center website, http://www.afns.ualberta.ca/Hosted/SRTC/
[4] Webster's Ninth New Collegiate Dictionary, 1990

At the Swine Research and Technology Center at the University of Alberta, there are two main programs, which are major parts of the foundation of the Swine Research Program in Alberta, and in Canada. These two large and strong programs are recognized internationally. By association, all research in swine in Alberta receives greater attention from the swine community.

## 2.2 Swine Nutrition at the University of Alberta

This section of the report reviews the concepts and scope of the research projects within the Swine Nutrition program. This section does not list or evaluate each project. A chronology of particular research projects and their abstracts are listed in the appendix. The purpose of the section is to understand the purpose, direction and objectives of the research undertaken under the Swine Nutrition Program at the University.

### 2.2.1 Ron Ball and the Research Background

Dr. Ron Ball is the lead researcher in the Swine Nutrition program. Ron Ball received his PhD. in Nutritional Biochemistry, in 1984, from the Department of Nutrition, College of Biological Sciences, University of Guelph. His thesis was focused on protein and amino acid requirements of the young pig determined by the oxidation of an indicator amino acid. He is Professor and Alberta Pork Producer's Research Chair in Swine Nutrition. He has also been Special Consultant, Division of Gastroenterology and Nutrition, Research Institute, at the Hospital for Sick Children Toronto since November 1997.

Dr. Ball came to the U to A in 1997 from the University of Guelph to assume the Alberta Pork Research Chair in Swine Nutrition. He accepted this position to spend more time in research and less in teaching and administration. U of A had plans at that time for a major re-development of the swine research unit. The plans accommodated his desire for facilities where he could conduct more advanced and more technically difficult research. Subsequently, an entirely new SRTC was built and he was able to design the ideal facilities for his planned research.

When interviewed by Alberta Pork and U of A he outlined the research program that he would undertake if chosen for the position. Alberta Pork played a key role in the development of this program because of their important financial contribution to swine research in the province. Beginning from that presentation he began developing the research plan. The first 5 year Strategic Research Plan (1998 -2002) was developed after consultation with the Research Committee of Alberta Pork in the fall of 1997 and early 1998. It was revised in late 1998 and early 1999. The current Strategic Research Plan (2003-2008) was revised in 2003. Although the main plan continued to be relevant, projects were re-ordered based on completed research and new priorities.

Professor Ball decided long ago that he would work in protein and energy metabolism because these are the 2 nutrients that most determine the cost of pig feed, and feed is the single largest cost area in pig production. Protein and energy intake also determine the lean and fat content in

the pig, which has the most influence on how much producers are paid. All other nutrients are minor, from an economic or research cost/benefit, compared to these.
Ball also made a conscious decision to undertake swine nutrition research that others were not conducting because it was either too difficult, required specialized equipment or skills, or was too expensive. The main reason for this was that the research funds invested in the program would therefore have unique results (ie. no duplication of existing research). In addition, he believed that the easy questions and research have been 'over-researched'. He asserts that there is little new information that can be gained from continuing to apply the traditional methods and the results are correspondingly of minimal value.

Ball also decided (with agreement from Alberta Pork) not to become involved in large feed and weigh experiments. Although this kind of experiment is the mainstay of animal nutrition research, nearly every swine nutritionist in the world has the facilities and expertise to conduct large feed and weigh experiments. Everywhere else in Canada, including Prairie Swine Centre, U of Manitoba, U of Guelph, etc, has sufficient people and facilities for these types of feeding trials. Therefore, it was agreed that Ball would undertake research questions and problems in nutrition that could not be solved by traditional feed and weigh experiments.

Some of the implications of these decisions were:

1. Specialized equipment and facilities were required, and the new SRTC was built with these issues in mind.
2. The new SRTC does not have facilities for feed and weigh experiments with grower or finisher pigs.
3. The type of research to be conducted would necessarily be more basic in nature and farther removed from commercial adoption.
4. The cost and length of time to required conduct this research would be greater than for simple feed/weigh experiments because the questions would be more complex and difficult to answer.
5. New methods had to be developed and new equipment constructed to address some of the unanswered questions or controversies. There are no guidelines or recipes in the literature to follow and the research must develop through by trial and error.
6. Due to the fact that protein and energy are the most important nutrients influencing cost and revenue, any improvements should have a significant effect on profitability of the Canadian pork industry.

Dr. Ball's areas of expertise are specific: amino acid (protein) and energy nutrition. He specifically uses high technology (isotope tracers, in vivo amino acid oxidation, in vivo protein turnover, real time oxygen consumption and carbon dioxide production or indirect calorimetry) approaches to questions in these areas. He does not conduct research in vitamins, minerals, feed processing, ingredient evaluation (except where new methods need to be applied), or feed formulation.

Ball argues that the advantages to remaining nutrient specific, and focused on high technology approaches, are:

- Little or no direct competition with other swine researchers in Canada.
- There is little or no duplication of research efforts or research funds within Canada.
- Progress is faster than if there were many different and unrelated research projects.

- The expensive and high technology equipment and highly trained and specialized staff are fully and thus efficiently utilized
- The students and post-doctoral students trained by Ball leave U of A with tools and techniques that help make them unique and highly valued because they are able to undertake complex high technology research.

The disadvantage of being specific is that Ball cannot quickly test a new product on the market or test someone else's approach or statements regarding swine feeding, etc. However, there are many others who can do this research. Another disadvantage is that students can become so specialized that they do not have the broad understanding of swine nutrition. This does not mean that they are less capable – they will have learned how to learn and how to do research; therefore they only need a little time if they wish to become expert and successful in a different area.

Observation

By any standard of comparison over the last 20 years, Dr. Ball has been prolific and effective in research, instruction and extension. He has written nearly 200 papers and chapters in peer reviewed or refereed publications and books. Journals to which he has contributed are among the most highly regarded in the world, including the British Journal of Nutrition, The European Journal of Clinical Nutrition, the American Journal of Physiology and the Journal of Animal Science. He is a regular contributing writer to the Canadian Journal of Animal Science and the Canadian Journal of Physiology. In addition he has contributed to about 300 abstracts and conference proceedings.

Dr. Ball's graduate students include 43 well-recognized leaders in swine and human health nutrition throughout the private sector, academia and the human health system. His extension efforts are highlighted by his leadership role in the Banff Pork Seminar, which has become one of the primary hog and pork industry conferences in North America. In 2002 his extension efforts were recognized through the Canadian Animal Industries Award in Extension and Public Service, Canadian Society of Animal Science. That award was granted "In recognition of excellence in extension and public service to the Canadian animal industries at provincial, national and international levels." Over the last twenty years, Dr. Ball has received over $6.6 million in research grant support and has been involved in grant support of over $20 million when collaborations are included.

As evidenced in the sections below which cite the comments of his peers around the world in academia and in the private sector, Professor Ball is world renowned and exceptionally respected in his field.

### 2.2.2 Research Program Description

There are three overall research objectives of this program:

1. Improve the efficiency of pork production in Canada.[5]
2. Improve the safety and quality of pork products.

[5] Strategic Research Plan of the Alberta Pork Producers Research Chair in Swine Nutrition, University of Alberta, 1998-2008

3. Determine amino acid requirements of humans.

The first objective relates to amino acid metabolism and requirements in pigs. The second objective pertains to the use of antibiotics in pork production. The premise is that reduced use of antibiotics would also be a benefit to producers. Reduced antibiotic use would reduce the cost of pig production by reducing direct drug costs and increasing pig performance because of less disease. With regard to the third objective, it is noted that the protein requirements of humans, like in pigs, is defined by the amino acid requirements. The problem is that little current information exists on human amino acid requirements.

While the second and third objectives are important, the focal point of the Nutrition component of the SRDP at the U of A is the first objective. Ron Ball's chief interest lies in quantifying the amino acid or protein requirements of young pigs as they grow to maturity. The most basic premise behind this is the fact that feed comprises about 70% of the cost of raising pigs. Ball believes the key is to provide the right amount of protein to the pig, again because protein accounts for 80 percent of the cost of the feed. Ball asserts that producers need more exact knowledge about how best to nourish their pigs. The goal is to learn more about the amino acid requirements of a pig at different stages in its life. This will allow the optimization of the amino acid intake to ensure the pig grows more efficiently and less expensively.

Objective one is where the bulk of the financial and intellectual resources have been focused. It is what the industry regards as the work of Ron Ball at the SRDP. As such, objective one is the focus of this review project.

Within that overall objective #1, the following are specific goals:

- Amino acid metabolism and requirements of the neonatal, weaned and grow/finish pigs
- Objectively and accurately determine the amino acid requirements of sows
- Develop a new method for determining true amino acid availability in swine feeds

Examples of recent research projects toward the objectives of the program are listed in Appendix A.

With regard to the first goal, this knowledge is seen as being important because as noted earlier, protein and amino acids are the major cost determinant in pig diets. The growth and development of the intestine is also highly affected by the amino acid composition of the diet. The research is designed to determine the nutrient requirements of the gut and developing improved weaning diets based upon this knowledge. These data will also be applicable to growing/finishing pigs during situations of gut stress such as reduced feed intake and recovery from digestive diseases.

More particularly it is important to note that the gut of the pig uses a high percentage of total amino acid intake. Some amino acids are used more than others. For example Lysine, Threonine, Methionine, are highly used by the gut. On the other hand, Arginine is only synthesized by the gut.

The second goal is designed to deal with the fact that amino acid requirements of sows are not accurately known, except for lysine. Knowledge of amino acid requirements of sows will allow

improved formulation and reduced feed costs for sows. Accurate information on requirements will also allow a reduction in protein content of sow feeds and thus nitrogen excretion in manure.

Very few data are available on amino acid requirements of sows. This is an issue to the industry because research by Ball has shown that sows are overfed protein. One key assertion is that optimizing amino acid intake may improve productivity and rebreeding. Furthermore, Ball has argued that basic nutrient maintenance accounts for up to 40% of the protein requirement of pregnant sows. However, maintenance amino acid requirements are poorly documented.

This research discovered that the amino acid oxidation method is useful to determine amino acid and protein requirements in sows. Meaningful measurements can be made as early as one day after a change in protein intake. The maintenance requirement for some amino acids is underestimated by previous research.

Goal number three is seen as important due to the fact that current methods for measuring amino acid availability are very slow and expensive. The current digestibility methods that are widely used also do not give true availability for protein synthesis, they only give apparent digestibility (disappearance) estimates. Data on true availability of amino acids for protein synthesis would significantly improve feed efficiency, improve growth performance and reduce feed costs per animal.

Specific to this challenge, it is to be recognized that digestibility is not the same as availability. True availability tests require expensive growth trials with grinding the entire pig. A rapid and affordable method is required for 'true amino acid availability'. Furthermore, the rate of amino acid oxidation is related to:

- amino acid requirement
- amino acid intake
- rate of protein synthesis

There are also questions regarding whether oxidation is related to 'true availability'

Finally, the fourth goal relates to the long-term basic research to discover new information on the biochemistry of amino acid metabolism. The biggest difference between this research and the other research areas is that the potential for application of this more basic research has a much longer term.

One of Ball's innovative methods is to use radioactive isotopes of the amino acids to provide exact tracking of where the acids are being used for protein synthesis, muscle growth or some other metabolic function in the pig's body. This method is very expensive relative to alternatives but it is more accurate. Ball's work has shown that 60 percent of dietary threonine is used in the mucous lining of the young pig's gut. When a threonine-deficient diet is provided, the piglet's ability to digest feed suffers. The study suggests that a threonine supplement might enhance gut growth, development of the digestive function and protection against disease.

Applied Versus Basic Research

Ball believes that a mix of basic and applied is required. Ball's team at the University conducts a mix of basic and applied research. Applied research can only develop as a result of more basic research. Basic research is where the ideas come from; applied research is the demonstration of how this knowledge can be used in a specific situation. By definition, the results of applied research are largely predictable if there is an understanding of the basic principles. Ball uses basic research to identify and then study new opportunities that may have a benefit to the industry.

Observation

Based on research conducted for this project involving discussions with academia and private industry there appears to be an understanding that applied research is only capable of providing small steps of improvement, and is often hampered by being applicable at specific times or under specific circumstances only. There is also an appreciation that basic research gives the opportunity to discover mechanisms that can either lead to a fundamental improvement of swine nutrition, or provide the tools to judge whether a nutrition decision is likely to be beneficial or not. Basic research is often not be viewed as cost-effective in the short run or if a narrow focus is desired. At the same time, however, there is widespread agreement that it is a necessary tool to assure the long-term success of the swine industry.

### 2.2.5 Extension

Professor Ball's main extension activity is Program Chair of the Banff Pork Seminar (BPS). He has held that position since 1998. BPS has more than doubled in attendance (from 350 to 860), size of program (12 speakers to 42), and budget ($70,000 to $260,000) during that time.

Each year Ball organizes a workshop at BPS focused on nutrition. The specific area is chosen with input from the BPS Advisory Committee and comments received from the feed industry. The target audience is PhD and MSc nutritionists (these individuals are mainly either feed industry or consultants to the feed industry) because these are the people that will implement new ideas in feed formulation and use new information on pig requirements and feed ingredients. For the last 2 years this workshop has been on amino acid supplementation to swine feeds. Prior years included topics such as: net energy, amino acid availability of feeds, feed related substitutes for antibiotics, enzymes, etc.

Ball also receives requests from individual feed companies, veterinarians, and managers of large farms for information, assistance and advice on nutrition. Furthermore, Alberta Pork provides numerous and extensive updates to producers on the applicable aspects of Dr. Ball's work

It is to be noted that the BPS is a major undertaking and has become an international success due to the work of Dr. Ball and the team at the Swine Centre. In fact, the BPS could be considered in itself to be a significant professional accomplishment. Few agricultural professors could point to such a massive extension undertaking. With that significant contribution noted, Dr. Ball does not spend even more time on extension, as his key focus is the actual research.

## 2.3 Swine Reproduction and Breeding Herd Management Program

The goal of the Swine Reproduction and Breeding Herd Management Program is to link studies on the basic mechanisms controlling reproduction and early embryonic development in the pig to problems of practical importance to the swine industry. Studies on factors affecting reproductive maturity in the gilt, the causes of lactational anoestrus and reduced fertility after weaning in the sow, and the effects of nutrition on reproductive performance are major areas of activity. The purpose of the section is to understand the purpose, direction and objectives of the research undertaken under the Swine Reproduction and Breeding Herd Management Program at the University of Alberta

### 2.3.1 George Foxcroft and Research Background

George Foxcroft is Canada Research Chair (Tier I) in Swine Reproductive Physiology, University of Alberta. He received his PhD from the University of Nottingham in 1972. His thesis was on the "Reproductive Physiology of the Post-Parturient Domestic Rabbit."

Foxcroft agreed to come to the University because he was recruited to a specific Natural Sciences and Engineering Research Council (NSERC) industry chair in Swine Reproductive Physiology in 1988. This offered the opportunity to join a very established R&D team in western Canada at that time led by Dr. Frank Aherne. This was followed by 10 years of intensive collaboration with Dr. Aherne that extended Foxcroft's established expertise in basic studies of reproductive biology and endocrinology to more applied questions of breeding herd management. Further opportunities at the U of A allowed him to successfully apply for a senior Canada Research Chair (CRC) through the faculty, which he has held since 2001. Foxcroft believes that these and other programs continue to make the U of A and the province of Alberta an attractive place to conduct agri-food research.

In September 1994, Dr. Foxcroft accepted the University of Alberta's invitation to act for a two-year term as Associate Chair (Research) in the newly created Department of Agricultural, Food and Nutritional Science (AFNS). In that capacity, he was to represent the research interests of some 45 tenured faculty members formerly working in the Departments of Animal Science, Plant Science, and Foods and Nutrition.

Following his first term at the University of Alberta, he accepted an invitation to serve a second term as Associate Chair (Research) in AFNS. In that capacity he took primary responsibility for the development of major proposals to federal and provincial funding agencies to support the vision of an integrated "Food for Health" program at the University of Alberta. Key goals were to attract $24 million of infrastructure funding, and external support for up to 10 new faculty positions in all areas of the Food for Health continuum, over a 5-year period. Phases 1 and 2 of the infrastructure program, supported with over $15 million in federal, provincial, industry and university funding will provide state-of-the art research facilities the poultry, dairy, beef and swine research programs based at the Edmonton Research Station, and a Human Nutrition Centre on campus.

As Chair of the Steering Committee, Foxcroft led the development of the new $5.7 million Swine Research & Technology Centre at the Edmonton Research Station. From the perspective of new appointments, he had a major involvement in overseeing the application to AVAC Ltd. that resulted in the award of $3 million to support the appointment of four important positions in the area of Agri-Food Processing.

Another key area of activity was to support the development of proposals for a Functional Foods Centre of Excellence and Foxcroft was a member of the presentation team that successfully applied to the Canadian Adaptation and Rural Development Fund (CARDF) for $460,000 of start-up costs for the Centre.

Teaching

During Dr. Foxcroft's University-based career he has taught a broad spectrum of physiology courses at the undergraduate level. Key teaching areas at the University of Nottingham included: first-year courses in mammalian physiology; second-year courses in digestive physiology and anatomy, renal physiology and anatomy, endocrinology and metabolism, neuro-endocrine regulation and a practical module on histological techniques; final year courses in "Digestive physiology in domestic animals" and "Pregnancy and parturition".

At the University of Alberta, Foxcroft has taught Reproductive Physiology Section; Regulation of Reproduction in Domestic Animals and Birds; Neuro-endocrine Regulation; and Comparative Reproductive Physiology.

At the University of Alberta, Foxcroft supervised or co-supervised 21 graduate students; to-date five have been awarded MSc and twelve, PhD degrees. He has acted as a Supervisory Committee member for numerous graduate students in AFNS, three students in the Faculty of Science, and three students in the Faculty of Medicine. He has served on PhD and MSc Examining Committees for students in his own Department, and in the Faculties of Science, and Medicine. In addition he has acted as External PhD/MSc Examiner for students at the following Universities; Aberdeen, Edinburgh and Bristol (UK), Saskatchewan and UBC (Canada), Sydney, Victoria and University of Western Australia (Australia).

Observation

As will be discussed in greater detail below, Dr. Foxcroft is an acknowledged world leader in the application of basic and applied research to improving breeding herd management at production level. Dr. Foxcroft has garnered respect and a dedicated following of his research across a wide spectrum of the swine industry across North America from leading firms in genetics, animal health, feed and production.

### 2.3.2 Research Program Description

Research Perspective

The Swine Reproduction Program has further advanced an understanding of the critical effects of management factors on breeding herd performance. The key objectives of the program are the following:

A. Improve sow fertility
B. Improve gilt management
C. Develop new reproductive technologies
D. Improve understanding of reproductive mechanisms

The Swine Reproduction and Breeding Herd Management program is driven by conceptually based research and the ability to attract funding from research agencies. In the more applied area the program objectives and priorities are usually in response to the guidelines of the funding agencies. (eg. Canada Pork Council, AIC Breeding Management Committee, AARI Research priorities, etc.) In Foxcroft's area of research, he asserts that increased efficiencies in breeding management and improved technologies for gene transfer are perennially listed as having a high priority in the industry. In essence the combination of basic and applied research grants that provide access to funding is probably the biggest driver of their program, but they also attempt to evolve a leadership position that will ultimately be a benefit to the pork industry. Specific applied projects usually originate from contact with specific production systems and consultant veterinarians. Foxcroft asserts that his team is a leader world-wide in adopting this approach to R&D.
The integration of basic and applied research attempts to establish the Foxcroft program in a leadership role. The current projects are a good example as they are directed toward the link between improved breeding management and improved utilization of nutrients, and reductions in environmental pollution from pig waste. Equally recent works on the impacts of prenatal programming of the pig fetus on postnatal survive ability and growth performance are cutting edge ideas.

Description

The basic focus of much of the Foxcroft led research relates to the management of the gilt pool. Further to that the research has been geared toward the following areas[6]:

- Selecting gilts for improved reproductive performance
- Use of boars in gilt selection programs
- Sexual maturity
- Growth targets for replacement gilts
- Nutrition management in gilts
- Selection for fertility
- Growth rate and time of first mating

[6] From Research to Reality, SRDP Publications and Presentations March 2001 – March 2005

- Heat synchronization
- Determinants of litter size

The Reproductive and Breeding Herd Management program is conducted with an interdisciplinary team, and inter-institutional network. It includes expertise in reproductive physiology/endocrinology, embryonic and fetal programming, muscle and gut development, immune function, and applied swine genomics and proteomics. The program links research in swine reproductive biology to innovations in assisted reproductive technologies and breeding herd management.

The Foxcroft program has strong collaboration with industry partners such as Hypor, Nutreco, Bioniche, Intervet (Canada), Janssen Pharmaceutical (Belgium), Lonza Corporation, Sygen/PIC, Mintube (North America) and Maple Leaf Foods.

### 2.3.3 Extension[7]

Basic and applied research results generated by the swine reproduction program and information on application in pork production, are provided to the industry using a range of delivery vehicles. These are summarized below, and grouped by type of activity into: A) Direct Industry Contacts through technical meetings and workshops; B) Written papers in industry publications; and C) Off-site research projects in collaboration with industry sponsors and commercial producers or production companies.

[7] Agricultural R&D Program Funding , Full Application Form, 2005/2006Swine Reproduction -Development Program (SRDP), Full proposal submission, Final Draft as of April 2006

A) Direct Industry Contact

| Activity | Target Audience | Desired Impact |
|---|---|---|
| 1.Swine Breeding Management Workshop | ▪ Production Systems Managers<br>▪ Barn Managers | SRDP's new flagship workshop, seeks to externally "train the trainer". Such trainers and supervisors will internally train subordinates. |
| 2.Banff Pork Seminar – Reproduction Sessions | ▪ Producer Owners<br>▪ Production Systems Managers | A long-standing tradition, this breakout session intends to influence the very top of the decision-making hierarchy. |
| 3.Red Deer Swine Technology Workshop | ▪ Barn Managers, Supervisors<br>▪ Stockpersons | Addresses the external training needs of personnel directly involved with sows and gilts. |
| 4.Manitoba and Saskatchewan Swine Seminars | ▪ Producer Owners<br>▪ Production Managers<br>▪ Barn Managers | Smaller and generally more production oriented seminars than BPS, uses similar speakers to influence and inform the mid production hierarchy personnel. |
| 5.Leman Conference | ▪ North American Swine Veterinarians<br>▪ Production Managers | SRDPinvited to develop a four-year agreement with the University of Minnesota to provide a Pre-Conference one-day Swine Reproduction and Breeding Management Workshop (2005 – 2009). |
| 6.Focus on the Future Conference | ▪ Producer Owners<br>▪ Production Managers | By invitation to participate in PSCI's flagship event, we focus on the delivery of targeted information aimed at the decision makers. |
| 7.American Association of Swine Veterinarians | ▪ Swine Practitioners | By invited participation in their workshops we influence the US, Canadian and Mexican veterinarians almost yearly. |
| 8.Canadian and American Societies of Animal Sciences | ▪ Academic Community | We are invited to share basic research findings that influence the research activities of the community. |
| 9.International Scientific Meetings | ▪ International Research Community | Demonstrate leadership in breaking science. The SRDP will host the VIIIth International Conference on Pig Reproduction in Alberta in 2009. |
| 10. International Extension Meetings | ▪ Society Membership | SRDP members are regularly invited to address the members of producer and veterinarian organizations worldwide. |
| 11. Sponsor Clients Meetings | ▪ Industry Sponsor Clients | We are routinely involved in influencing our Industry Partners' clients, in Canada and abroad. |

A summary of presentations made in the first term of the SRDP activities (2001 – 2005) provides an indication of, 1) the overall impact of SRDP-derived research, and 2), the considerable concentration of presentations to audiences in Alberta and Western Canada. Existing invitations for late 2005 and 2006 follow a very similar pattern

| Location | Year | | | | | Grand Total | Percentage |
|---|---|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2005 | | |
| Alberta | 1 | 6 | 11 | 13 | 22 | 53 | 50% |
| Saskatchewan | 1 | 2 | | | | 3 | 3% |
| Manitoba | 1 | | | 1 | | 2 | 2% |
| Ontario | | | | | 1 | 1 | 1% |
| Quebec | | | | 2 | | 2 | 2% |
| Canada | | | | 1 | | 1 | 12% |
| Canada/USA | | 4 | 1 | 5 | 3 | 13 | 4% |
| Europe | 1 | 1 | 2 | | | 4 | 6% |
| International | 6 | | | | | 6 | 6% |
| Mexico | | 1 | 1 | 4 | | 6 | 10% |
| South America | | 3 | | 7 | | 10 | 4% |
| USA | | | | 1 | 3 | 4 | 4% |
| Grand Total | 10 | 17 | 15 | 34 | 29 | 105 | 100% |

B) Written articles in Industry Publications

| | | |
|---|---|---|
| 1. Conference Proceedings | ▪ As above | Most presentations listed in A) above is associated with a paper in the published proceedings. |
| 2. Western Hog Journal | ▪ Producers, barn staff | Reaches those who do not attend conferences and workshops |
| 3. Bacon Bits | ▪ AB producers | Distributed with AB Pork newsletter |
| 4. Centred on Swine | ▪ Producers, barn staff, industry | Short articles on PSCI quarterly newsletter |
| 5. West Hog Ex, AB Pork SaskPork, Manitoba Pork | ▪ Producer members | Limited to a column, most relevant bits of information |
| 6. Prairie Hog Farmer | ▪ Most producers in Western Canada | Feature articles on SRDP activities and presentations at workshops considered worthy of wider circulation |
| 7. AFNS annual report | ▪ Faculty mailing lists | General interest articles on innovative research developments and new staff interests |
| 8. Avances en Suinocultura (Spain) and Suinos and Cios (Brazil) | ▪ International pork production community | Editorial advisory roles and formal agreements to extend SRDP-derived technical publications through these journals |

C) Current or planned Collaborative Research Projects with Industry

See appendix B for list of projects.

In addition to or to expand upon the above noted endeavors, it is noted that Foxcroft has been heavily involved in the development of leading scientific conferences (International Conferences in Pig Reproduction; Swine Species Symposium Committee); industry-related seminars (Banff Pork Seminar) and workshops (Swine Breeding Management Workshop based at the Swine Research & Technology Centre, Edmonton); and a contractual agreement to deliver a Leman Conference Workshop in Swine Reproduction and Breeding Management, 2005 – 2009).

Dr. Foxcroft has presented more than 120 papers at scientific meetings over the last ten years. This has been complementary to over 100 research papers presented over the past twenty years in prestigious academic journals such as the Journal of Animal Science, the Journal of Physiology, Theriogenology, and the Journal of Animal Reproductive Science.

A key point of strength for Dr. Foxcroft's work has been the involvement of leading private sector firms the operate in support of the North American hog industry. These leading firms include: Alberta Swine Genetics Corporation; Roussel-UCLAF, Paris; Hoechst Pharmacuticals U.K., Ltd; Intervet International B.V., Boxmeer, The Netherlands; Prudential Venture Managers Ltd., UK; Pedigree Petfoods Ltd., UK; Pittman-Moore Inc., Terra Haute, Ind., USA; Pig Improvement (Canada) Ltd; Pig Improvement (USA); Swine Graphics Enterprises, Iowa, USA

In association with Dr. Foxcroft's appointment as a senior Canada Research Chair in Swine Reproductive Physiology, he acts as Director of the multi-disciplinary Swine Reproduction-Development Program that involves five principal research scientists, graduate students, postdoctoral fellows, research associates and research technologists. His major roles are those of research director, advisor and coordinator. In this role he directly participates in the design of experimental work and in the preparation of publications.

Foxcroft's team seeks to publish the most meaningful results in the leading international journals in the field of mammalian reproductive biology (Reproduction, Biol. Reprod., Mol. Reprod. Devel.) and in leading animal science journals (J. Anim. Sci., Theriogenology, Anim. Reprod. Sci.). This has established an international reputation for basic research in reproductive physiology of the pig, as evidenced by the number of invitations to present papers on the endocrinology/physiology of swine reproduction at international scientific meetings. Also, the last six years has seen a further increase in the number of invited talks at international pig production meetings, providing evidence of Foxcroft's ability to translate research results into recommendations for improved breeding herd management.

Extension Observation

By any measure extension has been a key focus of Dr. Foxcroft. While it may not be of the traditional variety which typically means a series of group meetings with producers, it is a highly effective method of addressing challenges with industry leaders. These industry leaders, who are industry suppliers, in turn will work with producer clients as customers.

## 2. 4 Budget and Funding[8]

This section of the report provides an overview of the costs and budgets of the Swine Reproduction and Development Program at the University of Alberta. The purpose of this section is to provide perspective on the costs of the programs and the allocation of the funding.

The following is a listing of Research Funding within the Swine Research and Technology Centre at the University of Alberta. The funding outlined does not include University salary allocations. The research funding includes only those amounts granted from private sector funds as well as government grants such as AARI and ALIDF. Appendix A provides a listing of projects and budgets of individual projects undertaken by the Foxcroft and Ball as well as by other leading researchers in Swine Reproduction and Development at the University of Alberta. The appendix outlines the specific sources of project funding.

| | FUNDING TABLE A | | | | | |
|---|---|---|---|---|---|---|
| **RESEARCHER** | **2001** | **2002** | **2003** | **2004** | **2005** | **TOTAL PER RESEARCHER** |
| **Ball** | $ 560,933.00 | $ 577,000.58 | $ 521,778.68 | $ 480,206.36 | $ 293,612.90 | $ 2,433,531.52 |
| **Dixon** | $ 102,694.00 | $ 59705.66 | $ 0.00 | $ 0.00 | $ 0.00 | $ 162,399.66 |
| **Dyck** | N/A | N/A | N/A | $ 30,000.00 | $ 41,612.09 | $ 71,612.09 |
| **Feddes** | $ 244,308.82 | $ 144,649.18 | $ 329,580.25 | $ 220,040.83 | $ 93,793.70 | $ 1,032,372.78 |
| **Foxcroft** | $ 316,059.78 | $ 862,109.47 | $ 630,943.92 | $ 434,944.00 | $ 393,868.42 | $ 2,637,925.59 |
| **Sauer** | $ 0.00 | $ 136,359.59 | $ 276,892.89 | $ 138,527.47 | $ 0.00 | $ 551,779.95 |
| **Zijlstra** | N/A | N/A | N/A | $ 55,000.00 | $ 108,357.38 | $ 163,357.38 |
| **TOTAL PER YEAR** | $1,223,995.60 | $1,779,824.48 | $1,759,195.74 | $1,358,718.66 | $ 931,244.49 | **GRAND TOTAL $ 7,052,978.97** |

[8] UNIVERSITY OF ALBERTA, SWINE RESEARCH TECHNOLOGY CENTRE REPORT, 2001 – 2005, February 2006

With regard to outside or non-University sourced funding, over the last five years, Foxcroft and Ball have combined to generate about 70% of the total Swine Reproduction and Technology Centre funding over the last five years. Over the last five years, a representative funding total would amount to about $1million divided roughly evenly between the two lead researchers.

In addition to the non-U of A research funding outlined above, the following tables also provide university funding for salaries as well as the funding sources for capital expenditures, particularly the new centre.

| ALBERTA PORK | FUNDING TABLE B | | | | | |
|---|---|---|---|---|---|---|
| | **2001 - 2002** | **2002 - 2003** | **2003 – 2004** | **2004 - 2005** | **2005 - 2006** | **TOTAL** |
| **Swine Nutrition Chair** | $ 75,000 | $ 75,000 | $ 75,000 | $ 75,000 | $ 75,000 | $375,000 |
| **Facility (capital)** | $ 221,000 | $ 200,000 | $ 200,000 | $ 200,000 | $ 200,000 | $ 1,021,000 |
| **TOTAL PER YEAR** | $ 296,000 | $ 275,000 | $ 275,000 | $ 275,000 | $ 275,000 | **GRAND TOTAL $ 1,396,000** |

| U OF A | FUNDING TABLE C | | | | | |
|---|---|---|---|---|---|---|
| | **2001 - 2002** | **2002 - 2003** | **2003 – 2004** | **2004 - 2005** | **2005 - 2006** | **TOTAL** |
| **SRTC Faculty Staff** | $ 491,523 | $ 517,853 | $ 576,416 | $ 612,768 | $ 624,500 | $ 2,823,060 |
| **Facility (capital)** | $ 568,156 | $ 550,000 | $ 2,085,979 | $ | $ | $ 3,204,135 |
| **TOTAL PER YEAR** | $ 1,059,679 | $ 1,067,853 | $ 2,662,395 | $ 612,768 | $ 624,500 | **GRAND TOTAL $6,027,195** |

| PROV GOVT | FUNDING TABLE D | | | | | |
|---|---|---|---|---|---|---|
| | **2001 – 2002** | **2002 – 2003** | **2003 – 2004** | **2004 - 2005** | **2005 – 2006** | **TOTAL** |
| **Facility (capital)** | **$ 1,261,737** | | | | | **$ 1,261,737** |

| INDUSTRY/ OTHER | FUNDING TABLE E | | | | | |
|---|---|---|---|---|---|---|
| | 2001 – 2002 | 2002 – 2003 | 2003 – 2004 | 2004 - 2005 | 2005 – 2006 | TOTAL |
| **Facility (capital)** | $ 1750 | $ 30900 | $ 55,085 | $ 45400 | $93.300 | $ 226,435 |

Total Faculty Staff Funding $ 3,198,060
Total Facility Capital Funding $ 5,713,307

In addition to the overall research program funding, the following is a breakdown of specific project funding in which the researchers were either the lead or co applicant on the project.

| | FUNDING TABLE F | | | | | |
|---|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2005 | TOTAL |
| **BALL** | | | | | | |
| MAJOR APPLICANT | $ 594,458 | $ 619,176 | $ 374,261 | $ 276,084 | $ 275,336 | $ 2,139,315 |
| CO-APPLICANT | $ 197,927 | $ 384,470 | $ 373,470 | $ 373,470 | $ 211,967 | $ 1,541,304 |
| TOTAL | $ 792,385 | $ 1,003,646 | $ 747,731 | $ 649,554 | $ 487,303 | $ 3,680,619 |
| **DIXON** | | | | | | |
| MAJOR APPLICANT | $ 98,225 | $ 310,050 | $ 0 | $ 0 | $ 65,000 | $ 473,275 |
| CO-APPLICANT | $ 385,845 | $ 330,050 | $ 545,100 | $ 1,249,300 | $ 1,213,475 | $ 3,723,770 |
| TOTAL | $ 484,070 | $ 640,100 | $ 545,100 | $ 1,249,300 | $ 1,278,475 | $ 4,197,045 |
| **DYCK** | | | | | | |
| MAJOR APPLICANT | N/A | N/A | N/A | $ 106,500 | $ 321,966 | $ 428,466 |
| CO-APPLICANT | N/A | N/A | N/A | $ 0 | $ 65,000 | $ 65,000 |
| TOTAL | N/A | N/A | N/A | $ 106,500 | $ 386,966 | $ 493,466 |
| **FEDDES** | | | | | | |
| MAJOR APPLICANT | $ 35,000 | $ 215,000 | $ 187,000 | $ 171,500 | $ 49,000 | $ 657,500 |
| CO-APPLICANT | $ 67,000 | $ 193,000 | $ 134,000 | $ 148,000 | $ 20,000 | $ 562,000 |
| TOTAL | $ 102,000 | $ 408,000 | $ 321,000 | $ 319,500 | $ 69,000 | $ 1,219,500 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **FOXCROFT** | | | | | | |
| MAJOR APPLICANT | $ 622,110 | $ 740,725 | $ 734,725 | $ 770,725 | $ 634,987 | $ 3,503,272 |
| CO-APPLICANT | $ 295,427 | $ 47,000 | $ 18,000 | $3,122,858 | $ 132,500 | $ 3,615,785 |
| TOTAL | $ 917,537 | $ 787,725 | $ 752,725 | $3,893,583 | $ 767,487 | $ 7,119,057 |
| **SAUER** | | | | | | |
| MAJOR APPLICANT | $ 147,500 | $ 271,293 | $ 91,280 | $ 237,280 | $ 0 | $ 747,353 |
| CO-APPLICANT | $ 59,000 | $ 0 | $ 0 | $ 0 | $ 0 | $ 59,000 |
| TOTAL | $ 206,500 | $ 271,293 | $ 91,280 | $ 237,280 | $ 0 | $ 806,353 |
| **ZIJLSTRA** | | | | | | |
| MAJOR APPLICANT | N/A | N/A | N/A | $ 340,000 | $ 160,000 | $ 500,000 |
| CO-APPLICANT | N/A | N/A | N/A | $ 0 | $ 2,080,000 | $ 2,080,000 |
| TOTAL | N/A | N/A | N/A | $ 340,000 | $ 2,240,000 | $ 2,580,000 |
| | | | | | **GRAND TOTAL** | **$ 20,096,040** |

Funding Table F is based on actual funds received into research accounts in a given fiscal year (which is not always equal to the funding approved for a specific time period). Often there can be delays in getting funds in and set up for many reasons, including waiting for matching funds, getting the necessary approvals in place, hold backs and other adjustments. So the revenue received in a particular year could include some funds that were actually approved for the year before but for whatever reason didn't come in before the fiscal year end. Or it may not include funds that were approved but didn't get set up in time.

Table A therefore is a summary of all the revenue that flowed into accounts held by the researchers as primary investigators. It would not include funds where the researcher was a co-applicant, and someone else was the PI. It would also not include any salary or benefit costs (researchers are not allowed to hold funds that pay their salaries); for example the funds for Foxcroft would not include the money that pays under his Canada Research Chair award for his salary and benefits. It would include the research allowance that he gets as part of the award, that flows into one of his research accounts and can be used to fund his research.

Funding Table F on the other hand is taken from the researchers annual reports where they list each year the grants that have been approved where they are the major applicant or co-applicant. For the reasons explained above it wouldn't necessarily match with the funds received in the same time period.

## 2.5 The Contribution of Alberta Pork to University of Alberta Swine Research

Since inception in 1968, Alberta Pork has encouraged research and development by directing their research dollars to projects that enhance the producer's bottom line at the production level. Alberta Pork has long recognized the importance of swine research in terms of its ability to generate significant benefits to Alberta hog producers. In 1988, Alberta Pork commenced financial support to the NSERC/Industry Research Chair in Swine Physiology and Reproduction at the University of Alberta. Dr. Foxcroft was hired by the University to fill this Chair. Alberta Pork base funding for the Chair position was $25,000 per year from 1988 through 1996. In addition, Alberta Pork also supported various reproduction research projects under the Chair with financial grants averaging or exceeding approximately $50,000 per year from 1988 through 1996.

When the University decided to discontinue the long standing Swine Nutrition Professorship, due to budget concerns and the pending retirement of Dr. Frank Aherne, the Chair position funding was increased to $75,000 per year to help retain the Swine Nutritionist position. Dr. Ron Ball was subsequently hired with Alberta Pork providing base funding of $65,000 per year toward his salary, starting in 1997. The remaining $10,000 went to the Reproduction Chair (Dr. George Foxcroft). In 1999, when Dr. Foxcroft obtained full tenure at the University, the entire $75,000 commitment was dedicated to the Nutrition Chair position.

This base funding has continued for the past 10 years and is expected to end in 2006. In addition to the Nutrition Chair support, Alberta Pork has supported various nutrition research projects associated with the Chair, totaling approximately $90,000 per year since 1997. As well, Alberta Pork has contributed $80,000 per year in support for reproductive research projects. In summary: total Alberta research project support in the immediate past year was $75,000 for the Nutrition Chair, $170,000 for research projects and $200,000 as a contribution toward the Swine Research and Technology Centre construction (total commitment $445,000).[9]

### 2.5.1 Other Provincial Producer Association Funding[10]

Of course Alberta Pork is not the only provincial hog producer association that funds swine research. The following is a brief run down of funding and priorities in other major hog producing provinces:

Quebec

The Federation des Producteurs de Porc du Quebec's contribution to swine research and developpement amounted to $8.1 million during the last 15 years or roughly $540 000/year.

FPPQ's priority areas, for 2006, are:

- marketing activity and product quality

[9] Alberta Pork Research Support background papers 2004 and 2005.

[10] Sources of the information are the provincial hog producer associations. In Quebec the source was the Centre de developpement du porc du Quebec.

- production economics
- genetics and farm management
- environmental protection
    - animal health and welfare

Saskatchewan

Sask Pork's research budget has been a combination of core funding to the Prairie Swine Center which amounted to 20 cents per market hog and a budget of $75,000 for other related research, awarded based on applications and a committee review. The $75,000 research fund was reduced to $25,000 in 2004/05.

In addition to the research budget Sask Pork provides directly, it had a five-year, $1 million Sustainability Fund, which was used for research projects. That fund has now expired.

The following is a breakdown of research for the last three years. Note that in 2002-2003 $227,135 came from the Sustainability fund. Also, in 2003-2004 $122,356 came from Sustainability Fund.

2002-2003 - $698,836 (PSCI $407,491).....29% of check-off went toward research
2003-2004 - $606,751 (PSCI $408,738).....31% of check-off went toward research
2004-2005 - $479,116 (PSCI $410,126).....31% of check-off went toward research

With respect to focus areas for the research, the majority of the SustainabilityFund was spent on environmental issues and health and safety matters. Sask Pork's research dollars cover production improvements, animal care and health, engineering, and environmental issues.

Ontario

Ontario Pork spends approximately $1.5 million on swine research annually. Most of the funding is allocated to the University of Guelph as well as Michigan, Purdue and some western Canadian universities. Of Ontario Pork's $1.75 /head check off, approximately 20 cents is dedicated to swine research. The organization usually seeks to attain other grants in a 2 or 3 to one ratio of their own spending.

Top Research Priorities Identified include:

1. Environment
2. Food Safety
3. Animal Welfare
4. Herd Health
5. Nutrition
6. New Products & Technology
7. Pork Product Quality
8. Reproduction

Manitoba

Manitoba Pork Council does not allocate funding in any program area as a particular amount of levy funds. In 2006 Manitoba Pork Council budgeted total expenditures of approximately $4.3 million on income of approximately $4.4 million from levies (80 cents per market hog, culled sows and boars, and export breeding stock; and 19 cents per export weanling). In 2006 total expenditures allocated to research and environmental purposes was $733,500.

For 2006 Manitoba Pork Council's authorized expenditures in its Research & Environment envelope are:

Environmental Stewardship: $215,500
e.g. Manitoba Livestock Manure Management Initiative; Lake Winnipeg Research Consortium; Demonstration Projects & Technology Transfer

Production Research: $293,000
e.g. University of Manitoba (Animal Science); Prairie Swine Centre; VIDO; SIDNet; University of Alberta (Geo. Foxcroft)

Special Funding: $225,000
National Centre for Livestock and the Environment (NCLE) and the Glenlea Farm Education Centre (GFEC) co-located at the University of Manitoba's Glenlea Research Station (Final year payment of a total of $750,000 pledge).

The overall objectives of Manitoba Pork Council's environmental research funding are defined in the Research and Environment Committee's 2006 Work Plan as:
"Encourage hog producers to embrace and use sustainable farming practices in all aspects of pork production.

Support environmental research activities that are responsive to the needs of the majority of Manitoba's hog producers and are compatible with the principles of sustainable development. Targeted measures must be practical, affordable, consistent with established regulations and guidelines, and acceptable to the farming community as a whole."

The overall objectives of Manitoba Pork Council's swine production research funding are defined in the Research and Environment Committee's 2006 Work Plan as:
"Support swine production research activities that reflect the needs of the majority of Manitoba's hog producers and are compatible with the principles of food safety, environmental stewardship and animal welfare.

# 3.0 University of Alberta Swine Research Program Impact

This section of the report evaluates the impacts of the research undertaken in the Swine Nutrition and Reproductive and Breeding Herd Programs under the leadership of both Foxcroft and Ball. The evaluations are both qualitative and quantitative. The qualitative evaluations were undertaken by analyzing summaries and research project reports generated by the two programs. This qualitative evaluation was done from an economic rather than from a scientific perspective. The analysis, therefore, could not evaluate the scientific rigor or merits. Instead, the evaluation had a bias toward understanding the direction and contribution to the industry in Canada. The quantitative analysis utilizes economic modeling described in the subsection below. The quantitative analysis does not assess each project conducted by the researchers. Instead it assesses projects that were considered to be representative of the work of the researchers and were readily applicable to the George Morris Centre/Prairie Swine Centre model.

This section first describes the quantitative model and then takes the qualitative and quantitative assessments for each of the major programs.

## 3.1 Prairie Swine Centre/George Morris Centre Economic Model

To provide an assessment of the economic value of the University of Alberta swine research, the research results were placed in the context of a representative farm. This was facilitated using the Swine Enterprise Model developed by the George Morris Centre and the Prairie Swine Centre. The model is capable of simulating the impact on hog production costs and returns of a variety of changes in management and new technology, using a modern 600 sow farrow to finish operation as a base. Within the structure of this model farm, the levels of variable production costs, fixed costs, and revenue from hog sales are simulated at a detailed level. This model has previously been used to evaluate the value of swine research at the Prairie Swine Centre by Engele *et al*[11]

The model is separated into eight linked modules:

1. Productivity/pig flow module
2. Labour module
3. Water/manure module
4. Variable cost module
5. Feed/nutrition module
6. Capital cost module
7. Carcass value module
8. Enterprise returns module

The productivity/pig flow module contains the productivity assumptions and linkages in pig flow contained in the model. Based on the basic parameters relative to the sow herd, sow

[11] See K.M. Engele, D.L. Whittington, A. Mussell, and J.F. Patience *An Integrated Approach to Developing Strategies For Improving The Financial Competitiveness of Saskatchewan Pork Producers*, ADF Project #20030620

productivity and pig growth, this segment of the model determines the required square footage of barn space required, the number of pigs in each stage of production at a given point in time, and the number of females required in the gilt pool. The first table below presents a summary of some of the default assumptions contained within this module.

The labour module provides a summary of labour required given the size of the facility being simulated and the labour cost. It provides a summary of the total staff requirement, functional areas of staff, wage/salary schedule, and benefits.

The water-manure module simulates the water consumption and manure production of pigs at each of the three stages of production. It calculates the manure output and required manure storage, the nutrient analysis of manure, and acreage required for land application of manure.

The variable cost module summarizes the costs of production that are linear with respect to production intensity and largely independent of technology. The second table lists the contents of the variable cost module.

The feed module contains three distinct components. The first component relates pig weights and pig growth to distinct diets. A total of 4 starter diets, 2 grower diets, and 4 grower diets are included. A second component tracks prices for alternative feed ingredients that can be used to formulate the diets. Finally, the third component balances the diets on the basis of least-cost. Based on historic prices, diets are balanced on the basis of average feed ingredient prices, diets balanced on the basis of low feed ingredient prices, and diets balanced on the basis of high feed ingredient prices. For the purposes of this evaluation, diets based on average prices were used.

The capital cost module assigns capital costs for barns, manure storage, and sows based on information from the swine productivity module. It accepts input from the productivity model and water/manure module to calculate barn square footage and cubic feet of manure storage required, along with the capital cost associated with sows.

The carcass value module draws upon historic data on hog marketing weights and hog prices along with common carcass grading grids and premiums (weight premium, loin eye depth premium, and hog health premium). Thus, for a given hog price the carcass value module calculate expected revenue per hog based on index, premium and carcass demerits.

Finally, the enterprise returns module combines the results of the above modules and reports them as a *pro forma* income statement for the operation. A summary of the income statement is reported in the results section below.

**Table: Assumed default production parameters in Swine Productivity Module**

| Category | 600 Sow |
|---|---|
| **Breeding Herd** | |
| Litters/Sow/Year | 2.40 |
| Farrowing Rate | 90% |
| Culling Rate – Sows | 40% |
| Replacement Gilts – Cost | $400 |
| Gilts in pool | 10 |
| Pigs Born Alive/Litter | 11.2 |
| Pre-Weaning Mortality | 10% |
| Pigs Weaned/Sow/Year | 24.2 |
| **Nursery** | |
| Mortality Rate | 2% |
| Production Cycle (weeks) | 7.5 |
| **Grow-Finish** | |
| Mortality Rate | 2% |
| Production Cycle (weeks) | 14 |

**Table: Default parameters in Swine Variable Cost Module**

| | | |
|---|---|---|
| A.I. Supplies | $0.45 | per hog marketed |
| Barn Supplies | $1.50 | per hog marketed |
| Maintenance & Repairs | $3.62 | per hog marketed |
| Management & Consultant Fees | $1.58 | per hog marketed |
| Marketing & Transportation | $5.00 | per hog marketed |
| Miscellaneous | $0.05 | per hog marketed |
| Office Supplies | $0.25 | per hog marketed |
| Property Tax | $1.15 | per hog marketed |
| Utilities (Natural Gas/Power/Phone) | $4.50 | per hog marketed |
| Veterinary Supply & Service | $2.00 | per hog marketed |
| Labour | $11.90 | per hog marketed |
| Insurance: buildings/equipment | $1.10 | per $ for $100 coverage |
| Insurance: animals | $1.10 | per $ for $100 coverage |

To quantify the economic effect of swine research findings from the University of Alberta, the following was undertaken. First, a set of default values contained in the model were simulated to illustrate costs and returns under existing technology. A second simulation run was then made based on productivity improvements that were attributed to swine research. These were then compared to reveal the net benefit on a per-pig basis. To aggregate the impact of these per-pig results to the level of the Alberta hog industry, the research was classified according to ease of implementation based on the Prairie Swine Centre evaluation according to: Easy, Moderate and

Difficult. “Easy” projects are those innovations that require little labour and little or no capital; “Moderate” projects require a longer period to implement, but still require little labour or capital; “Difficult” projects require significant lead time or planning, and is either labour or capital intensive.

It is assumed that “Easy” projects are adopted by 80% of the industry within a year. “Moderate” projects are estimated to be adopted by 40% of the industry, and “Difficult” projects are estimated to be adopted by 10% of the industry.

In assessing the benefits of University of Alberta research, summaries provided by researchers, supplemented by technical reports were used as input in changing default parameters. In many cases, the specific results from the research were technical and outside of the scope of economic expertise. The summaries of research impacts were relied upon heavily in estimating impacts, and these were not independently verified. These summaries were employed using the productivity benefits found, and leaving the economic benefit resulting from them to be independently determined using the model.

Based on the summaries and technical papers, projects were selected for evaluation that had benefits directed at the hog production component (and could therefore be easily simulated in the model) and for which the research had been completed.

Sections 3.3 and 3.5 below apply the PSC/GMC model to specific research projects by Foxcroft and Ball. The appendix C provides the details of the model.

## 3.2 Qualititiative Assessment of Nutrition Research at the Univeristy of Alberta

### 3.2.1 Significance of the Research

General Overview

As noted in section 2.2.2, the basic goals of Dr. Ball's Swine Nutrition program are the following:

- Amino acid metabolism and requirements of the neonatal, weaned and grow/finish pigs
- Objectively and accurately determine the amino acid requirements of sows
- Develop a new method for determining true amino acid availability in swine feeds

With regard to the goals associated with young pigs, the key problem to be addressed is that weaned piglets rarely achieve their growth potential. Performance during the first week of post-weaning affects performance to market weight. Many feed and feeding management practices affect post-weaning performance. This is an issue because the digestive tract of the early-weaned piglet is physiologically and metabolically immature. Early-weaning diets must be highly digestible, and therefore are very expensive. To stimulate gut growth and shorten the adaptation period from the pre- to post-weaning, the premise of the Ball research is that diet would reduce cost and increase performance to market.

Researchers have long known that intestinal development increases following weaning but is dependent on nutrient intake. The question therefore has been whether feeding more of the limiting nutrients can enhance intestinal development. By doing so the time and amount of the expensive diet can be reduced as can intestinal disease while improving performance.

By any standard, the methodology used by Ball and his team is leading edge. One example of this is when the scientists seek to measure amino acid requirement at 10-12 days. In order to do that, they surgically install catheters in the stomach, portal vein (liver), external jugular vein, femoral vein. They feed a synthetic diet either into the stomach or into the vein. Feeding into the vein allows the measurement of requirements for the rest of the body separate from the gut.

Another example of the research significance is the work with Arginine (ARG), which is required for protein synthesis and N (nitrogen) excretion from the body. Research in this area discovered that the true metabolic requirement for ARG is at least 4 times the current recommended intake.

Overall findings included the following:

- Amino acid requirement of the gut accounts for a large proportion of whole body requirement
- A healthy gut is required to synthesize metabolically essential amino acids
- Additional supplementation of critical amino acids may reduce weaning stress in young pigs

Historical Perspective on Nutrition Research

The following are some of the highlighted accomplishments of Ball's research:

1. Early Weaned Piglets.

As an MSc student (1976-1979), he conducted experiments with early-weaned pigs (2 weeks) fed immunoglobulins extracted from animal blood. At the time this was only the second occasion this had been studied. During his PhD research (1981-1984), he determined the amino acid requirements of piglets at 2 to 3 weeks of age, because this had not been done before. By the 1990's the standard industry practice had become early weaning at less than 3 weeks of age and inclusion of plasma proteins (immunoglobulin) in the diet. His research was among the very earliest conducted in early-weaned piglets. This is the first example of how Ball anticipated the future needs of the industry and prepared the ground work for future applications.

2. Indicator Amino Acid Oxidation to Determine Amino Acid Requirements.

Ball developed the method as a PhD student at the University of Guelph. It was an entirely new concept and novel approach to measuring amino acid requirements. It has many advantages over other methods, including very rapid results, elimination of many confounding factors and elimination of need to make several assumptions. This method was developed for use in pigs but he subsequently adapted this method for use in humans and chickens. Others researchers have used this method in humans, poultry, fish, and mink. The FAO/WHO Committee on Protein and Amino Acid Requirements recently declared the human adaptation of this method the new 'Gold Standard' for determining requirements, replacing the old standard, which had been in place for more than 50 years. One of the biggest advantages of this method is that because it is so rapid, a pig can be reused every few days and fed a different level of amino acid. In this way it can measure, for the first time, the requirements of individual pigs. This has never been possible before. The science can now describe the standard curve for variation in amino acid requirement within the population; again this has not been possible before (Bertolo et al 2005). The implication of this is that we will soon be able apply economic analyses to decide what is the optimum economic level of amino acid to feed (ie less than, equal to or greater than the requirement) depending upon the cost of protein (amino acid) in the available feedstuffs and the price of pigs.

3. Indicator Amino Acid Oxidation and True Metabolic Availability of Amino Acids in Foods.

In the last 7 years Ball developed a new way of measuring the amount of amino acid in a feed that is used for protein synthesis in the body. This question has been a major issue in swine nutrition for 50 years. The reason is that protein (pig meat) is the product and amino acid content of feeds must be ideal for maximum protein deposition (muscle growth) by the pig. The previous method, ileal digestibility, has a major fault because the loss of endogenous protein from the body into the intestine (enzymes, intestinal cells, protective mucin protein, intestinal immunoglobulins, etc) could not be separated from the protein that came from the feedstuff. Although estimates have been made of this loss, it is extremely difficult. In addition, a single set of values are currently used for all feedstuffs. This is clearly not correct because different feedstuffs have different patterns of loss of endogenous proteins (Myrie et al in preparation).

Ball's new method includes all protein synthesized in the body after a meal, whether it is muscle that is deposited or endogenous protein that is lost, and therefore gives, for the first time, an accurate estimate of the amino acid in the feed that is available for protein synthesis by the pig (Moehn et al 2005).

Combined together with the new way of measuring requirements the industry will eventually have a completely new set of more accurate data with which to formulate diets. (ie better knowledge of the pig amino acid requirements and better knowledge of the feed amino acid availability) This will enable the calculation of economic optimums for input (feed) and output (pork) as compared to what should be outmoded concepts - least cost diet formulation for maximum pig gains.

4. Intestinal Utilization of Amino Acids.

Ball' team were among the first (Bertolo et al 1998) at about the same time as a research group at USDA in Houston TX) to show that the intestine of the pig uses very substantial quantities of dietary indispensable amino acids, especially threonine, lysine and methionine. This is critically important because it had previously been assumed that the gut was passive – that it digested and absorbed nutrient but had little impact on their use in the body. Ball showed that 60% of the dietary threonine (the 2nd limiting amino acid diets based wheat and barley) was utilized by the intestine and never made it through to the muscle. This was an astounding finding but it has since been confirmed by several groups. He identified that the threonine was used to synthesis the protective mucins in the intestine and that when threonine was made deficient in the diet that all the pigs developed severe diarrhea simply because they lack enough intestinal mucins. (Law et al in preparation). The U of A team subsequently showed that the pig intestine also uses a great deal of methionine and branched chain amino acids. (Shoveller, Elango). The research has not yet shown what the intestine is doing with all these amino acids; it is a potentially very important question in gut health, gut growth and development, and resistance to and recovery from disease.

5. Lysine catabolism in the pig.

Lysine is the first limiting amino acid in pig diets and an enormous amount of data on pig requirements for lysine exists. However, Ball discovered that there was almost no knowledge of the intracellular metabolism of lysine or the regulation of catabolism of lysine by the pig. ). The U of A team discovered, for the first time, that lysine is broken down at a significant rate (about 10% of requirement) even when lysine was very deficient (only 70 or 80 % of requirement, Moehn et al 2004). They are also the first group to closely study the enzymes that regulate lysine breakdown in pig tissues (Pink et al in preparation). They found that both intestine and brain catabolizes a lot of lysine. This has lead them to strongly believe that lysine breakdown in the body must serve some, as yet unknown, function. This is regarded as critically important to discover what this is because lysine is supplemented to almost every kilogram of pig feed.

### 3.2.2 Applications

Many of the key commercial applications from the research conducted in Alberta since 1997 are yet to come. Beginning eight years ago Ball set out to develop certain methods and techniques

(see above). The data developed during the last 8 years was mainly on method development and validation. The U of A team are now at the point were a large data set of information is required to enable uptake and use by the industry.

The research on growing/finishing pig amino acid requirements and variability has immediate application. These data are already in use. There is more data to release soon that will also be of immediate use (Methionine availability in different sources of methionine). The team has applied for 2 patents relating to the methods for determine amino acid requirements and availability. These are currently in review.

This is not to say that Ball's research has not provided applicable results. The following section provides quantitative evidence of the impact of some of the "by-products" of the central research conducted by Ball.

With that noted, however, it is pertinent that while the largest body of Ball's research has yet to be commercialized, many of his interim findings are easily adoptable and useful in commercial production settings, as readily outlined in section 3.3 below. Much of his work is very long term in nature. His recent work on lysine catabolism in pig tissues identified several additional questions and possible opportunities. The long-term opportunity is to reduce lysine catabolism and thus make more of the dietary lysine available for use in muscle growth. This has enormous potential economic impact because billions of dollars are spent every year on lysine for pig feed supplementation. However, it will take years of intensive basic research to discover and understand the Whys, Wheres, Whens, Hows. etc., of lysine metabolism within cells before it can be understand whether it is even possible or acceptable to interfere with these mechanism.

## 3.3 Quantitative Evaluation of Swine Nutrition Projects

This section does not attempt to undertake an exhaustive evaluation of all the projects conducted by professor Ball. This section takes a quantitative examination of projects that appeared to be conducive to working within the model and that were also representative of the work of Ron Ball.

The following research projects were selected under this basis:

- Determination of sow amino acid requirements using the indicator amino acid oxidation method
- Validation of the net energy system for pigs in Canada
- Synergism of phytase and xylanase addition to finisher pig diets
- Development of low protein diets for sows: Effect on performance and energy metabolism

Appendix C provides detailed tabulation of the results which are simply summarized below.

### 3.3.1 Sow Amino Acid Requirements

Based on the results of this study, the following results attributed to the study were tested:

- 2.5 instead of 2.4 litters/sow
- Increasing progeny growth rate by 10 g/day
- Sows eat 1.0/mt of feed per year therefore average feed costs drop by $10/mt

The first impact has a direct result of revenue, as more hogs are sold for the same number of sows. The second effect generates more revenue as hogs are marketed at heavier weights and generally index better within the grading grid. However, relatively heavier growing pigs consume more feed, so increased feed costs occur as well, and improved used of physical facilities and sows results. The third aspect reduces sow feed costs.

The results are presented in the appendix. Total revenue increases by approximately $100,000, or $.85/pig. Slightly more facilities are required in farrowing, but on a per pig basis all facilities costs decrease. Sow and boar feed costs decrease with a slight increase in market hog feed costs, but with a net savings in feed costs. Improved capacity utilization results in a variety of cost savings in fixed and other variable costs. The net effect is an improvement in profitability of $4.02/hog.

Because this is a nutritional intervention, it is classified as relatively easy to implement. Thus, it is assumed that the benefit of $4.02/hog could accrue to 80% of hog production within the first year. Given 2005 Alberta hog marketings of about 3.8 million head, the immediate value of this innovation is roughly 4.02*3.8 million*80%, or $12.22 million. If this added productivity were capitalized using a rate of 8% over an infinite period, the value is roughly $153 million to Alberta hog producers.

### 3.3.2 Net Energy System for Pigs

Based on the results of this study, the following results attributed to the study were tested:

- Overall decrease of $2/mt for all gilt and barrow diets
- 30g/day increase in all gilt and barrow stages of growth

The impact of the above results are to increase the marketing weights of slaughter hogs which increases revenue and to decrease feed costs (with due adjustment for additional feed consumption from heavier weight pigs). The results are presented in Appendix C Table 2. The table shows that revenue increases $2.61 per hog and total cost increases by $1.03. The net benefit is $1.56/hog.

As above, because this is a nutritional intervention, it is classified as relatively easy to implement. Thus, it is assumed that the benefit of $1.56/hog could accrue to 80% of hog production within the first year. Given 2005 Alberta hog marketings of about 3.8 million head, the immediate value of this innovation is roughly 1.56*3.8 million*80%, or $4.74 million. If this added productivity were capitalized using a rate of 8% over an infinite period, the value is roughly $59.28 million to Alberta hog producers.

### 3.3.3 Phytase and Xylanase Addition to Finisher Pig Diets

Based on the results of this study, the following results attributed to the study were tested:

- Reduce water by 25%
- Reduce manure production by 10%, based on 40% water wastage @ 25% reduction
- Manure application rate increases by 10%
- ADG increases for gilts and barrows by 50 g/day for each phase of growth

The impact of the above results are to decrease manure handling, storage, and application costs, increase the marketing weights of slaughter hogs (and thus increase revenue), and to increase feed costs due to heavier weight hogs. The results are presented in Appendix C Table 3. The table shows that revenue increases about $3.00 per hog, feed cost increases by $1.93, and manure handling cost decreases $.54/hog. The net benefit is $1.59/hog.

Because this is a nutritional intervention, it is classified as relatively easy to implement. Thus, it is assumed that the benefit of $1.59/hog could accrue to 80% of hog production within the first year. Given 2005 Alberta hog marketings of about 3.8 million head, the immediate value of this innovation is roughly 1.59*3.8 million*80%, or $4.83 million. If this added productivity were capitalized using a rate of 8% over an infinite period, the value is roughly $60.42 million to Alberta hog producers.

### 3.3.4 Low Protein Diets in Sow Feeds

Based on the results of this study, the following results attributed to the study were tested:

- A 7.2% reduction in pre-wean ADG, based on (242/261) but applied to the model ADG rates
- Pig weaned increase from 10.08 to 10.7/litter

The effect of these developments is to increase the total number of hogs marketed, decrease feed costs, and improve utilization of facilities. The results are presented in Appendix C Table 4. The table shows that revenue per hog actually decreases by $. 02/hogs, but more hogs are sold. Feed costs decrease by about $.59 per hog, feed cost increases by $1.93. The net benefit is $4.51hog

Because this is a nutritional intervention, it is classified as relatively easy to implement. Thus, it is assumed that the benefit of $4.51/hog could accrue to 80% of hog production within the first year. Given 2005 Alberta hog marketings of about 3.8 million head, the immediate value of this innovation is roughly 4.51*3.8 million*80%, or $13.7 million. If this added productivity were capitalized using a rate of 8% over an infinite period, the value is roughly $171.38 million to Alberta hog producers.

## 3.4 Qualitative Assessment of Reproductive and Breeding Herd Management Programs at the University of Alberta

### 3.4.1 Significance of the Research

The major R&D achievements of the Swine Reproduction Program has been to advance an understanding of the critical effects of management factors on breeding herd performance. In addition, the program has sought to understand the complex mechanisms mediating short- and long-term effects of inadequate nutrition on gilt and sow fertility, and on pre- and post-natal development.

For the past several years, the focus of the program has been to seek improvements in gilt development programs. This was and has been a priority because it can lead to major increases in breeding herd efficiency. Proper selection and management of replacement gilts has a proven impact on lifetime non-productive days. The reproductive technology program has maintained that effective gilt management programs are needed that will meet replacement targets from a smaller pool of gilts, and with gilts with improved lifetime breeding performance. This will reduce annual replacement rates, improve sow fitness, decrease sow death loss, and increase labor efficiency and space utilization. The premise has been that by making gilt management more efficient, the impact is to improve the utilization of space and labor and achieve a flow of eligible (service-ready) gilts within the design specifications of the facility.

Based on the compilation of research projects completed over the last five years as well as discussions with academics and the private sector researchers, the following factors have become apparent regarding the work of the reproductive program:

- It has achieved the goal of being internationally recognized as one of the leading, multidisciplinary, research groups in swine reproductive biology worldwide.
- It has become a world leader in the development of efficient and sustainable breeding herd management programs, achieving over a 20% improvement in production efficiency in on-farm collaborative projects.[12]
- It has developed innovative new basic research on prenatal programming of muscle fiber development, which has already seen application by one of the most technically advanced production systems in Canada.

Research of the Swine Reproduction and Breeding program has provided advanced ideas on the reorganization of production enterprises to provide improved gilt management and a supply of superior breeding females to production units. By improving the predictability of breeding performance of the weaned sow, it allows producers to improve opportunities to meet weekly breeding targets. The major R&D achievement of the Swine Reproduction Program is that it has advanced an understanding of the critical effects of management factors on breeding herd performance.

[12] This is a claim that is frequently made by the literature on the program but it has not been verified by George Morris Centre research.

The key applied achievement of the programs are the advances in breeding herd efficiency and ability to show "proof of principle" in applying these technologies to large modern commercial units. New technologies in reproductive management (eg. assessment of boar fertility, and improved embryo transfer techniques) are emerging as major achievements of the program. New activities in applied geonomics are expected to provide opportunities for improved selection for reproduction merit and production efficiency.

## 3.5 Quantitative Evaluation of Swine Reproduction and Breeding Herd Management Projects

### 3.5.1 Improved Management of the Gilt Pool

Professor Foxcroft maintains a focused research program in swine reproductive physiology. A represenative aspect of this is his work with Patterson, Pettitt, and Beltranen in 2002. This specific study showed that pre-pubertal weight of gilts is not an accurate predictor of age at first estrus, and that by introducing gilts numbering 120% of eventual requirements to boar stimualtion, gilt productivity was improved. Thus, the following key results were tested in the model:

- Increase in the value of gilts culled, because culling occurs at a weight at which relatively more cull gilts are shipped in the core of the grading grid.

The principal effect of this is to increase the revenue from hogs marketed, as structurally more revenue is generated from the sale of cull gilts recognized as candidates for culling before they reach weights that result in deductions in the grading grid. This is shown in Appendix C Table 5. Feed costs increase marginally as relatively more females are introduced into the gilt pool, and the miscellaneous costs associated with gilts increases slightly. The table shows that revenue per hog increases by $ 1.72/hog. Feed costs increase by about $.04 per hog, miscellaneous costs increase by $ .03/hog, and the facilities costs increase by $.16/hog. The net benefit is $1.63/hog

Because this is a management process intervention, it is classified as moderately difficult to implement. Thus, it is assumed that the benefit of $1.63/hog could accrue to 40% of hog production within the first year. Given 2005 Alberta hog marketings of about 3.8 million head, the immediate value of this innovation is roughly 1.63*3.8 million*40%, or $2.48 million. If this added productivity were capitalized using a rate of 8% over an infinite period, the value is roughly $30.97 million to Alberta hog producers.

## 3.6 Beneficiaries of the Swine Nutrition and Swine Reproduction Programs at the University of Alberta

### 3.6.1 Benefits and Returns of the Research

As noted earlier in this report, AARI notes the following "rewards from agricultural research and development":

- Economic Benefits
  - reduced average costs of production
  - increased returns from higher yields
  - improved quality of products
  - improved disease and insect resistance
  - new uses for agricultural products
- Consumer Gains
  - more abundant supplies of food
  - improved food quality and safety
  - lower costs
- Additional Indirect Benefits
  - greater employment
  - thriving rural communities
  - increased exports
  - improved rural infrastructure
  - environmental sustainability

In the case of the work of Foxcroft and Ball, the benefits of the research are directly focused on the economic classification. That is, the research of both Foxcroft and Ball is almost exclusively going to result in reduced costs of production and increased returns. The reduced costs of production and improved returns from Foxcroft and Ball's research are the result of the following:

- better feed conversion and daily rates of gain
- more effective usage of feedstuffs
- lower death loss
- greater numbers of pigs per litter
- improved growth rates
- more effective breeding herd management and selection
- increased value of culls

Further to those points, it is of interest to return to the 2001 Canadian Journal of Agricultural Economics paper entitled "Returns to Canadian Swine Research." The research "Returns to Canadian Swine Research" was a research project with the purpose to present estimates of the returns to Canadian federal swine research. It considered research expenditures between 1974 and 1997. The estimates were obtained using Agriculture and Agri-Food Canada's Canadian Regional Agricultural Model (CRAM). The economist authors of the study found that overall,

Canadian federal swine research expenditures were found to have generated high rates of return. The net present value of the results of the research was found to range from $7.6-12.1 billion in constant 1996 dollars. The benefit-cost ratio was found to range from 6.4 to 22.4. That is, for every dollar invested in swine research, the returns to that research amounted to between 6.4 and 22.4 dollars.

If this form of cost-benefit analysis is applied to the work of Foxcroft and Ball, as a starting point, is it noted from section 2.5 of this report, that both Foxcroft and Ball have received external funding of about $2.5 million each in total over the five years from 2001 through 2005. If the very conservative ratio of 6.4 is used, it can be asserted that the $2.5 million invested in the research of Foxcroft and Ball will yield returns of $16 million each.
Based on the quantitative analysis utilizing the George Morris Centre/Prairie Swine Centre model in sections 3.4 and 3.5 above, it is readily apparent that the $16 million is a bare minimum return. For example even one aspect of Ball's research, relating to protein in sow feeds was found to be able to generate returns of over $13 million in one year alone. The one randomly selected component of Foxcroft's work, relating to the increase in the value of gilts culled, was found to generate returns of $2.5 million to producers in just one year. That is, in one year, this research finding, which is not a central component of Foxcroft's work, generated returns equal to the total Foxcroft funding over five years.

The point of this discussion is not to place a specific dollar figure on the returns to the work of Foxcroft and Ball. The point of this discussion is to provide evidence that there is no question that the work of Foxcroft and Ball has generated returns far in excess of the funds invested in the research. The work of Foxcroft and Ball has generated returns well in excess of the minimum returns that swine research typically generates. That is, based on the evidence, the research of Foxcroft and Ball is well with the bounds of benefits predicted by the 2001 swine research paper in the Canadian Journal of Agricultural Economics.

# 4.0 External/Jurisdictional Assessment of Impact of the Research Programs

The purpose of this section of the report is to assess the role played by other leading research organizations, both academic and private industry in Canada and abroad. The purpose is also to assess the impact that these research programs have had on their respective industries. As well, interviews were conducted to assess their familiarity with the research conducted in Alberta and their perceptions of it.

Section 4.1 provides a description of the other research programs that exist in Canada, including the goals, objectives, research expertise, and funding relationships. Section 4.2 provides a comparison of all of the research programs listed, how their research expertise overlaps, how they complement each other and if there are any gaps in research based on the perceptions of industry personnel. Section 4.4 describes the assessment of Alberta's swine research programs by other leading swine researchers and research users in Canada. Section 4.5 summarizes the section.

## 4.1 Canadian Jurisdictional Overview of Swine Programs

This section provides a description of the research expertise, goals, objectives, funding and challenges of the other Canadian swine research programs examined. Much of the following information is taken directly from the Program's websites and through personal communication during the industry interviews that were conducted and discussed in detail in Section 4.3.
The purpose of this section of the report is to assess the role played by other leading research organizations in Canada and to assess the broad based impact that these research programs attempt to have had on their respective industries.

The following is a list of the programs that were examined:

1. AAFC Dairy and Swine Research and Development Centre, Lennoxville, QC
2. AAFC Lacombe Research Centre and the Beaverlodge Research Farm, Lacombe, AB
3. Prairie Swine Centre, Saskatoon, SK
4. Vaccine and Infectious Disease Organization, SK
5. University of Manitoba, Swine Research Program and National Centre for Livestock and the Environment, Winnipeg, MB
6. University of Guelph Pork Research Program, Guelph, ON
7. Groupe de Recherche sur les Maladies Infectieuses du Porc (GREMIP), University of Montreal, Faculty of Veterinary Medicine, QC
8. Atlantic Swine Research Partnership Inc. Charlottetown, PEI

### 4.1.1 AAFC Dairy and Swine Research and Development Centre

The Lennoxville Dairy and Swine Research and Development Centre (the Centre) was established in 1914 and has gone through a series of name changes over the years, the last one occurring in 1994. The Centre's swine complex was built in the first half of 1999. The facility does not house a permanent swine herd; instead animals are bought and sold according to research needs. The Centre employs 25 researchers and their scientific teams as well as a

technology transfer team employed to ensure that the research meets the industry. The mission of the Centre is to make the Canadian dairy and swine industry more competitive through innovative research.

The goal of the research Centre is to improve the efficiency of Canadian swine production. The Centre tries to meet this goal through research in increasing sow productivity. Specific focus is in terms of total weight of piglets weaned annually, and through studies on welfare, the environment, nutrition, endocrinology of sows during gestation and lactation and growth of feeder hogs. The Centre also conducts swine genetics research and research relating to meat, carcass and boar semen quality, as well as on the economical and environmental impacts of swine production systems (http://sci.agr.ca/lennoxville/activ/pork-porc_e.htm). There are a number of researchers working in the Centre with key research expertise in a number of these issues.

Funding: AAFC will invest up to 50% of the total cost of a project conducted by the Centre in collaboration with a private company willing to support the project and willing to use the information once the study is complete.

### 4.1.2 AAFC Lacombe Research Centre

The Lacombe Research Centre is a federal government research laboratory operating under the auspices of and mandate of Agriculture and Agri-Food Canada. It is located in Lacombe, Alberta on 808 hectares of land. It has facilities for raising beef cattle and hogs, a holding barn, abattoir, blast chiller, coolers, cutting room, taste panel kitchen, sensory analysis booths, greenhouse, plant growth chambers, dryers, threshers, and seed storage, laboratories, and offices. Affiliated with Lacombe are the Beaverlodge Research Farm and the Fort Vermilion Field Site. Beaverlodge controls 360 ha of land at two sites and rents about 35 ha of land a year for research. The Fort Vermilion Field Site, operated during the growing season, owns 187 ha of land and rents about 3 ha of land for research (http://data.fptt-pftt.gc.ca/fedlabs/fedlab_e.cfm?id=8, Retrieved May 12, 2006).

The mandate of Lacombe Research Centre is to conduct research on the ante- and post-mortem factors that influence red meat: yield, quality, safety, and preservation. Lacombe also manages the only federal research program in apiculture. With its affiliated sites and research partners, the centre develops integrated, sustainable crop and animal production systems and crop varieties for the short-season environments of the Parkland and northwestern Canada (http://data.fptt-pftt.gc.ca/fedlabs/fedlab_e.cfm?id=8, Retrieved May 12, 2006).

The key research areas and areas of expertise at the Lacombe Research Centre include:

- Meat quality
- Meat safety
- Forage-beef interface
- Integrated cropping systems

With respect to funding, the Centre supplements its federally funded salaries, operating and capital expense resources with research and in-kind grants from provincial governments, producer groups, meat processing industry and agri-business. It is active in the release of plant

varieties and the commercialization of technologies developed through their research (http://data.fptt-pftt.gc.ca/fedlabs/fedlab_e.cfm?id=8, Retrieved May 12, 2006).

### 4.1.3 Prairie Swine Centre

Prairie Swine Centre (PSC) Inc. is a non-profit research and technology corporation with expertise in four disciplines – behaviour, nutrition, engineering and the environment. The mission of Prairie Swine Centre Inc. is "to provide a centre of excellence in research, education and technology transfer, all directed at efficient sustainable pork production." The research program, with a decidedly near market emphasis, seeks to improve the financial position of pork producers by defining feeding and management systems that maximize net income. In addition, the Centre carries out research to address issues and opportunities in environment and animal well-being (http://www.prairieswine.com/Overview/OverView.htm, Retrieved June 5, 2006).

The mandate of Prairie Swine Centre Inc. includes research, technology transfer and education. The research program seeks to fill a niche identified by the pork industry, to conduct near market research that can be applied within a one to seven year time frame. Because of those close linkages with the commercial pork industry, technology transfer is emphasized as a central part of the Centre's operation. Education, for the most part, involves training or supporting training, at the diploma, graduate and professional level. A close partnership exists with the University of Saskatchewan's Colleges of Engineering, Agriculture and Veterinary Medicine (http://www.prairieswine.com/Overview/OverView.htm, Retrieved June 5, 2006).

The research team at the PSC are evaluated on the success of meeting the research objectives that have been created by the Board of Directors and are reviewed in detail every five years – this was last done in 2003 in which there was strong endorsement to continue with the current programs. The following lists the objectives and their focus. The first three objectives focus on economic efficiency and the last three objectives focus on sustainability.

Research Objective 1: To define optimum feeding and management procedures to reduce the cost of feeding out grower-finisher pigs (20 kg to market) by at least $2.00 per head.

- Currently the focus is on energy, amino acid work and animal management.

Research Objective 2: To increase the value and use of local and "opportunity" feeds in swine diets.

- Including research into the maximum economic returns from local feed diets, dealing with variability, digestibility, carbohydrate metabolism.
- There is relatively little research done in this area and therefore makes it very important.
- The research focuses on specific local ingredients such as flax, barley, and canola.

Research Objective 3: Optimizing net income.

- This research currently focuses on animal behavior and engineering, floor space allowable and temperature.

Research Objective 4: To develop systems for improving air quality inside hog barns, for health and productivity of people and pigs, and reduce to external odour emissions. – basically the welfare interests of pig, producer and consumer.

- Gestation housing of sows
- Social behavior of animals and keeping them positive

Research Objective 5: Reduce the cost of production by optimizing the physical environment in commercial barns.

- Interior air quality for pigs and workers
- Inside the barn not outside the barn because lots of people work on environment outside the barn but little research focuses on air quality in the barn
- Ammonia, H2S, odour generation

Research Objective 6: To develop new information on operating systems and management procedures which ensure the long-term environmental sustainability of pork production.

- Overall environmental footprint of pig industry.

When the PSC was first started the concept evolved through a committee of pork producers. The PSC became incorporated because the vision that the advisory board created required that the PSC hire more new employees.

Prairie Swine Centre Inc. was originally built in 1980 by the University of Saskatchewan, and served as their swine research and teaching facility. At that time, the Centre consisted of two 100-sow and one 50-sow unit, each with its own gestation, and weanlings area, a small 240 head feeder barn and a small office/service building (http://www.prairieswine.com/Overview/OverView.htm, Retrieved June 5, 2006).

The PSC is still effectively owned by the University and the University does provide funding for the Centre, but the Centre also now has other means of funding, including from producer associations and the revenue from the sale of livestock. Also, the contract research portion of the work done at the Centre is increasing in size and importance. This work primarily includes work from private companies that would like some technology tested. PSC may also receive contract research through Saskatchewan Agriculture and Food (SAF), but SAF does not fund the PSC in any other form. PSC does interact with SAF with respect to its technology transfer activities but SAF does not have research staff that could work with the researchers at the Centre.

### 4.1.4 Vaccine and Infectious Disease Organization

The Vaccine and Infectious Disease Organization (VIDO) conducts research and development of vaccine and immunotherapeutic technologies for livestock and humans. VIDO's mission is to be a pre-eminent research institute investigating the pathogenesis of infectious diseases and the development of effective therapeutic and prophylactic methods to control infectious diseases of humans and animals. Current research interests include vaccines against a number of food-borne organisms, and novel vaccine delivery systems including needle-free methods. VIDO is a financially self-reliant, non-profit organization owned by the University of Saskatchewan and operates with substantial support from the governments of Alberta and Saskatchewan as well as Government of Canada and industry competitive grants. It collaborates extensively with external institutes and companies and provides a respected training environment (http://www.vido.org/about/index.php, Retrieved June 5th, 2006).

Originally the Veterinary Infectious Disease Organization, VIDO's mandate was to develop vaccines for the protection of livestock against serious and economically devastating diseases, and to ensure the technology reached the producer. In March 2003, VIDO's logo and name changed to the Vaccine and Infectious Disease Organization to better reflect the extension of our research activities into new areas – for example human diseases such as hepatitis C and SARS, and the rapidly developing technologies of genomics and proteomics (http://www.vido.org/about/story.php, Retrieved June 5th, 2006).

VIDO's research priorities are determined by the Board of Directors that is made up of industry, government and the University of Saskatchewan. On a shorter term basis, the Director suggests projects that should be undertaken and the researchers also determine their own research paths. With respect to funding, generally it is mixed between contract research (usually 1/3 of total funding), grants awarded for scientific endeavours (1/2 of total funding) and the Saskatchewan Agricultural Development Fund makes up the rest. The provincial government does not provide any direct funding to VIDO. Funding through the government would only be acquired through a contract or awarded grants.

### 4.1.5 University of Manitoba, Swine Research Program and the National Centre for Livestock and the Environment

The Swine Research Team in the Department of Animal Science at the University of Manitoba states that it is committed to helping Manitoba's pork producers meet industry challenges through innovative research and teaching programs. Among other research projects, scientists are studying strategies to increase the utilization of locally-produced crops, management strategies for optimizing sow productivity, optimum transportation conditions for weanlings, and alternative strategies for the use of antimicrobial agents in swine diets (http://www.manitobapork.com/research.php, Retrieved June 5th, 2006). The Swine research program at the University of Manitoba concentrates on including researchers from many different disciplines and providing research across the supply chain from animal research in laboratories to meat quality research.

In 2002, funding was provided to establish the National Centre for Livestock and the Environment. The Centre allows the research teams to conduct research programs that are long term in nature, for example 15-20 years, and that use an integrated production approach and allow researchers to approach hypotheses from a whole-system perspective. The term "Holistic" is often used to describe the approach the Centre seeks to adopt. This Centre is set to open next year.

Glenlea Research Station currently houses all of the swine research facilities and includes two 350 sow farrow to finish barns, five 250 pig nursery grower finisher units, additional manure storage units and feed processing and milling equipment.

Swine research at the University focuses on and includes expertise in:

- Nutrition
- Animal behaviour
- Animal reproduction
- Feed and feeding

- The environmental impact of swine production

The research is said to be a mix of applied (about 60%) and basic (40%).

In order to determine research priorities at the University, researchers meet with a research committee from Manitoba Pork annually, as well as the Canadian Pork Council. Researchers also bring back ideas and information from producers when asked to speak at meetings and conferences. As well, provincial extension staff is consulted on an annual basis.

Unlike the research Centres in Alberta or Saskatchewan, the University does not have a direct funding relationship with the Ministry of Agriculture. The Province did provide money toward the new Center but they do not fund the research projects directly. As a faculty of agriculture the department gets some funding from MAFRI for the whole faculty but not for swine research in particular.

The primary funding comes from industry. Manitoba Pork is very supportive of the University's swine research efforts. Manitoba Pork states that it understands the need for basic research before applied and will provide funding for both types of research even if it means not seeing an on-farm result for years.

Individual researchers receive funding from other industry sources such as feed companies or chemical companies for certain research projects. Other funding comes from federal grant programs such as NSERC.

### 4.1.6 University of Guelph, Pork Research Program

The pork/swine research that takes place at the University of Guelph is not structured as a program as it used to be in the past. In the past the Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA) had provided funding for animal research programs that included swine, dairy and beef. Now, OMAFRA provides funding for research in food and environmental sustainable production systems.

A number of University faculties work in the swine research that is being conducted including the department of population medicine, the veterinary school, department of animal science and the department of agricultural economics to name a few.

There are a number of facilities used for swine research at the University including Arkell Research Centre which houses a 300 sow farrow to finish operation, a 80 sow farrow to finish operation at Ridgetown College and an abattoir and isolation facilities for research in infectious disease.

Due to the various departments and researchers that work in swine research there are more than a few core competencies that the swine research is focused on. Recent research has focused on infectious disease, immunology, virology, nutrition, genetics, reproduction, epidemiology and the economics of various aspects of swine production.

The Ontario Agricultural Services Coordinating Committee has a swine sub-committee made up of producers, packers, feed mill managers etc… that gets together once a year and looks at the University's swine research priorities. The University then modifies their research priorities based on the comments made by that committee. The Agricultural Research Institute of Ontario (ARIO) then evaluates the Guelph program every four years and looks at how well researchers met the OASCC priorities.

OMAFRA provides the primary funding to maintain the research being conducted on swine at the University of Guelph. Approximately $3 million per year is provided by OMAFRA, this money has traditionally paid for the infrastructure and maintenance of the research facilities and then researchers go out and contract other work. Approximately $12 million in research money is brought in through external sources and contract work. Ontario Pork is a significant donor with about $1million per year.

OMAF does not participate in the research directly. Instead the ministry only oversees the work. They do more of the technology transfer initiatives resulting from the research and ensure that there are venues to bring the research findings to the industry for use. However, one research suggests that this is a bit of a problem the government aren't the ones working in the industry so it is sometimes not appropriate for them to be doing the technology transfer. This researcher continued to say that 'Canada is different and less forward thinking with respect to technology transfer like the US is. At major land grant universities, there are professors that spend 25-50% of their time on extension and therefore work in the industry and take what they have learned to the industry. This is very appropriate because they also work closely with those professors that only conduct research and can take the research of their colleagues to the industry as well.

### 4.1.7 Université de Montréal, Faculté de Médecine Vétérinaire Groupe de Recherche sur les Maladies Infectieuses du Porc (GREMIP), Université de Montréal, Faculté de Médecine Vétérinaire

GREMIP was founded in 1982 in the Faculty of Veterinary Medicine at the University of Montreal. It rapidly evolved to become the most important research group on bacterial diseases of swine in North America. Research at GREMIP focuses on the pathogenesis of bacterial infections in swine. Among the major research themes at GREMIP is the molecular and cellular characterization of some virulence factors of prominent bacterial pathogens of swine such as Actinobacillus pleuropneumoniae, Escherichia coli, Salmonella, Streptococcus suis and Haemophilus parasuis. Other research topics include antibiotics and health, vaccinations, viral diseases, bacteriology and immunology. By combining both fundamental and applied research, the research group seeks to enhance the control of these infections through the development of diagnostic tools and new vaccine-based therapy. The recent recruitment of new researchers allowed the GREMIP to develop a new research theme in porcine virology, specifically focusing on Porcine respiratory and reproductive syndrome virus (PRRSv) (http://www.medvet.umontreal.ca/gremip/ang/index.htm, Retrieved June 5th, 2006).

Research priorities within the group are primarily determined through industry needs and by being involved with practicing veterinarians that can help the researchers to be aware of the emergence of new health issues in swine production. Also, individual researcher interests determine research direction.

Financing of the research activities at GREMIP is upwards of $5 million annually. It is provided by many governmental (NSERC, FQRNT, CORPAQ) and industrial organisms, as well as Université de Montréal (http://www.medvet.umontreal.ca/gremip/ang/index.htm, Retrieved June 5th, 2006).

### 4.1.8 Atlantic Swine Research Partnership Inc.

In the fall of 2002, representatives of the swine producer associations in the three Maritime Provinces incorporated a non-profit research corporation to conduct strategic research activities for the development of the Atlantic Canadian industry. The farmers have provided seed money to the company, which will fund key strategic activities. As a private sector research corporation, it will have the capacity to leverage other funding sources; as well it will be able to issue research tax credits for eligible contributing partners.

The mission of the company is to empower Maritime swine producers to participate in the research and innovation needed to face present and future challenges.
A producer's survey of research priorities was carried out in 2002, with the following as the key areas identified by Atlantic swine producers. The categories were similar for all regions and thus sent a clear signal of research direction.
The top priorities were:

- Reducing Cost of production
- Nutrition with a key emphasis on reducing feed cost.
- Herd Health
- Environmental Management

When the projects require expertise that is beyond the skill of any one researcher, the partnership coordinates with other professionals to complete the projects.

In the immediate future, the partnership plans to bring on stream a second research position for manure and environmental management. Manure disposal, nutrient management, and odour control have become significant factors affecting cost of production as well as eliciting community concern. The partnership will create a manure management research chair at the Nova Scotia Agricultural College. This will require additional core funding which is actively being sought.

The partnership has initiated information technology processes to deliver the research findings to industry and community involving regular electronic transmission, newsletters, research seminars, and peer reviewed articles. So far response to completed projects has been positive enough to continue the flow of funds from industry to the partnership.

### 4.1.9 Review of Programs' Overlap and Complement (Deficiencies)

Table 4.1 provides a summary of the research expertise and research focus at each of the swine research programs described in Section 4.1. Table 4.1 shows that when looking at the broad view of expertise across the country, there is some significant overlap with respect to nutrition, disease research, economic impact research and animal behaviour to name a few areas of study. However, as noted by an interviewee, 'there is slight overlap in the areas of expertise but the

specific foci and emphases differ.' Reviewing the recent work that has taken place at a number of the programs can substantiate this view, which is very important. The recent works in broad areas of nutrition for example occur at different facilities across the country but emphasis varies materially from centre to centre. The same can be said for broad areas such as sow productivity.

While there is general overlap in many research interests, however for the most part the centres/programs complement each other very well. One interviewee noted that 'the Canadian swine research group is so small and we need to be able to communicate and interact together as a team therefore having some overlapping expertise is good for that'. Although the research is not identical, 'the general overlap allows researchers to carry on research from other work conducted in Canada but maybe with a different approach or perspective. This relationship provides very good value to the research in general and to the industry'. Although the fundamental questions or objectives of the research may overlap, the approaches in addressing the issues are different and the comparison of two studies conducted differently provide value to the research industry.

Again, a random analysis and review of various specific projects conducted for this project across the various centres substantiates this complementary versus substitution claim. Table 4.1 shows that there are clearly similar areas of broad expertise but the projects themselves tend to be very diverse.

Similarly, work that can't be repeated is regarded by the scientific community as being ineffectual. The repeatability of results is an important aspect of the scientific methodology and all scientists try to duplicate the work of others and learn from it, therefore overlap in expertise is a good thing because then the work is tested among other researchers. Overlapping research interests also provide backup researchers across the country and the ability to discuss and collaborate with other centres.

There are a few emphases that are in fact very different. With the establishment of the National Centre for Livestock and the Environment at the University of Manitoba research will focus on long-term impacts of production systems. This facility will allow researchers to pursue projects that could last 15-20 years. On the other hand, the Prairie Swine Centre in Saskatoon focuses on 'near-market' research with the aim of having results to producers within 1-3 years of project initiation. Various researchers, even within the same program or centre, conduct a mix of basic and applied research. One interviewee suggested that the mix is appropriate.

Lastly, the industry is generally aware of what others are doing so that overlap of research does not occur or is kept to a minimum. The overlap that occurs may be most prominent between the University research programs and the government research stations because one interviewee did note 'there is no overarching umbrella that brings together the Universities across the country and the federal research stations, therefore, the connection between universities is strong and the connection between federal research stations is strong; but the two groups are slightly disconnected'.

Perhaps not surprisingly, all of the interviewees agreed that the swine research being conducted across the country provides good value to the industry and represents a good cross section. Based on the review of the programs and projects across the country, it can be acknowledged

that the research is clearly industry centered with a noted mix of applied and basic focus. This review can also concur that there is a strong awareness and understanding of various research areas across the country.

## 4.2 Western Canadian Swine Research Context

Within western Canada there are many researchers in many disciplines and many locations. Based on the results of this research project, it has been determined that no one in Canada is doing research similar to either Foxcroft or Ball.

With regard to energy metabolism in pigs, Dr M. Nyachoti ( UManitoba) has acquired a calorimeter for energy research in pigs. He apparently has not yet conducted any experiments because of difficulty in operating the equipment successfully. Dr JT Yen, USDA Clay Center Nebraska, was active in calorimetry in pigs but he died almost 2 years ago and has not been replaced. There are 2 quite active calorimeter groups in Europe, in France and the Netherlands, and minor groups in Germany and Denmark.

Furthermore, every pig research station in Canada has someone who does classical amino acid digestibility with ileal canulas, including Dr. Ball. However, the U of A team is the only swine nutrition group in Canada using isotope tracers and measuring in vivo amino acid oxidation and protein turnover. Dr deLange (UoG) collaborated with Ball on several amino acid oxidation studies but he did not continue with oxidation or tracer studies after 1997t. Dr J Patience has conducted many amino acid requirement experiments by feed and weigh. The only other groups using precise radioactive tracers to study amino acid metabolism in pigs are located in Houston, TX (USDA), France (INRA) and Wageningen (the Netherlands). This is virtually no overlap among this select group because: they use different sizes of pigs; are asking different, although related questions; and they each apply tracer technology in slightly different ways because of differences in resources and regulations.

Prairie Swine Centre works in many areas. PSC is the only place in Canada doing large-scale animal behavior research. They also conduct large-scale research on sow reproduction; they have a 600-sow unit designed for this. They conduct many nutrition experiments; primarily to demonstrate known ideas to convince producers to adopt them. These nutrition experiments require large numbers of animals in a commercial environment to properly study and deal with problems that are commercially relevant. Due to the fact that much of their work is of the demonstration type, PSC rarely has their research published in quality peer-reviewed journals.

Swine nutrition research at U of Manitoba is focused primarily on environmental impact of swine production. Dr J House is conducting quite basic research on methionine metabolism; Dr M Nyachoti is conducting feed evaluation and environmental research.

In Alberta, Dr Ruurd Zijlstra is conducting feed processing research and feedstuff evaluation. Dr Eduardo Baltrenena conducts feed evaluation research. Both are using traditional methods for feedstuff evaluation, however Zijlstra is also working to develop rapid new Near Infrared technology methods.

**Table 4.1: Swine Research Expertise across Canada**

| Institute | Broad View of Expertise | Current or Recent Projects |
|---|---|---|
| AAFC Dairy and Swine Research and Development Centre | • Sow productivity<br>• Animal welfare<br>• Production environment<br>• Nutrition<br>• Genetics<br>• Economic and environmental impacts of production<br>• Meat quality | • Increasing milk production by optimizing hormonal status and the management systems used during gestation and lactation.<br>• Role of prolactin in mammary gland development<br>• Effect of various management systems on sow, gilt and piglet performance.<br>• Identify stress factors that affect productivity and welfare.<br>• Needs of swine for B-complex vitamins.<br>• To accelerate genetic improvement for desirable production traits using molecular and quantitative genetics<br>• To better understand the mechanisms involved in the regulation of immune responses and of the role played by cytokines<br>• Developments of a mathematical model to determine feeding and management methods that will optimize swine production systems.<br>• Effects of pre-slaughter handling on meat quality<br>• To improve management of manure, slurry and other by-products to be used as fertilizers |
| AAFC Lacombe Research Centre and the Beaverlodge Research Farm | • Meat quality<br>• Meat safety<br>• Forage-beef interface<br>• Integrated cropping systems | • Post-mortem evaluation and control of the variation in composition and quality of carcasses and meat<br>• Prevention of meat contamination with and growth of pathogens and spoilage bacteria during processing and distribution<br>• HACCP implementation and quality management<br>• Factors affecting palatability of meat<br>• Molecular markers for improving meat and carcass traits<br>• Anti-microbial strategies to improve the safety and extend the storage life of meat<br>• Development and assessment of methodologies and instrumentation for the estimation of carcass yield and grading<br>• Ante-mortem management of livestock stress, meat yield and quality |
| Prairie Swine Centre | • Animal behaviour<br>• Nutrition<br>• Engineering<br>• Environment impact<br>• Economic efficiency<br>• Sustainability | • Focus of research is 'near market' research (1-3 years before it can be used by producers)<br>• Two major foci are economic efficiency and sustainability<br>• Optimum feeding and management procedures to reduce the cost of feeding<br>• Maximum economic returns from local feed diets<br>• Focus on animal behaviour and engineering to optimize net income<br>• Improvement of air quality inside swine barns<br>• Social behaviour of animals<br>• Operating systems and management procedures to ensure long-term environmental sustainability |
| Vaccine and Infectious Disease Organization | • Vaccine technology development | • Research is not strictly livestock focused.<br>• Neonatal immunization<br>• SARS |

| | | |
|---|---|---|
| | | • Bacterial biology and antimicrobials<br>• Food safety vaccines<br>• Molecular interactions in pathogen recognition<br>• Bovine and porcine adenovirus vectors |
| University of Manitoba, Swine Research Program and National Centre for Livestock and the Environment | • Nutrition<br>• Animal behaviour<br>• Animal reproduction<br>• Feed and feeding<br>• Environmental impacts of swine production | • With the new National Centre, research will be focused on long-term projects (15-20 years)<br>• Research focuses on the whole value chain<br>• Improving reproductive efficiency: relationship between reproductive performance, lighting periods and hour of day that sows are weaned<br>• Impact of temperature on stress and productivity<br>• Transport of young pigs and stress levels<br>• Effects of housing type and exercise on sow and gilt health<br>• Assessing nutrients in MB crops to maximize home grown advantage of using local feed<br>• Impact of diet on the immune system<br>• Effects of water quality on pig performance<br>• Assessment of odour and how to measure it and how diet affects it<br>• Methods for measuring seepage beneath manure storages<br>• Movement of nitrates and microorganisms in soils after manure application<br>• Identifying and finding control measures for harmful micro-organisms in meat products<br>• Economic impact of swine production at the community, regional and provincial level |
| University of Guelph, Pork Research Program | • Infectious diseases<br>• Immunology<br>• Virology<br>• Nutrition<br>• Genetics<br>• Epidemiology<br>• Reproduction<br>• Economics | • Carcass composting<br>• Effects of timing of sow and gilt insemination on performance<br>• Effects of vitamin E for growing-finishing pigs<br>• Effects of heat, humidity and farm size on transport losses<br>• Effect of light and heat on stress levels<br>• Effects of genetic consistency on carcass and profits<br>• Effects of storage methods on pathogen survivability<br>• Measuring the amount of methane that pigs produce<br>• Strategies to minimize pig pathogens<br>• Improving the effectiveness of frozen semen<br>• PRRS virus vaccinations |
| Groupe de Recherche sur les Maladies Infectieuses du Porc (GREMIP), University of Montreal, Faculty of Veterinary Medicine | • Infectious diseases<br>• Porcine virology<br>• Vaccinations and therapy<br>• PRRSv<br>• Bacteriology<br>• Immunology | • Epidemiology and control of enterobacteria in swine<br>• Pathogenesis and control of Salmonella in infection in swine<br>• Anti-microbial resistance of microorganisms<br>• Identification of virulence factors of E. coli associated with post-weaning diarrhea in piglets<br>• Regulation of expression of virulence factors<br>• Development of serological tests for the detection of Salmonella and Yersinia enterocolitica in pigs |

| | | |
|---|---|---|
| | | • Diagnosis and control of porcine mycoplasmosis<br>• Development of molecular tools for the diagnosis of bacterial diseases of pigs<br>• Development of vaccines |
| Atlantic Swine Research Partnership Inc. | • Nutrition<br>• Feeding<br>• Economic efficiencies of production<br>• Herd health<br>• Environmental impacts | • Research into the feeding value of: rye, hulless oats, and soybeans<br>• The value of enhanced key anti-oxidants on pig health and pork quality<br>• The value of enzymes and probiotics on growth, feed efficiency, manure odour and greenhouse gas emissions<br>• Factors involved in the development of Post-weaning and Wasting Syndrome in commercial pigs<br>• The feasibility for selecting for enhanced immune capacity during genetic selection of purebred pigs<br>• Cost of production associated with commercial feed sources available in Atlantic Canada<br>• Carcass demerit and shrink associated with increased transportation length of pigs from farm to slaughter |
| University of Alberta, Swine Reproduction & Development Program and Swine Nutrition Program | • Swine nutrition<br>• Amino acids<br>• Reproduction<br>• Gilt development | • Determine amino acid requirements<br>• Evaluate feedstuffs<br>• Develop new nutritional methods<br>• Improve pig health by diet<br>• Use pig as method for human nutrition<br>• Improve sow fertility<br>• Improve gilt management<br>• Develop new reproductive technologies<br>• Improve understanding of reproductive mechanisms |

## 4.3 Academic and Scientific Impact of the Programs Within Canadian Universities

This section assesses the Alberta swine research programs' impact on the domestic swine industry from a research and academic perspective. This was conducted through consultations with private and academic research leaders across the country from the research programs and centers listed above. These consultations were undertaken to assess their familiarity with the research conducted in Alberta and their perceptions of it.

In total 15 interviews were carried out with various researchers from the above mentioned research centers and programs. In addition, interviews were performed with swine researchers from other centres and Universities that do not have a pork or swine research program per se. A formatted questionnaire was developed for use during the consultative/interview process to ensure consistency of information collection; it is shown in **Appendix A**. All of the consultations were conducted via telephone interview and/or email correspondence.

The type of information that was collected during the interviews includes:

- Familiarity with the Alberta research program, key research personnel
- Familiarity with specific work that has come out of the research programs
- Perception of quality, rigor, efficacy and applicability of research
- Perception of uniqueness of what the University of Alberta programs provide the industry or the overlap of research that is being conducted (this was covered in the discussion in Section 4.2 and will not be covered in this section)
- Perception whether the University of Alberta should continue to foster the expertise in swine nutrition and reproduction that exists there now
- Interviewee's own research expertise
- How research priorities are determined at the centers and universities ((this was covered in the discussion in Section 4.2 and will be covered further in Section 6.0 and will not be covered in this section)
- During these interviews researchers were also asked to express their views on the research needs of the future for the swine industry, this will also be discussed in Section 6.0.

The following discussion represents the results from the 15 Canadian interviews completed.

### 4.3.1 Familiarity with the Centre, Research Programs and Key Research Personnel

Interviewees were first asked whether they were familiar with the University of Alberta's Swine Research and Technology Centre, particularly its Swine Reproduction and Development Program and/or the Swine Nutrition Program, as well as the key research personnel.

The majority of interviewees were very familiar with both the research programs and the key research personnel. Most have also worked closely with either Ron Ball or George Foxcroft. As mentioned in Section 4.2 by one interviewee there seems to be a disconnect between the federal research stations and the Universities and this seems to be the case since some of those not familiar with the programs and researchers were from the federal research stations. Also, there

may be a slight disconnect between swine researchers in Quebec compared to the rest of the country since a high number of those we interviewed in Quebec were unfamiliar with either the program and/or Ron Ball and George Foxcroft.

All of the researchers that know and have worked with Foxcroft and Ball expressed their high regards for the quality of their work and the value that they have provided the industry.

### 4.3.2 Familiarity and Perception of Specific Research from the Alberta Research Program

Interviewees were then asked about their familiarity with some of the specific work that has been done at the University of Alberta in the Swine Reproduction and Development Program and/or the Swine Nutrition Program and to comment on the quality and intellectual rigor of the research in these programs.

Overall respondents were familiar with some specific work that has been conducted at the University of Alberta. Both the work and the researchers are highly respected. Below are comments received that are representative of the overall sample:

- Extremely relevant work for our industry
- The research focus at the University of Alberta provides relevant research that has affected Canada's swine production competitiveness.
- Good quality research
- Excellent innovative research and useful for swine nutrition and even for human nutrition. The research on reproduction is also at a high level.
- It can be seen from the scientific publications that both researchers are published in that they are excellent researchers and conduct research with rigorous methodology.
- One of the reason's the PSC doesn't do work in swine reproduction is because of the world class program at the University of Alberta, therefore there is no point in duplicating the program
- Foxcroft's work is absolutely first class and he does a good job of extending his work to commercial applications.
- Ball's work is excellent, he is published in the top journals
- Ball is the authority in amino acid research
- Ball's work is not as application-friendly, it would be hard to find a producer who would have used Ball's work on his/her operation
- The work that comes out of Foxcroft's program is always high quality and quite rigorous, the general feeling is that any work that comes out of there is highly reputable. The actual experiments that are conducted are very detailed, very well put together.
- Very familiar with the work. The quality of this work is first rate, a sound blend of basic and applied research. Some of what they do is very basic but both researchers can talk and describe their research to both scientists as well as pork producers.
- Yes, familiar with some studies and articles that have come from both researchers. The work shows that they are looking at issues that are very important to producers and to the industry and to maintaining its strength. The research is very well designed and well executed and this leads to high quality and rigor of the work.

Overall, the general thinking from across Canada is that the work that comes out of the University of Alberta programs is of very high quality and regarded as having intellectual rigor and is very reputable.
Interviewees were asked if they have ever used the results of the research from the two programs in their own research. Many of the interviewees have not only used their work but have collaborated with the researchers at the University of Alberta. As mentioned in Section 4.2, repeatability of results is an important aspect of the scientific methodology and all scientists try to duplicate the work of others and learn from it, therefore a few of the interviewees mentioned conducting similar research projects with a different approach than Ball or Foxcroft and comparing their results and findings.

A number of comments were made that Foxcroft's basic work is not used because he does a good job of applying it himself.

Some of the representative comments include:

- Have used Ball's work in background of what we do, but have not taken his conclusions and changed them to fit into a research project that we are conducting.
- Yes, have used the research results from Foxcroft to build on other experiments. This research is definitely very applicable to the industry and George does a good job of explaining how that can take place and the benefits of the application. George interacts with producers and explains this to them. However, any good program needs a mix of applied and basic research and this program maintains a good mix of both.
- Yes, we have used their work and have collaborated with Ron Ball – have made recommendations on weaner pig nutrition based on Ron's work.
- We have used George's work in our gilt breeding and development. We have borrowed some analysis techniques from George to use in our experiments.
- Have not used the research for my own purposes primarily because we look at different issues, but find the results interesting.

By their comments the interviewees suggest that the work coming out of the University of Alberta programs is highly valuable and used to continue to learn more with further exploration from other researchers or the personnel at the University themselves to be applicable to the industry.

Lastly, interviewee's were asked if Alberta should continue to build on the swine nutrition and swine reproduction expertise that now exists at the University of Alberta. This question was asked since the key research personnel, who the industry is just as familiar with or more familiar with than the program itself, are in the latter stages of their careers. Interviewees agreed that the research being conducted at the University is extremely important, valuable and such a high quality that they agree that it needs to be continued.

One interviewee suggested that he was impressed with the recruitment process that the University of Alberta uses. The specific appreciation is centered in that the University recruits personnel based on the strength of the candidates and not by the type of research that they conduct to fit a niche. This makes the interviewee slightly pessimistic or concerned that these research programs will not be retained even though they should be continued.

One interviewee suggested that if the research programs were not fostered then the University of Alberta would be missing out on important research and already established industry connections. Furthermore, there is the concern that the industry would not be building on the successes of the past if this research does not continue.

There is a prevailing view among several researchers across the country that there are many young researchers that could step into a more public role at the U of A. There is a perceived problem that the programs at the University of Alberta are the 'Ron and George show' and not simply the programs themselves. Whereas, at Guelph or the University of Manitoba for example there are many more researchers that come and go and there is not a dependence on one or two. Therefore, it is an appropriate time to be grooming junior researchers to carry on the more public roles that Foxcroft and Ball have been put in. It is also important to begin grooming now since Foxcroft and Ball have talent and leadership that need to be passed down.

Observations

There is a tendency to be skeptical about the opinions voiced by academics regarding the work of their counterparts in other universities. That is, the perception is that researchers may not be inclined to speak frankly or in a less than favorable way about colleagues. It is important to note, however, that these interviews were conducted with anonymity guaranteed. Furthermore, based on previous research projects conducted by the George Morris Centre as well as staff academic experience, academic researchers typically are willing to critique the work of others in the field. In fact, it is the nature of scientific researchers to probe and to question results. In that light it is of great interest to find that in this case, various researchers from across the country are expressing such a high level of appreciation for the work of their contemporaries. In fact, the level of respect and regard for which the two lead researchers are held is unusual. This respect is a testimony to the rigor and efficacy, which the programs exhibit, from an academic and scientific perspective.

Furthermore, both Foxcroft and Ball were hired to research chairs with the support of Alberta Pork that specified nutrition and reproductive physiology and breeding management as the areas of focus. The infrastructure and research programs that are therefore developed at the University of Alberta since 1998 clearly reflect this focus. There is no comparable infrastructure or research activity at other Western Canadian universities or research institutions. Indeed within Canada, no comparable program in the swine area exists.

Over the years the complimentarily of research activities has avoided major duplication and the three producer boards discuss areas of specialization and research overlap on a regular basis. Indeed in several instances, the nutrition program at the Prairie Swine Centre, the health vaccine R&D of VIDO, and the Swine Reproduction Development Program at the University of Alberta attract funding from all three producer check-off programs. This implies that these agencies recognize the regional expertise that exists, and are prepared to consider out of province funding.

## 4.4 International Academic Analysis of University of Alberta Swine Research Programs

This section assesses the Alberta swine research programs' impact on the international swine industry. This was conducted through consultations with private and academic research leaders in the United States, Europe and elsewhere to assess their familiarity with the research conducted in Alberta and their perceptions of it.

In order to receive a satisfactory number of responses to our request, we cast a broad net with respect to asking researchers from a number of countries to participate. We did approach researchers in Denmark and France but received no responses. In the United States we targeted universities with swine research programs and centers. In addition, specific questions were asked of international scholars who had conducted research with either Ball or Foxcroft.

The following is a list of the programs/institutions that the researchers that we spoke with are associated with:

Australia:
1) Australasian Pig Science Association
2) Pig and Poultry Production Institute, South Australian Research and Development Institute

France:
1) Cybélia - Groupe GLON, Centre d'affaire ODYSSEE, Pork Research and Development

Scotland:
1) Scottish Agricultural College: Animal Nutrition and Health Department and the Animal Behaviour and Welfare Department

United States:
1) USDA, Animal Health Division
2) Ohio State University
3) University of Minnesota, Swine Disease Education Centre
4) Purdue
5) Texas Tech University
6) University of Pennsylvania
7) University of Kentucky
8) University of Missouri-Columbia
9) Kansas State University
10) University of Illinois
11) Michigan State University
12) Iowa State University, Iowa Pork Industry Center

In total 25 interviews were conducted with various researchers from the above mentioned research centers and programs. A formatted questionnaire was developed for use during the consultative/interview process to ensure consistency of information collection; it is shown in **Appendix B**. In some cases these consultations with the researchers were conducted via telephone but the majority were conducted through email. The international interviews were very similar but shorter than those described above in Section 4.3 with Canadian swine researchers.

In addition to those formal interviews, more informal confidential interviews were conducted via e-mail with selected academics from approximately 10 universities and government stations in the US and Europe. These interviews were conducted confidentially and as such, the institutions will not be noted in this report.

Types of information that was collected during the interviews include:

- Familiarity with the Alberta research program, key research personnel
- Familiarity with specific work that has come out of the research programs
- Perception of quality, rigor, efficacy and applicability of research
- Interviewee's own research expertise
- How research priorities are determined at the centers and universities
- During these interviews researchers were also asked to express their views on the research needs of the future for the swine industry (Appendix B, Question B3), this is discussed in Section 6.0.

The following discussion represents the results from the 24 interviews completed.

### 4.4.1 Familiarity with the Centre, Research Programs and Key Research Personnel

Interviewees were first asked whether they were familiar with the University of Alberta's Swine Research and Technology Centre, particularly its Swine Reproduction and Development Program and/or the Swine Nutrition Program, as well as the key research personnel.

The majority of interviewees were familiar with the research programs (19/24), three were vaguely familiar and two did not know of the programs. A few respondents did comment that they had toured the facilities or have seen the researchers from the programs at industry conferences and presenting research. A number of respondents did comment that they were more familiar with the research and key researchers than the actual programs at the University of Alberta.

In that regard, the majority of the interviewees were familiar with the key research personnel; Dr. Ron Ball and Dr. George Foxcroft. Many were familiar with both researchers and their work which is highly regarded; the degree of familiarization reflected the interviewee's own area of expertise. A couple of interviewees also mentioned Dr. Aherne and his work from years past. Only one comment out of the 24 interviews was negative toward the researchers, in particular George Foxcroft, the interviewee suggested that George Foxcroft is overconfident and not open to alternate observations regarding his research.

### 4.4.2 Familiarity and Perception of Specific Research from the Alberta Research Program

Interviewees were then asked about their familiarity with some of the specific work that has been done at the University of Alberta in the Swine Reproduction and Development Program and/or the Swine Nutrition Program and to comment on the quality and intellectual rigor of the research in these programs.

The majority of respondents were familiar with some specific work that had been conducted; only three respondents were not familiar with any work coming out of the programs. Examples of research that respondents were familiar with include:

- Reproductive efficiency work
- Amino acid requirements for pigs
- Reproductive endocrinology in the sow

Overall, the general thinking is that the work that comes out of the University of Alberta programs is of very high quality and regarded as having intellectual rigor and is very reputable. Specific comments can be seen in **Appendix F**

Interviewees were asked if they have ever used the results of the research from the two programs in their own research. Approximately half of the respondents had use the research results in some form including developing their own models, in order to choose the direction of their own research, to construct controls in experiments, in literature reviews, extension programming and in industry presentations. Again, see Appendix C for specific comments. Interviewees were also asked to comment on the programs' efficacy and applicability to the industry.

In general, the majority of interviewees feel that the research coming out of the University's swine research programs has good efficacy and excellent applicability to the industry and its needs; see complete comments in **Appendix F**.

Based on the survey results the following is a representative comment of the views of the international academics that responded regarding Dr. Ball:

> I have used his basic nutritional results to adjust my research protocol when I used to work for an amino acid company. Currently I am further away from directly using his research results, but would incorporate his research results pertaining to lysine and threonine metabolism if or when I conduct research evaluating these amino acids in animals. I do consider his results on threonine metabolism in designing research experiments utilizing fibrous feeds in nonruminants as his research has shown the impact that method of feeding or diet formulation may have on threonine requirements.
>
> Dr. Ball seems to be very efficient in publishing his research as well as training well qualified students. He also appears to be very efficient in getting his students to get their data published.
>
> Dr. Ball's program will continually be used by other scientists in evaluating not only their basic research program, but will also use his basic and applied research to move forward their own research program that can be directly applied to the animal industry.

Another comment that is perhaps even more representative of what international peers have to say is the following:

> Dr. Ball's research is high quality and is relevant to both biomedical and agricultural audiences. I have great respect for his work. These studies are state-of-the-art methods in nutrition and metabolism using novel approaches with isotopic tracers to identify gut and whole body metabolism and nutrient requirements. I use his work to formulate new ideas and hypothesis in my research projects.

Observations

Based on the comments received from key international swine researchers the University of Alberta's Swine Reproduction and Development Program and Swine Nutrition Program are well-known and highly regarded throughout international academic circles.

It can be said that the high quality and rigorous research that is conducted in these two programs has had a significant impact on the international swine industry research community. This can be stated because they are highly recognized and have spawned research at other centers in many forms. The key example in this regard has been the ability and willingness to build on the U of A research results or by utilizing the research in literature reviews.

A final point to note is that based on the reviews of the swine programs across Canada and the international sampling, it should be noted that the work of Foxcroft and Ball is unique. That is while there may be similar broad areas, the specific work is not being duplicated elsewhere. This is not an assertion regarding the value of the work necessarily, but it is a very important point to note going forward.

## 4.5 Private Sector Perceptions of University of Alberta Swine Research Programs

This section of the report summarizes the views of approximately 30 officers and staff members in the Canadian and US swine industries. The interviews and questions were structured in a similar manner to those noted above within the academic field. These staff members are from across section of sectors including producers, feedmills, packing, genetics and animal health. The purpose of this section is to discern the industries understanding and appreciation for the swine nutrition and reproductive technology programs at the University of Alberta.

As with the academic interviews, these discussions with industry personnel were not meant to be representative surveys. Their purpose is simply to solicit well-informed opinions and viewpoints. In that regard, the discussions with producers were slanted toward those that were reasonably aware of the U of A programs and their history. In fact, discussions with industry suppliers and downstream participants were also geared toward those staff that might be most aware of the U of A.[13]

With that noted, the overwhelming majority of interviewees were aware or somewhat aware of the work of Foxcroft and Ball. Of those that were aware of the two scientists and their work,

[13] It would make little sense to hold discussions with staff in areas or jobs that are not involved with either nutrition or breeding.

there was strong appreciation and respect for their work. For example, a familiar expression with regard to Ball was "world class scientist." A common view regarding Foxcroft was that he was respected internationally. There was a sentiment among a very few that Foxcroft's work was no longer necessary or that Ball's work was too basic and not applicable. The view on Foxcroft was that the time for that research had passed and that genetics companies or larger production firms were more than capable of moving forward without that research. Even with those who expressed concerns, there was strong respect for the work and capabilities of the two scientists.

Of those that were familiar with the work of Foxcroft and Ball, most also said that they utilized their work in their own fields. This was particularly true of Foxcroft's work and to a lesser extent with Ball's work. For example feed industry nutritionist have collaborated with Foxcroft and utilized his research papers when working with producers and when conducting their own tests. Genetics firms, familiar with Foxcroft, utilize his papers in order to manage their reproductive programs. One of the largest genetics firms for example states that they look to Foxcroft's work in order to follow it and build on it and help their customers. This firm contributes financially to the reproductive management program.

Similarly an exceptionally large hog production operation says that they utilize Foxcroft's work to provide answers to their challenges in reproductive technology. This firm also has funded reproductive technology research at the U of A. This view is shared by another very large producer group in the United States.

Of course this view is not universally shared. Two very large western Canadian production units have said that they have used the work of both programs. With that noted, however, they assert that the U of A work is too basic and that in recent years they have chosen to utilize and fund the work of the Prairie Swine Centre as well as a swine research centre in the US.

Observations

There is no way to categorically claim that the private sector either does or does not place value on the work of the two programs. Nevertheless, based on discussions with industry personnel that do work with the research results of the two programs, it is clear that it is valued. This is particularly true of the work of Foxcroft. Industry leaders and adopters utilize the reproductive technology results and apply it to their own operations or to the operations of their clients. The industry appreciates that the work of Ball is sometimes more basic research that can be applied and utilized by other researchers.

## 4.6 Beneficiaries of the Research Summary

The discussion in section 3, regarding the qualitative and quantitative results of the research of Foxcroft and Ball, indirectly indicates that the ultimate beneficiaries of the work of Foxcroft and Ball are hog producers. The basic and the applied research of Foxcroft and Ball are focused on the hog producer's economic performance via the mechanisms of nutrition and reproductive technology.

With that noted, it is also important to note that producers are typically indirect beneficiaries of the research. In the case of Ball, for example, the overall nature of his research is very basic. Dr. Ball himself notes that many of the end points of his work have yet to come to fruition. In fact, the research projects and results quantified in section 3.3 above may be regarded as important by-products of his research.

In that regard, producers from Alberta, Western Canada, and around the world, who are or will be the ultimate beneficiaries of the work of Dr. Ball, have yet to fully appreciate or enjoy the outcomes of his work. This is not particularly unusual as this is the nature of basic research in its early and mid-stages. With that noted, however, it is import to recall that even the by-products of his research as evidenced in section 3.3, have powerful benefits for producers.

With regard to Foxcroft, again, much of his research can be classified as basic research. At the same time, however, he has tended to focus a greater share of his professional time on projects involving industry. This is not a value judgment or a statement that is either positive or negative. Instead it is just a matter of approach. In particular, Foxcroft's projects, workshops and private counseling have tended to focus on areas in which large scale producers, feed companies, nutritionists, veterinarians and genetics companies are deeply involved. As such, these larger-scale producers or industry suppliers have tended to be direct beneficiaries of the work of Foxcroft. In fact, as noted above, it is the industry suppliers such as genetics companies, feed companies, nutritionists, etc, that have embraced the work of Foxcroft to advance their own programs. These companies then utilize the work of Foxcroft in their own businesses. These businesses in turn are on the front-lines dealing with the needs and demands of hog producers.

Other beneficiaries of the work of Foxcroft and Ball are of course the graduate students and other universities around the world that follow the work of these two scientists. In fact as is chronicled in the sections of this paper, the work of Foxcroft and Ball is respected and admired in academia around the world.

In summary then the beneficiaries of the research of Foxcroft and Ball are the following:

1. Hog Producers
2. Academics and University Researchers around the world
3. Hog industry supply companies

# 5.0 Future Swine Research Program Focus and Opportunities

This section of the report discusses the swine research needs of the future. This section also discusses what role the University of Alberta could play in providing research requirements to the industry. Finally, this section of the report reviews what role the Nutrition and Reproductive programs could have in the future. The basic purpose of the section is to evaluate future needs and to assess what role, if any, the two programs might play in the future.

It is important to emphasize that although industry and academic staff were asked for their opinions regarding the future priorities, this report is not purporting to provide an industry viewpoint. Industry leaders and academics were asked their opinions on the future, but this in no way implies a consensus view or even that these views are representative. Opinions were merely asked in order to understand general perspectives and concerns.

## 5.1 Framework for the Future

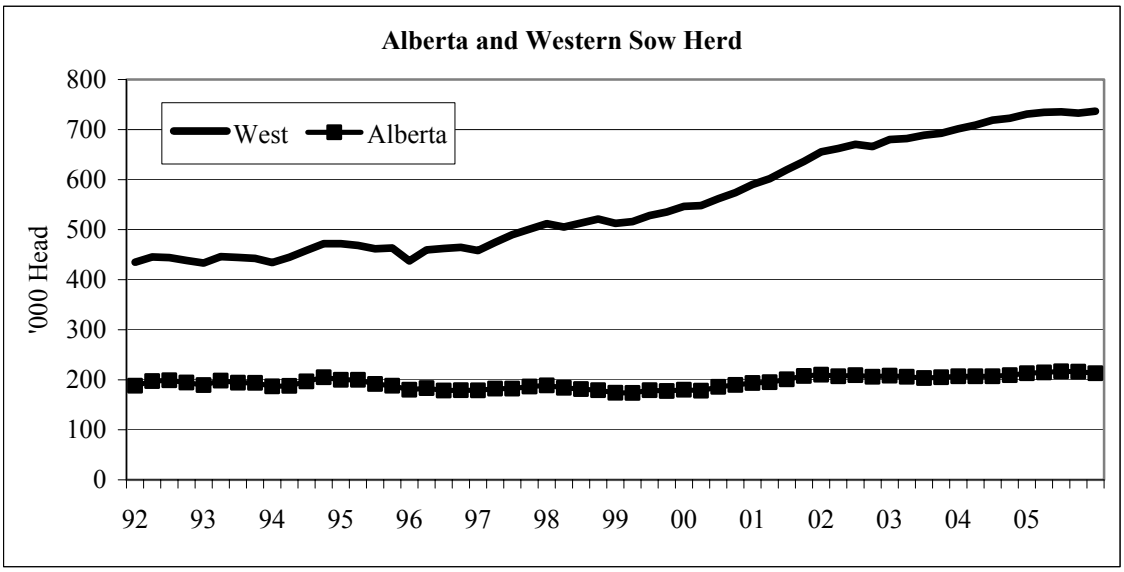
This section of the report seeks to describe the broad framework and conditions in which the industry will be operating within the next five to ten years.

The George Morris Centre defines competitiveness as the ability to profitably gain or maintain market share in domestic and export markets. That definition takes into consideration costs, efficiency, productivity and revenue growth. Clearly, for any industry to survive and prosper it must be competitive with other companies, regions or countries. A key assertion of this paper is that for any research program to have value in the future, it needs to contribute to the pork industry's competitiveness in Alberta. It needs to do this by contributing in any way to the reduction of costs, increased efficiency, improved productivity or revenue growth.

It is within that definition of competitiveness that the research priorities of the future will be evaluated and determined. In addition to that definition, the future reality of Alberta's production environment and the pork market dynamics must also be considered

### 5.1.1 Producer and Hog Numbers

A starting point in assessing future needs is to provide a description of what the industry might look like in the future. The overall description needs to begin with an assessment of sow numbers and industry size. The following graph shows the quarterly sow herd inventory in western Canada in general and in Alberta in particular from 1992 through 2005.




**Source: Statistics Canada**

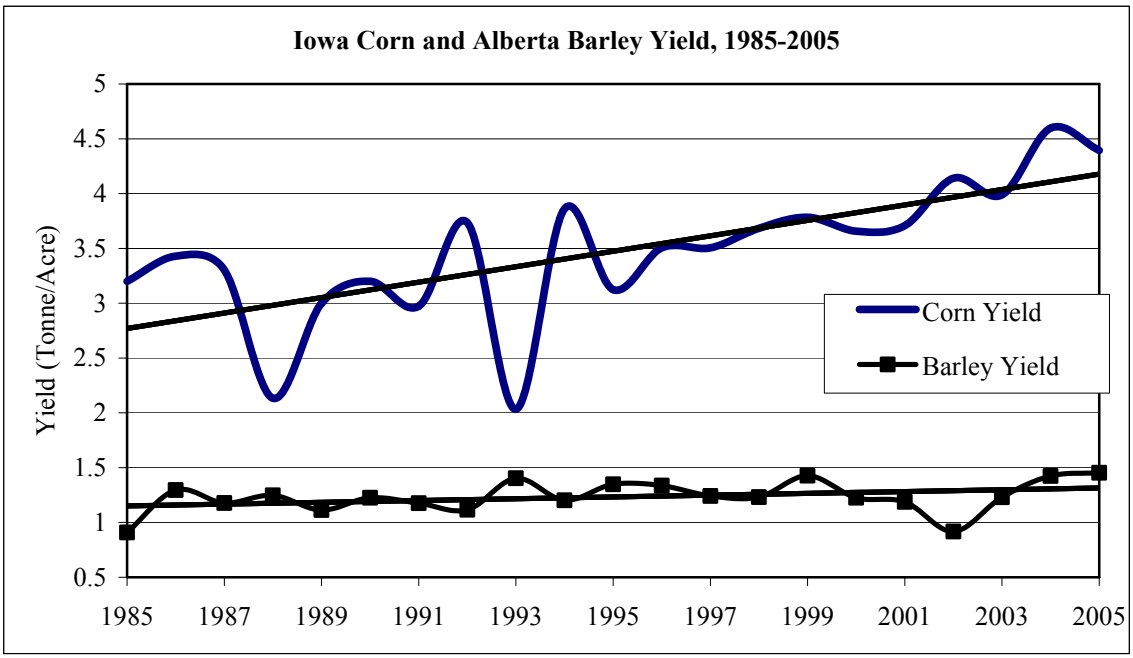
The graph shows that there has been little or no growth in Alberta during the past decade and a half. At the same time, however, the western herd has grown dramatically, driven by growth in Manitoba and to a lesser extent in Saskatchewan. Key reasons typically cited for this lack of growth are the following:

- Expensive land prices in Alberta relative to the other prairie provinces
- Weaker market access to packers, particularly in the US
- Higher feed grain prices in Alberta compared to Manitoba and Saskatchewan
- Higher labor costs

More recently, the imposing burdens of Alberta's environmental controls have also served to impede production growth in the province. In addition, the soaring costs of energy have brought forward new demands for alternative fuels, many of which are grain based.

With regard to feed costs, the main reason for higher feed costs in Alberta is of course the exceptional demand for feed grains due to the province's cattle feeding base. Another less well-known, but equally important reason is the ongoing lag in barley yields on the prairies in general and in Alberta in particular. This lack of advance in barely yields stands in contrast to the corn yields in the US mid-west. This is a supply and productivity issue that is growing annually (see graph below).

Finally another reason for the higher feed costs in Alberta relate to the fact that Alberta is closer to tide water than the 2 more easterly prairie provinces. Given that fact, there is more freight further inland. That means the feed gets cheaper as you go north and east on the prairies. Fundamentally, the less freight to tide water means higher feed prices.




**Source: Statistics Canada CANSIM database and USDA National Agricultural Statistics**

Moving forward to the future, there is nothing to suggest that these major challenges will be lessened. In fact, as the industry moves into the lower priced end of the hog cycle, it is expected that a material number of operations will exit the hog business in Alberta. This is on top of the fact that, according to Statistics Canada data, over the last ten years up to 2005 the province had already lost up to 50% of its operations. That estimate is far greater than the losses in other leading hog producing provinces.

The producer and sow numbers of course have profound ramifications for Alberta Pork, the most important swine research funding operation in Alberta. As producer and sow numbers stagnate or decline, the ability to fund research becomes increasingly difficult.

### 5.1.2 Market Dynamics

Canada, and in particular Alberta, is focused in export markets for pork. Canada now exports over half of all pork production. This does not even count the live hog exports. Export markets are primarily growing due to the expansion of lesser-developed economies around the world.

Domestically, the Canadian market for pork is characterized by a high level of stability. The domestic market neither grows nor declines in a material manner.

The ramifications of these general export and domestic market dynamics are that Canada needs to ensure access to export markets in order to continue to grow. Domestically, it becomes even more important to provide value and differentiation to consumers who have a wide variety of choices. It appears that leading pork processors in Canada have chosen to differentiate their pork offerings based on safety, health, animal welfare and other factor such as those.

### 5.1.3 Implications

Given those broad dynamics described above, the following are the implications to the industry and to the future swine research situation.

- Alberta producer check off money for research programs will become increasingly scarce. Furthermore, those producers that remain in the industry will be much larger and more focused than ever on the allocation of check-off and research dollar expenditures.
- Access to export markets is crucial. Key barriers to entry will include animal health issues, as well as animal welfare and consumer safety issues, both real and imagined.
- In domestic markets as with export markets, consumer safety and product differentiation will be important from a marketing as well as market demand perspective.
- Within both export and domestic markets the need for competitively produced and priced pork products will continue to be the most important market driver.
- The drive for alternative fuels has both positive and negative ramifications for feed costs. On the positive side, there could be increased access to cheaper bio-fuel based byproducts. On the negative side, this increased demand could increase the cost of feed grains.

These implications in turn are the key issues that the industry will face in the future. As outlined in this framework for discussion, the assertion here is that future swine research in Alberta must address these key issues.

### 5.1.4 Industry Priorities

Industry leaders in academics, government and the private sector (including producers) were canvassed to determine their thoughts on priorities for swine research in the future. This canvassing was part of the overall process of understanding their perspectives on the work of Foxcroft and Ball. Based on these leaders' assessment of where the industry is headed in the future and their own business priorities, these leaders put forward general thoughts on what swine research is needed. The following is a summary of the representative thinking of future research priorities (not listed in any particular order). It is important to note that this listing is no way meant to be a representative sample of what "the industry," believes to be the priorities. Beyond the first hand research conducted for this project, it is also noted that during 2004, the pork industry in Alberta, led by Alberta Pork was engaged in a strategic planning process to evaluate and discern swine research priorities. That process involved a consulting firm and a two-day planning process/worship, which included a variety of industry representatives.[14] The major focus of the workshop was defining ways for Canada and Alberta to maintain and reinforce their competitive advantage in an increasingly competitive global market. At that time, the top three priorities identified by the workshop were:

- Regaining our feeding advantage
- Disease detection, prevention and treatment – specifically foreign animal diseases
- Policy and Market Analysis

[14] Alberta Pork, Research and Development Strategic Planning Session, August 2004, Workshop Summary

Other higher ranked priorities included societal acceptance of modern production practices; air, soil and water benchmarks; carcass quality and; alterative energy sources.

The top priority evolving from the session relates to the feed grain productivity and quality issue. The second ranked priority regarding disease is also an obviously important challenge that will be with the industry for many years.

For its part, Alberta Pork through its research committee has tended to prioritize its swine research in the following manner:

Level 1 Pig Nutrition
Reproduction
Health and Disease

Level 2 Animal Behaviour/Wellbeing/Care
Environmental Issues (Air/Water/Soil)
Genetics
Marketing – Optimizing Producer Value

Prioritizing

There is no intent in this report to provide representative samples of what the industry desires for research priorities. At the same time, however, based on George Morris Centre understanding of industry priorities, the listing below in fact does provide solid guidance as to the swine research priorities of the future, the following are key challenges.

- The need for swine research in Alberta is overtaken by the need for research into feed grain productivity, quality and yields. This is necessary in order to address the growing lack of productivity on the prairies, relative to competing regions in the US (see graph above).
- The potential negative impact of swine disease and health challenges are obvious. Research into causes and prevention of swine health challenges is a very important priority now and in the future.
- There is a need for research into alternatives to antibiotics. Consumers domestically and internationally are demonstrating an aversion to meat from livestock treated with antibiotics. It is thought necessary to develop antibiotic alternatives in order to ensure continued export access and domestic market development.
- As of now, it is too early to tell whether alternative fuels are going to be harmful or beneficial regarding feed grains costs. This is a future issue, however, and the pork industry needs to understand how to utilize and benefit from the by-products of this feed sector.
- Improve reproduction and nutrition productivity. There are no two issues more important to swine competitiveness than increased nutrition efficiency and improved breeding herd productivity. Both of these areas address cost reduction and revenue enhancement and both issues will always be important. There will always need to be a focus on swine nutrition and reproductive technology if there is going to be serious efforts toward productivity and competitiveness.

## 5.2 Structure of Swine Research Funding in Alberta

The purpose of this section of the report is to suggest ways in which the future role of swine research in Alberta can be determined and how to manage the funding of that research. This section discusses funding framework concepts but does not seek to discuss the role of the various funding bodies, as they currently exist in Alberta. That information is easily accessed and publicly available. At the same time, the possible venues, including federal and provincial bodies, are almost too numerous to fully list. As such, it is the concepts that are addressed here as opposed to the specific vehicles. The only vehicles that are addressed in any way are the lead bodies in Alberta, which are AARI, ALIDF, Alberta Agriculture (AAFRD) and Alberta Pork.

### 5.2.1 Current Funding Mechanisms

Current funding practices in Alberta are based on the competitive market place of ideas. That is, while there is a great deal of government and academic funding behind swine research, there is also a material amount of private sector and producer money backing the research. In addition, the government funding bodies operate by default as a competitive marketplace for research funds. Ultimately, each researcher has his basic salary at least partially funded by the University but beyond that, swine research must compete with all other livestock, or even all other agricultural priorities for a limited pool of public and private funds. Even within the swine research realm, each scientist ultimately competes either as a team or individually for funding. The competition is based on ideas that are ultimately focused on the future needs and priorities of the industry.

The Funding Cycle[15]

Every year there are always winners and losers in the research funding marketplace. It is expected that the dollars go to the best ideas, person, place etc. Research in Western Canada functions like a free market economy. Each scientist is an entrepreneur in research, operating like a small business. For example, a leading scientist will market his own research ideas to an organization (funding body or firm for example). If the organization decides to buy the idea, the researcher is given money and, in return, provides new knowledge and information. The more valuable the ideas, compared to competitors, the more money the researcher can ask for and receive. The better the reputation the researcher has, compared to competitors, for delivering a quality product on time, the more likely he is to sell the next idea. When the researcher receives more money for more ideas, he makes more progress than competitors, publishes more papers, trains more graduate students, receives bonus salary increments and receives more recognition nationally and internationally. It is an increasing cycle that is limited only by the time, energy or ideas of the scientist.

As noted in section 2.1 of this report, even within a specific research area, collaboration within and across institutions is not common or widespread. There are several reasons for this but the most important one is that the scientists are all competitors for the same limited pool of grant money.

[15] Based on a written interview with Ron Ball

Current Funding Bodies

Within Alberta, the key private funding body is Alberta Pork, not simply in terms of dollars but in terms of influence. Since its inception in 1968, Alberta Pork has encouraged research and development in the improved production and marketing of hogs and pork. Steered by a producer Research Committee, Alberta Pork research funding has mainly been directed to projects that enhance the producer's bottom line at the production level. The main research focus has been pig nutrition, reproduction, health and disease followed by animal wellbeing and care, environment and marketing.

The portion of the producer's per hog levy invested in research is usually matched by other funding providers/grantors. Alberta Pork considers that this other funding is an important way to maximize the impact of producer seed money.

The Alberta Pork Research Committee periodically meets with its research partners to ensure that producer needs are satisfied. The ongoing process of meeting funders and research institutions creates understanding that leads to mutually agreeable research plans, greater collaboration between researchers and more effective projects.

The main local research institutions that Alberta Pork has worked with include:

University of Alberta
Prairie Swine Centre Inc.
Vaccine Infectious Disease Organization
Lacombe Research Station (AAFC)
University of Calgary
Alberta Research Council

In addition to Alberta Pork, swine based companies within Alberta and around the world provide private funding for swine research at the University of Alberta and at bodies across the prairies. The government of Alberta and the Federal Government are also active in funding swine research in Alberta. The main provincial government funding bodies related to swine research are AARI and ALIDF. Directly and indirectly related to these bodies is Alberta Agriculture (AAFRD). The department is a key partner in the decision-making and funding processes for both AARI and ALIDF and its direction is sought in all major directional issues and priorities. Alberta Agriculture, Food and Rural Development has appointed two non-voting members to the board of ALIDF.

AARI and ALIDF are members of the fifteen-member Agriculture Funding Consortium. Agriculture and Agri-Food Canada is also a member of the Consortium. The Consortium is a cooperative group of funding agencies whose goal is to streamline the grant application process and offer more collaborative opportunities. With one application, applicants can reach every member of the Funding Consortium. The process is simplified for applicants, yet still ensures their proposals are exposed to a number of funding agencies. Members of the Funding Consortium represent both industry sector groups and government agencies, so research and development priorities are consistent with an industry-based perspective.

Whether individually through the AARI and ALIDF or through the Agriculture Funding Consortium, the funding mechanism forces researchers to articulate their ideas, plans and projects within the overall priorities of the funding organization. To further ensure the strength and merits of these ideas, the mechanisms require industry funding, often in a matching amount.

The funding mechanisms in place today are by design or default built to encourage competition for research dollars based on the strength of ideas. The current funding framework in Alberta therefore fits well within this competitive marketplace of ideas.

While the forum is arguably very sound in Alberta, there are adjustments that could be made. For example researchers convincingly argue that experience indicates that grant selection committees that are not predominately scientists make less informed decisions because they lack the detailed and specific knowledge necessary to predict the long term outcome of the research and whether the individual is likely to be successful. Committees that are not predominately scientists are poor at identifying the qualities that make up top researchers compared to those that are in lower tiers. The current forms used in Alberta make it very difficult to assess the quality of the scientist. For other federal funding bodies such as NSERC and CIHR, the quality and experience of the scientist is as important as the proposed research.

### 5.2.2 Future Funding Concepts

Top researchers are typically not willing to dilute their money and ideas with someone whom the funding agencies, by allocation of their limited money, have already decided are less deserving. For example top researchers assert that large group projects without exception are much less successful than if the best 2 or 3 people had received the funding they required rather than everyone receiving less funding than actually needed. This is counter to the fact that many funding agencies often believe that forcing collaboration is a more effective use of their limited resources. Instead the reality is that more of the research investment can be less productively used because no individual scientist received sufficient funds to conduct a high quality program. In the other case a larger group is forced to compromise and thus conduct research that was less complete and produced less truly new information.

If the non-funded individuals and ideas are truly deserving of funding, then the system obviously needs more money. Both economic and biological principles mean that if this is happening (ie there are many deserving ideas and people that are not-funded) then the returns to additional investment will be significant.

*As such, a first key funding concept for the future is that funding should be focused on exceptional ideas and targeted priorities rather than generally spread.*

Funding priorities are often determined based on focus groups and industry forums, as in the 2004 workshop noted above. Industry, government and academics are often asked to participate in groups to set priorities for future research. These government and producer group forums can set goals in large areas and are logical and meaningful ways to determine these large goals. Beyond that, however, group settings also do a very poor job of selecting specific needs. Identification of global priorities or needs should be determined by industry – for example ‘research to regain comparative feeding advantage’ or ‘reduce environmental impact of pig

production' or improve reproductive potential'. However, only the scientists who are active in the area have sufficiently detailed knowledge of the world literature to identify the specific questions required to move forward on these priorities.

*A second key funding concept for the future is to note that industry priority setting is a worthwhile and logical endeavor. At the same time, however, it needs to be stressed that the priorities should be broad based.*

Another key point that needs to be addressed is the increasingly global nature not only of the swine industry but of swine research funding. For example in the case for Dr. Ball an important source of research funding is a firm from Germany while Foxcroft's funding often comes from major swine firms in the US. As a result, benefits of the research, whether at the University of Alberta or at any university, cannot be constrained by a local focus. Research now, more than ever will have global impacts and global reach. This does not mean that there are not specific local needs that should be addressed, but local production systems can be beneficiaries, as can producers around the world.

*Further to that point, another concept that needs to be recognized is that research project funding decisions should not be prejudiced by whether they are locally focused.*

As a final observation, research funding should be both project and program based. That is, researchers should be able to argue for longer term program funding geared to longer-term objectives. These programs can have several projects and targeted to those broader reaching objectives as opposed to project-by-project funding approvals. Long term stable funding of top notch Strategic Research Plans by government agencies is necessary for top-notch research vision to become reality. (Similar to the funding from NSERC and CIHR where 5 year grants are awarded to the most experienced and productive scientists). NSERC and CIHR are considered by leading scientists to be the two most competitive research funding agencies in Canada.

*A final concept for consideration therefore is that funding of strategic programs involving projects as tactical steps should also be open for funding on a longer term (five year) basis.*

Observation

Within the relatively minor adjustments noted above, it can easily be argued that the funding mechanism available to swine researchers in Alberta is properly structured and adequately flexible to varying needs. Fundamentally the market prevails in the Alberta structure and scientists with the best ideas and the most industry support will be allowed to prevail.

## 5.3 Nutrition and Reproductive Management as Future Swine Research Priorities

For the purposes of this project, the guiding principle is the competitiveness of the Alberta hog and pork industry. Within that broad framework, many research priorities can be applicable. In fact, each of the priorities listed in section 5.1.4 are nearly completely geared toward the advancement of the competitive position of the Alberta (and prairie) hog industries. Under the

spirit of the principles enunciated in section 5.2.2, each of these priorities can and should be allowed to come to the forefront by qualified scientific and industry backers.

The objectives and priorities of the Swine Nutrition and the Swine Reproduction and Breeding Herd Management Programs are clearly focused on competitiveness. These programs have gained the success that they have, as shown in this paper, due to the strength of the arguments put forward by Foxcroft and Ball. Moving forward, however, the question for this paper to address is not based on the strengths of Foxcroft and Ball, but on the strengths of the specific programs. That is because for the next five to ten years, the question that is the focus for this paper is not the individual scientists but the overall swine research priorities.

As has been noted in this paper many times in varying ways, there is nothing that impacts the competitiveness of an individual swine unit or of a industry in a regional more than nutrition and reproductive productivity. Both are at the forefront of being able to do more with less, or generating more output with reduced inputs.

In that regard, both Foxcroft and Ball have generated strategic plans outlining the merits of their future research priorities. There is no need to reiterate those plans in this space as they are both readily accessible.[16] The following two parts to this section outline the basic message of the two plans and provides a commentary on the relative merits.

### 5.3.1 Swine Nutrition as a Future Priority

Support to the swine industry has several main components: genetics suppliers, feed suppliers, equipment and construction suppliers, transportation suppliers, and packing plants. In the middle of this network is the commercial pork producer. Increasing market concentration in Western Canada has resulted in a small number of companies dominating each of these areas, with one exception. The majority of pigs are produced by farmers who purchase these supplies from other specialized companies. They depend upon these specialized companies to market up-to-date and modern and competitive supplies.

The exception is feed. Most farms still make their own feeds and still purchase their supplies from individual grain farmers. Only the very largest farms currently employ the expertise necessary to micro-manage this cost centre. Therefore, although feed is usually the single largest operating cost, it is often the least well managed in response to changes in market pressures.

Looking to the future, the Nutrition Program at the University of Alberta has argued that there are two things that need to be accomplished. One is to increase the unbiased information available to pork producers in such areas as: ration formulation, identifying pig growth potential, developing farm specific nutrition programs, quality control of ingredients, accurate nutrient analysis, etc. The second is to improve the nutrient information available on Western Canadian

[16] Strategic Research Plan of the Alberta Pork Producers, Research Chair in Swine Nutrition, University of Alberta, 1998-2008; Swine Reproduction -Development Program (SRDP), Full proposal submission, Final Draft as of April 2006, Dr. Foxcroft

feedstuffs and improve the information available on the nutrient requirements of Western Canada pigs under Western Canadian conditions (environment, disease, local feedstuffs, etc). Ball has repeatedly claimed that this will improve the cost competitiveness of the industry and support long-term sustainability of a pork industry in this region.

The Swine nutrition research program is focused on developing the next generation of information that will be needed on both the pig side (better knowledge of nutrient requirements) and the feed side (better knowledge of nutrient availability).

Priorities

A. Determine the amino acid requirements of modern high performing sows during both gestation and lactation. This includes measuring the biological and physiological parameters necessary to develop a much more accurate computer model that predicts sow nutrient requirements based on weight changes, number and weight of pigs and potential pig weight gain during lactation.

B. Further develop the indicator amino acid oxidation technique in order to: 1. more rapidly determine amino acid requirements in individual pigs and sows, and 2. more rapidly determine the true metabolic availability of amino acid in pig feeds.

C. Determine why pigs continue to metabolize indispensable amino acids, such as lysine, even when they are the limiting amino acid in the diet.

D. Adapt and improve the Net Energy system for use in Canada. Net energy is the next generation in diet formulation for energy. This is analogous to Ball's work on developing a method to true metabolic amino acid availability in feeds; net energy is the measure of true metabolically available energy. Protein and energy in the diet must be in correct balance to achieve optimum growth and body composition. Therefore it is necessary to move both of these areas forward fully to achieve the next big step in improving diet formulation for pigs. Dr Soenke Moehn and Dr. Ball are currently the only swine nutritionists in Canada with demonstrated expertise in the calorimetry methods necessary to accurately determine net energy value of feeds. Traditional slaughter methods, which are the methods available to others, have many errors and are much less accurate.

### 5.3.2 Reproduction and Breeding Herd Management as a Future Priority

As noted in Section 3, for the past several years, the focus of the program has been to seek improvements in gilt development programs. This was and has been a priority because it can lead to major increases in breeding herd efficiency. Proper selection and management of replacement gilts has a proven impact on lifetime non-productive days. The reproductive technology program has maintained that effective gilt management programs are needed that will meet replacement targets from a smaller pool of gilts, and with gilts with improved lifetime breeding performance. This will reduce annual replacement rates, improve sow fitness, decrease sow death loss, and increase labor efficiency and space utilization. The premise has been that by making gilt management more efficient, the impact is to improve the utilization of space and

labor and achieve a flow of eligible (service-ready) gilts within the design specifications of the facility.

Looking to the future, the Reproduction and Breeding Herd Management team has kept its focus on the fundamentals outlined above. Its vision remains to be recognized as the world leader in swine reproduction, developmental biology and assisted reproductive technology. It seeks to apply this expertise to provide Canadian producers with the most cost-effective, yet sustainable, production practices worldwide.

Moving forward, however, the program seeks to build on this expertise and move further into the next steps in this area. In that regard, the program is looking to establish Alberta as the leader in applied swine genomic and proteomic research. In addition, the unit is looking to develop a new research focus on improved Assisted Reproductive Technologies, leading to bio-secure and cost-effective gene transfer at all levels of swine production.

Research is going to focus on three main areas:

A. Regulation of embryonic and fetal development and prenatal programming of postnatal health, growth performance, nutrient utilization and meat quality to achieve a 20% improvement in nutrient capture into differentiated pork products.
B. Innovative new research on gamete biology, directed to delivery of new and certified Assisted Reproductive Technologies (ART) to the swine industry, and application of this research to bio-secure and cost-effective gene transfer at all levels of swine production.
C. Collaborations with Canadian producers to address issues of sow longevity and breeding herd efficiency to develop the most sustainable and economically competitive pork production technologies in North America.

With regard to the first area, a primary objective will be to build on the international recognition of the current program for studies defining nutritional and metabolic effects to determine the involvement of gene imprinting as a potential mediator of these effects. State-of-the-art applied genomic and proteomic techniques will also increasingly be used to study effects of different nutritional regimens on early embryonic survival and pre-natal programming in a broader context.

This work will impact variability of growth potential among individual animals. This in turn leads to increased feed costs and greater nutrient loss into manure, due to variable feed utilization in a population of animals. Research under this theme will address:

- Nutritional effects on DNA
- The role of gene imprinting in mediating nutritional effects on embryonic development.
- Relationships between patterns of prenatal loss and muscle development of the fetus and neonate.
- Relationships between embryonic and maternal gene expression, reproductive performance of the dam, and the health, viability and fitness of offspring.
- The role of functional nutrients in prenatal programming in swine.

With regard to the second area, it is noted that in the swine industry, movement of genetic resources currently relies heavily on the shipping of live animals. The high cost of transport, as well as the potential risk of disease transmission has made the transfer of genetics in this fashion impractical in many circumstances. The shipping of porcine embryos represents a genetically sound means of disseminating genetic material; however, the high cost and technical know-how required for existing surgical embryo transfer (ET) procedures in swine have proven prohibitive. Non-surgical embryo transfer (nsET) represents an efficient and cost effective means of disseminating genetic material. Generally the porcine cervix has proven to be a barrier for nsET, but the recent development of new instruments for this purpose has stimulated new interest in this area.

Artificial insemination (AI) with fresh semen is commonly used to move genetic material in the pork industry. However, lack of early indicators of boar fertility and efficient procedures for the cryopreservation of boar semen makes this form of gene transfer much less efficient than in say cattle. Therefore, identification of boars with low fertility before they enter the boar stud would have dramatic effect on profitability. Combined with improved AI procedures and increased use of cryopreserved boar semen, this would facilitate more efficient use of genetically superior boars whose genetic merit for meat production could be more widely disseminated.

In comparison to other areas of the livestock industry, and particularly the dairy sector, the pork production industry has been hindered by limitations in applying ET and AI technologies to the same degree and would greatly benefit from advances in the area of ART in swine. Therefore, the objectives of the research under this theme will:

- Address limitations to the use of embryo transfer in the swine industry.
- Optimize techniques to identify and use of genetically superior boars.
- As part of the requirement for improved ET programs, development standardized programs for controlling follicle development and oocyte maturation with exogenous hormones.
- Working with new industry partners, develop innovative technologies for use in both the gilt and the lactating and weaned first parity sow, resulting in fixed-time ovulation and AI.

## 5.4 Future Requirements of a Successful Swine R & D Program

### 5.4.1 The Context

The challenge of advancing a successful swine research and development program should be considered within the context of the structure of the swine industry, both nationally and internationally. Within this setting, the following observations need to be considered:

1. Firstly, swine production and related management practices are a major agri-industrial enterprise that is international in scope. In this regard, approaches to breeding, production, housing and nutrition from region to region and country to country are similar. While local conditions and feedstuffs may vary, the principles underlying the production and management decisions are the same.

2. New practices and innovation are readily adopted. This follows from the previous point citing the international character of the industry. Scientific and farm journals are circulated worldwide and it is not unusual for innovators and industry leaders to travel to conferences anywhere in the world. Furthermore, the research community at the university graduate and post graduate student level is decidedly international in composition with many students from Asia (notably China), South America and Africa now attending North American education institutions. In effect, the swine production sector is highly interconnected to the extent that new advances and innovations are quickly tested, adopted and/or adapted in every major swine producing region.

3. Production efficiency (nutrition) and reproduction are common concerns across all swine producing regions and will continue to be foremost concerns. This is a simple reflection of two fundamental production factors specific to swine production. These are: (a) feeding is the major cost factor; (ii) breeding efficiency – namely conception, litter size and piglet health, is a key determinant in overall productivity and in turn efficiency and profitability.

4. Advances developed anywhere will be adopted everywhere. This is particularly true of publicly funded, non proprietary research. The international nature of swine production and the inherent drive to achieve increased efficiencies as well as the need to improve and/or maintain industry competitiveness, assures this adoption phenomenon. Since many of the world's largest swine producing regions (EU, US, Canada, and Brazil) are also the world's largest pork exporters, this fundamental dynamic will continue.

5. While research and development may be spatially specific in terms of where the researchers are located and where the research actually occurs, outcomes will be internationally relevant, where applicable. Simply, research and development does not and will not operate in isolation. This is true whether research is conducted in the public domain or in the private domain. The only question with respect to private research is not whether it will be duplicated elsewhere, but how quickly it will be done so.

6. Further to the previous point, it follows that research and development benefits are never confined solely to the region in which the investment is placed. While there may be some advantages gained by early adopter within the region, these will be a short lived as information disseminates and wide scale adoption occurs.

### 5.4.2 Key Issues Facing Swine Research and Development in Alberta

Alberta faces a number of realities and issues regarding a swine research and development strategy. First the realities:

1. Alberta operates as only one swine research and development centre within a large international industry. Furthermore, within Canada there are several other provinces and institutions engaged in swine research. In addition, many swine producing countries are home to significant research and development resource commitments and capabilities. Thus, the question of duplication is a legitimate one. Further it raises the question

concerning the opportunity for and the ease of collaboration in order to more effectively leverage any one individual jurisdiction's research investment, in view of the international character of the industry.

This paper has determined that there is little or no evidence of duplication of the work of Foxcroft and Ball. It has also argued that collaboration has merits but is not always beneficial.

2. It should also be acknowledged that Alberta is a very small player in a large international market. In fact, as a swine-producing jurisdiction it is one of the smallest. Just within Canada, Alberta ranks fourth as a swine-producing province. Globally, it ranks behind several countries, states and/or regions. Thus by virtue of its size, Alberta would not be expected to be a major player in national or international swine research, particularly if the research investment is consonant with the number of animals produced or size of industry.

.

3. Despite its relative size, it appears that Alberta has established unique capabilities in two key areas of particular relevance to swine production. These are: nutrition specific in the area of amino acid metabolism; and reproductive physiology. Both these areas contribute significantly to the efficiency imperative and there is no evidence to suggest that these factors will diminish in importance into future. Instead it is likely to continue – with changing feedstuffs (such as by-products) and increased understanding of inter-cellular metabolism and net-energy use. While it might be argued that Alberta's strengths in these two areas have occurred either by default or design, nevertheless they stand and are well regarding as significant ongoing contribution and capacity for the industry at large. It would appear that Alberta as a swine jurisdiction is 'punching well above its weight' in terms of its contribution to the national and international swine research and development community.

4. Finally, it is evident based on the findings of this undertaking that there is no overarching umbrella that brings the Universities and the federal research stations across the country together. While the industry is generally aware of what each institution/researcher may be doing, overlap appears to be kept to a minimum. However, the situation does raise the question of what might be possible with a more formal review and research allocation process in the context of clearly recognized centres of research capability.

The preceding analysis raises a most fundamental question:

- Should Alberta be a player in the world of swine research and development?

In other words is it advantageous for Alberta to support and maintain such a capability?

The consideration of this question strictly on the basis of industry size and current growth trends (which have been flat), suggests a response that could easily be: "Why bother!" Clearly it can be argued that the research needed to benefit Alberta production can and will occur elsewhere. Thus the province's producers would simply adopt and adapt research findings as they emerge. Further, if one were to ask whether there are truly nutrition and reproduction issues specific to

Alberta, these too may be difficult to identify. Thus from a purely practical and perhaps even mercenary perspective, a positive response to the most fundamental question posed above, may find little support.

However the role of swine research and development within Alberta should be considered from a broader strategic perspective and the province's potential as a major producer and exporter of agri-food products. Clearly a signal (such as reduced or discontinued funding) to curtail swine research sends a very clear message that swine production is not an area of strategic interest to the province of Alberta. Consider the following:

- The rising worldwide demand for red meat. As incomes rise around the world, so does the demand for protein. Pork is already the number one consumed meat in the world. Global demand will continue to grow.

- Shifting global production. Swine production in some well established regions are already in decline. This has already occurred in the United Kingdom, the Netherlands and can be expected to continue in Western Europe. Further, within Canada a similar pattern is likely to emerge in the more heavily populated regions of the country – namely Ontario and Quebec.

Despite current competitiveness concerns specifically in the area of feed grains, Alberta is well suited for livestock production. It has a large land base (hence very low livestock densities), the ability to produce large quantities of feed grain and a limited human population thus reducing the risks of conflict between producers and non-farm residents.

Furthermore, more than one-half of Alberta' agri-food processing and production is directly related to livestock and livestock products. Clearly, the growth and health of the province's agri-food industry is inextricably tied to a healthy livestock sector. In this regard, livestock feeding is a critical first step to adding value to the province's agricultural production base – in the case of swine, the sector adds value to the production of feed grains (barley and feed wheat).

Finally, the province has clearly declared an aggressive growth plan for its agri-food sector. This includes significant growth for both the swine and cattle industry with strong commitments to increase the research and development capacity to stimulate such growth including substantive growth in value added products and processes.

Thus as a larger set of strategic factors including demand and supply forecasts are taken into consideration, Alberta is indeed a highly favourable location for swine production into the future. Thus the need for a swine research and development capability has significantly more relevance both short term and long term.

A positive response to the question, then leads to additional questions:

1. What areas of swine research make a meaningful and relevant contribution and perhaps even lead?

2. How can Alberta maximize return on research investments while minimizing duplication?

These questions are addressed in the following sub-section.

### 5.4.3 A Framework for a Successful Swine Research and Development Program

A key objective of this undertaking is to identify the future requirements/components of a successful swine research and development program for Alberta in the Western Canadian context. This is addressed is follows. A number of key principles are identified, as are some possible strategic and structural considerations.

1. Recognize the international nature of the swine industry and the scope of swine research and development. This characteristic demands a singularity of focus and a clear commitment to building research strengths in selected areas. The approach of trying to be all things to all people is simply a formula for mediocrity leading to little or no success.

2. Recognize the inherent tension between the practical short-term interests of producers versus the long term and at times seemingly uncertain (and perhaps at times obscure) objectives of basic research. This tension is a fundamental dynamic of the industry and the challenge for research funders and the swine industry, is to transform this dynamic into a creative force rather than a conflicting one.

3. Understand that focused research capacity in and of itself creates opportunity. Without capacity (principle investigators, technicians, facilities and equipment), nothing can happen. This observation flows from the principle that success builds success and ideas create new ideas.

4. Commit to building and deepening those areas in which strength, reputation and results have already been established. Alberta has already had the good fortune of having built capability in the areas of amino acid metabolism and reproductive physiology. Clearly this capability revolves around the leadership of two key individuals. Now is the time to broaden the leadership and build the strength of these programs.

5. Commit to a research priorities selection process that is iterative in nature. This requires a structured process that solicits direct input from practical production concerns versus the pure research interests of the scientific community. This may involve the establishing of:

    - Production research priorities sub-committee comprising representatives of the production community.
    - Scientific research priorities sub-committee comprising representatives of the science community.
    - A research priorities committee with representatives from the above committees. This committee should be chaired by an individual with a high degree of familiarity with both production and research issue. Meetings would be conducted as necessary until key priorities and budgets are agreed upon. Note: specific to governance, we

suggest that this committee have equal representation from the production sector and the research community, plus the chair.

Finally the establishment of an arm's length scientific peer review committee comprising international scientists should be considered. Such a committee would meet every five years to review the scientific integrity and international quality of the research activities and findings.

6. Commit to facilitating a more formalized national swine R&D roundtable to collaborate, establish priorities and allocate research to centres best suited based on strengths. The time has come for industry organizations and research institutions within Canada to develop a more strategic approach to swine research. The same approach has already begun with respect to the marketing of pork. It is likely that the roundtable should begin in a relatively informal manner whereby representatives of each institution are invited to an exploratory forum. This would begin the process of developing a standing agenda, increasing familiarity among the key players. Alberta can play a key role in facilitating this process. It could begin by discussing such an approach with Saskatchewan and Manitoba as a western Canadian initiative. It is likely that Ontario would be very interested in such an approach.

   This roundtable process should involve an administrative function involving provincial pork bodies as well as the Canadian Pork Council. The administrative function would be responsible for keeping a national accounting of pork research funding and projects as well as project results. This would assist the process of priority setting, potential collaboration, as well as helping to ensure that duplication is kept to a minimum.

   Furthermore, this national framework would also help establish funding responsibilities. In particular, the national roundtable could place accountabilities on different beneficiaries of research as well as governments. It could set guidelines for funding basic and applied research.

7. Use the national roundtable experience to begin the establishment of an international roundtable including US, Netherlands, Denmark, China, and Brazil. It follows that if Canada can successfully establish a national swine research and development roundtable, it can play a key role in facilitating an international roundtable. In both cases, the Banff Pork Seminar is an ideal setting to begin both national and international processes.

8. Seek and facilitate the formation of national and international sources of funding. The international nature of swine research and development requires that Alberta no longer proceed in a 'go it alone' manner. The establishment of a national swine research & development roundtable coupled with clear centres of expertise will clearly assist this process. This is clearly a long-term strategy. However as national and international structures develop, parallel national and international funding opportunities will also emerge and/or become responsive to funding requests. Again, Alberta can play a key role in facilitating this development.

### 5.4.4 Framework Perspective

Fundamentally, with regard to the framework for future research, this paper is effectively arguing in favor of the status quo, but with an important caveat. That caveat is that the swine industry needs to provide its own research structure and priorities. This will help ensure government funding bodies such as AARI and ALIDF as well as the Consortium, that the industry is working on top priorities and that Alberta has a valid and constructive role within that structure. That is to say, this endeavor is saying that the industry and funding providers in Alberta should keep moving forward. The move forward would be toward increasing the swine research funding structure and framework to ensure higher levels of comfort for funders and higher levels of achievement for the industry.

Another key point to note is that while national priorities and frameworks are very important, they do not take away the competitive marketplace of ideas that Alberta has wisely developed with regard to funding. Instead the framework will give reassurance to the funding bodies that the competitive marketplace is indeed well focused on swine industry priorities.

# 6.0 Summary and Conclusions

The previous section of this paper argued the merits of specific research priorities. Within the broad framework of competitiveness, the following key priorities for the future of the swine industry in Alberta need to be addressed:

1. Research into feed grain productivity, quality and yields.
2. Research into causes and prevention of swine health challenges and disease.
3. Research into alternative to antibiotics.
4. Research into the utilization of the by-products from the emerging bio-fuels industry.
5. Improve reproduction technology and breeding herd management.
6. Improve nutrition productivity.

Each of these areas is going to be crucial to the future of the swine industry in Alberta. At the same time, however, when research is done in these areas, it will be utilized and advanced by other regions in Canada and around the world. That is the nature of research. The only priority area noted above that could be argued to be more Alberta-specific would be the feed grain productivity issue.

As noted in Section 5, the current research structure and funding forums in Alberta have a great deal of merit. Minor adjustments could be made and the systems are flexible enough to adopt these adjustments. The key point of merit is that they force researchers to compete in the marketplace of ideas. The best ideas with the most support will get the funding. With that system in force, the priorities outlined above will require top-notch scientists with industry backing to make the argument for their programs.

With regard to the programs of Nutrition and Reproduction at the University of Alberta, both Foxcroft and Ball have put forward argument and plans for the future. Both would acknowledge that it is the program and the scientists that are crucial for success. At the same time, however, the question for the future is not so much the merits of either Foxcroft or Ball as scientists as it is the merits of the programs that they have lead. With regard to the merits of Foxcroft and Ball as scientists, however, it needs to be restated that both have demonstrated that they are world leaders in their fields. Both are respected worldwide in both private and academic circles.

While there are strong arguments for the first four priorities noted above, there are also strong arguments to be made for keeping the nutrition and reproduction programs in the future, regardless of the presence of either Foxcroft or Ball. The following are the key arguments, based on the research within this paper:

A) The programs are unique in the world with no duplication of the research
B) The programs are highly respected in the private sector and in academia and have established the University of Alberta as a world leader in the respective areas.
C) The facilities and structures at the Swine Centre are uniquely focused on the research areas of these two programs and would require significant retrofitting if a change in direction is sought.

D) Both programs have established high levels of success in addressing industry needs, particularly in swine reproduction. Swine nutrition still requires more time for the work to be fully applicable on a commercial basis but advances are moving forward. Even the by-products of the nutrition research can lead to improvements in production efficiency and profitability.
E) Even without Ball and Foxcroft, the intellectual capital and intellectual structure and support are in place to carry on the advancements.
F) Both programs have and will generate profitable returns to industry, although not necessarily just the Alberta industry.
G) The research is already demonstrated the capability to increase margins for Alberta producers by tens of millions of dollars per year.
H) Both swine nutrition and reproductive technology are irrevocably tied to swine production competitiveness. There will always be a need for research and development in these two areas as they are centerpieces of swine industry productivity.

In summary, this paper has asserted that the most important part of any research is in fact the research scientists themselves. Going forward however, the University and funding bodies need to understand the merits of the scientific programs, regardless of the presence of the leading scientists. In that regard, this paper can provide evidence of the merits of carrying these programs forward into the future.

As a caveat, however, this paper has not been able to declare that the programs on nutrition and breeding are more important than priorities 1-4 above. The net result of this paper is simply the following:

A) Past decisions to fund the work of these two programs have been well grounded and have yielded exceptionally strong results for the swine industry around the world both academically and in private industry
B) The funding mechanisms currently in place in Alberta require minor adjustments but are structured to attain competitive benefits for the industries that they serve.
C) There are sound arguments, based on competitive forces to continue to fund the work of the Swine Nutrition and the Swine Reproduction and Breeding Herd Management Programs.
D) There is a need for a national forum to structure and direct swine research priorities, strategies and projects. Within that structure the competitive marketplace for swine research can take place.

## 6.1 Addressing Project Objectives

The following were the objectives of this project:

1. Assess the historical impact that the Programs have had on the Alberta, Western Canadian, and international swine industry
2. Assess the current impact that the Programs have had on the Alberta, Western Canadian, and international swine industry
3. Assess the future impact that the Programs will and can have on the Alberta, Western Canadian, and international swine industry (and other possible future industries)
4. Assess the most vital areas of research and development (R&D) focus for a future Swine Program over the next ten years based on the current and future industry opportunities and challenges
5. Determine the most effective role that a future Swine R&D Program can perform in the Western Canadian context, especially in relation to existing resources and infrastructure in Western Canada
6. Conduct an assessment of other similar programs around the world and briefly assess the impact they have had on their respective industries
7. Identify the future requirements/components of a successful swine R&D Program (includes budget, staffing, governance model, partnerships/collaborations, level of scientific excellence, etc) for Alberta in the Western Canadian context

This paper has sought to address each of the objectives in order to address the purpose of the paper which was to assess the value and role of the Swine Reproduction and the Swine Nutrition Programs, and to provide insight into what a future Swine R&D Program should focus on for Alberta in the Western Canadian context.

Objectives 1 & 2 were addressed in sections 2-4. Essentially the impacts of the programs were to establish the University of Alberta as a world leader in swine nutrition and swine reproductive technology. The research resulting from these two programs provided the industry, particularly producers in Alberta, with financial benefits very conservatively in the hundreds of millions of dollars. The research also provided other academics around the world with standards and guidance in which to follow their own research initiatives. The work of the two programs at the University of Alberta also provided leading companies in the feed, genetics and nutrition sectors, advances that have allowed them to better serve the producer sector across Canada.

Looking to the future with objectives 3&4, it is noted that these programs will always be vital to the competitiveness of the swine industry. These programs can continue to play a leading role in these areas across the world for the foreseeable future. Within that context, however, it does not mean that these are the only or most important areas of research that could be pursued. It simply means that there has been a record of success upon which Alberta can build if it so chooses.

With regard to objective 5, once again, it is noted that there could be many sound, well thought through priorities for swine research in Alberta, western Canada or all of Canada. Certainly the two programs in question could play an important part in the future. The key question that Alberta industry and government participants must decide, however, is whether or not they want

to be a player in the research arena. If not, there is little evidence that producers or industry in Alberta would directly suffer, in the near term. If on the other hand, Alberta decides that swine research is important and worth playing a role in the industry, then the current programs provide a sound basis for the future.

Objective six was addressed by way of conducting an assessment of swine research programs around the world. It was determined that there were no similar programs to those in Alberta. It was noted, however, that while there were no similar programs, that most swine researchers around the world were aware of and respected the work of Foxcroft and Ball.

Finally, objective seven was addressed by essentially arguing in favor of the status quo in Alberta in terms of governance, budgets, staffing etc. That is, to say the current system works very well in bringing forward the best ideas for funding and providing a forum for the best ideas and projects to foster. Within that context, however, this paper also argues that there is a need to move forward with a national and eventually an international forum for swine research priorities, tactics, strategies and administration. (see section 5.4)

# 7.0 References

Returns to Canadian Swine Research, Brinkman et al, Canadian Journal of Agricultural Economics, July 2001.

AFNS Website, Research page
http://www.afns.ualberta.ca/Research/Index.asp?page=Animal%20Science
Swine Research and Technology Website, Overview and Research pages
http://www.afns.ualberta.ca/Hosted/SRTC/

Swine Research and Technology Center website, http://www.afns.ualberta.ca/Hosted/SRTC/

Strategic Research Plan of the Alberta Pork Producers Research Chair in Swine Nutrition, University of Alberta,
1998-2008

From Research to Reality, SRDP Publications and Presentations March 2001 – March 2005

Agricultural R&D Program Funding , Full Application Form, 2005/2006Swine Reproduction - Development Program (SRDP), Full proposal submission, Final Draft as of April 2006

UNIVERSITY OF ALBERTA, SWINE RESEARCH TECHNOLOGY CENTRE REPORT, 2001 – 2005, February 2006

K.M. Engele, D.L. Whittington, A. Mussell, and J.F. Patience An Integrated Approach to Developing Strategies For Improving The Financial Competitiveness of Saskatchewan Pork Producers, ADF Project #20030620

# 8.0 Appendices

## Appendix A: SRTC Research Grant Funding List of Projects[17]

| TITLE OF PROJECT | RESEARCHER | SOURCE | AMOUNT RECEIVED | YEAR |
|---|---|---|---|---|
| Nutrition Chair | **Ball** | Alberta Pork | $ 75,000 | 2001 |
| | | | $ 75,000 | 2002 |
| | | | $ 75,000 | 2003 |
| | | | $ 75,000 | 2004 |
| | | | $ 75,000 | 2005 |
| Nutrition Research Funding Program | **Ball** | Alberta Pork | $ 105,000 | 2001 |
| | | | $ 105,000 | 2002 |
| | | | $ 92,947 | 2003 |
| | | | $ 92,947 | 2004 |
| | | | $ 92,947 | 2005 |
| Validation of a rapid method for amino acid availability | **Ball** | Alberta Agricultural Research Institute | $ 34,429 | 2001 |
| | | | $ 74,689 | 2002 |
| | | | $ 74,689 | 2003 |
| Intestinal amino acid metabolism in the young pig | **Ball** | Alberta Agricultural Research Institute | $ 81,075 | 2001 |
| | | | $ 70,725 | 2002 |
| Feed ingredients that stimulate mucin secretion increase threonine requirements | **Ball** | Alberta Agricultural Research Institute | $ 40,082 | 2001 |
| Development of low protein diets for sows | **Ball** | Alberta Agricultural Research Institute | $ 44,738 | 2001 |
| | | | $ 9,718 | 2002 |
| Amino acid metabolism in pigs | **Ball** | National Sciences and Engineering Research Council of Canada, Operating | $ 32,550 | 2001 |
| | | | $ 32,550 | 2002 |
| | | | $ 41,000 | 2003 |
| | | | $ 41,000 | 2004 |
| | | | $ 41,000 | 2005 |
| Ultrasound blood flow probe for research on intestinal nutrient uptake in swine | **Ball** | National Sciences and Engineering Research Council of Canada, Equipment | $ 31,196 | 2001 |
| Reducing greenhouse gas emissions in swine | **Ball** | Canadian Agri-Food Research Council, Climate Change Funding Initiative | $ 58,330 | 2001 |
| | | | $ 29,800 | 2002 |
| | | | $ 29,800 | 2003 |
| Neonatal protein and energy metabolism | **Ball** | Canadian Institutes of Health Research, Operating | $ 90,470 | 2001 |
| | | | $ 90,470 | 2002 |
| | | | $ 90,470 | 2003 |
| | | | $ 90,470 | 2004 |
| | | | $ 90,470 | 2005 |
| Use of indicator amino acid | **Ball** | Canadian Institutes of Health | $ 107,457 | 2001 |

[17] UNIVERSITY OF ALBERTA, SWINE RESEARCH TECHNOLOGY CENTRE REPORT, 2001 – 2005, FEBRUARY 28, 2006

| | | | | |
|---|---|---|---|---|
| oxidation to determine amino acid requirements | | Research, Operating | $ 107,457<br>$ 107,000<br>$ 107,000<br>$ 152,967 | 2002<br>2003<br>2004<br>2005 |
| Effectiveness of NAC as a source of cysteine in parenteral nutrition solutions | **Ball** | CIHR, Industry Matching<br>Fresenius-Kabi Uppsala, Sweden | $ 26,071<br>$ 65,987 | 2001<br>2001 |
| Regulation of lysine metabolism in pigs | **Ball** | Alberta Agricultural Research Institute | $ 40,825<br>$ 40,825<br>$ 40,825 | 2002<br>2003<br>2004 |
| Nutrition Research Laboratory | **Ball** | National Sciences and Engineering Research Council of Canada, Equipment | $ 41,000 | 2002 |
| Comparison of neoven and vaminolact in a piglet model | **Ball** | CIHR, Industry Matching<br>Fresenius-Kabi Uppsala, Sweden | $ 34,930<br>$ 84,939 | 2002<br>2002 |
| Amino acid research program | **Ball** | Degussa AG, Germany | $ 20,000<br>$ 20,000 | 2002<br>2003 |
| Peptide delivery with lactic acid bacteria | **Ball** | National Sciences and Engineering Research Council of Canada, Strategic | $ 96,000 | 2002 |
| Targeted probiotics | **Ball** | NSERC, Strategic Grant | $ 176,000<br>$ 176,000 | 2003<br>2004 |
| Synergism of phytase and xylanase enzyme addition to finisher pig diets | **Ball** | Alberta Agricultural Research Institute<br><br>Finnfeeds International (Danisco) | $ 16,767<br>$ 16,767<br>$ 20,000<br>$ 20,000 | 2004<br>2005<br>2004<br>2005 |
| Methionine requirement in starter pigs | **Ball** | Degussa AG, Germany | $ 43,470 | 2004 |
| Methionine availability in starter pigs | **Ball** | Degussa AG, Germany | $ 21,000<br>$ 21,000 | 2004<br>2005 |
| Sow amino acid requirements using indicator amino acid oxidation | **Ball** | Agriculture & Food Council<br>Alberta Livestock Industry Development Fund<br>Ontario Pork | $ 23,750<br>$ 23,750<br><br>$ 15,000 | 2005<br>2005<br><br>2005 |
| Validation of the net energy system for pigs in Canada | **Ball** | Agriculture & Food Council<br>Alberta Livestock Industry Development Fund | $ 22,475<br>$ 22,475 | 2005<br>2005 |
| Amino acid research program | **Ball** | Degussa AG, Germany | $ 20,000 | 2005 |
| HPLC for amino acids analyses | **Ball** | National Sciences and Engineering Research Council of Canada, Equipment | $ 56,057 | 2005 |
| Importance of intestinal immune defense of providing glutamine in the weaning diet of infants using a | **Ball** | Canadian Institutes of Health Research, Operating | $ 59,000 | 2005 |

| | | | | |
|---|---|---|---|---|
| novel pig model | | | | |
| Regulation of the invasive cell phenotype | **Dixon** | NSERC Operating Grants Program | $ 24,370 | 2001 |
| Gene expression in developing embryos and the uterus during early gestation in the pig | **Dixon** | Alberta Agricultural Research Institute / Alberta Pork Producers Development Corporation | $ 53,475 | 2001 |
| Lysine metabolism in growing pigs | **Dixon** | Canada-Alberta Hog Industry Development Fund | $ 66,965 | 2001 |
| Gene expression patterns leading to meat quality outcomes | **Dixon** | Alberta Agricultural Research Institute / BeefBooster | $ 98,880<br>$ 75,000 | 2001<br>2002 |
| Swine reproduction and development program | **Dixon** | Alberta Agricultural Research Institute / Alberta Pork / Genex<br><br><br><br><br>Alberta Pork<br><br><br><br>Genex/Hypor Ltd.<br><br><br> | $ 170,000<br>$ 225,000<br>$ 225,000<br>$ 225,000<br>$ 225,000<br>$ 80,000<br>$ 80,000<br>$ 80,000<br>$ 85,000<br>$ 50,000<br>$ 50,000<br>$ 50,000<br>$ 50,000 | 2001<br>2002<br>2003<br>2004<br>2005<br>2002<br>2003<br>2004<br>2005<br>2002<br>2003<br>2004<br>2005 |
| AHFMR – Major equipment program – Beckman centrifuge | **Dixon** | Alberta Heritage Fund for Medical Research | $ 20,000 | 2001 |
| AHFMR – Major equipment program – Canberra Packard Standard Fusion | **Dixon** | Alberta Heritage Fund for Medical Research | $ 35,000 | 2001 |
| Integrated studies on embryonic survival and development in swine | **Dixon** | National Sciences and Engineering Research Council of Canada | $ 149,275<br>$ 149,275<br>$ 149,275<br>$ 149,275 | 2002<br>2003<br>2004<br>2005 |
| Regulation of lysine metabolism in pigs | **Dixon** | Alberta Agricultural Research Institute | $ 40,825<br>$ 40,825<br>$ 40,825 | 2002<br>2003<br>2004 |
| AHFMR – Major equipment program – Flow Cytometry workstation | **Dixon** | Alberta Heritage Fund for Medical Research | $ 20,000 | 2002 |
| Immune function in the transition cow | **Dixon** | Dairy Farmers of Canada / National Sciences and Engineering Research Council of Canada, Strategic | $ 49,200<br>$ 49,200 | 2004<br>2005 |
| Applied animal genomics/proteomics | **Dixon** | Canadian Foundation for Innovation / Innovation and Science Research Investment | $ 655,000 | 2004 - 2006 |

| | | | | |
|---|---|---|---|---|
| | | Program | | |
| Thermal cycler with real-time detection | **Dixon** | National Sciences and Engineering Research Council of Canada, Research Tools & Instruments | $ 65,000 | 2005 |
| Start-up funds | **Dyck** | University of Alberta | $ 30,000 | 2004 |
| New Faculty Grant | **Dyck** | Alberta Ingenuity | $ 46,500<br>$ 46,500 | 2004<br>2005 |
| Industry support of embryo transfer R&D | **Dyck** | Hypor Canada | $ 30,000<br>$ 30,000 | 2004<br>2005 |
| New Opportunities Fund – infrastructure grant | **Dyck** | Canadian Foundation for Innovation / | $ 135,466 | 2005 |
| Small Equipment Grants Program | **Dyck** | Alberta Innovation & Science | $ 110,000 | 2005 |
| Research tool and instruments grant | **Dyck** | National Sciences and Engineering Research Council of Canada | $ 65,000 | 2005 |
| Odour control | **Feddes** | National Sciences and Engineering Research Council of Canada | $ 19,570<br>$ 19,750<br>$ 19,750 | 2001<br>2002<br>2003 |
| Worker health | **Feddes** | Canadian Institutes of Health Research | $ 244,000<br>$ 32,000 | 2001<br>2002 |
| Water reuse | **Feddes** | Alberta Pork | $ 14,500 | 2001 |
| Greenhouse gases | **Feddes** | Climate Change Funding Initiative in Agriculture | $ 35,000<br>$ 35,000 | 2001<br>2002 |
| Livestock Odour | **Feddes** | Alberta Livestock Industry Development Fund | $ 23,000 | 2002 |
| Worker health | **Feddes** | Alberta Congress Board | $ 7,500 | 2002 |
| Odour control | **Feddes** | Alberta Livestock Industry Development Fund / Alberta Agricultural Research Institute / Alberta Agriculture, Food & Rural Development | $ 167,000<br>$ 167,000<br>$ 133,000 | 2002<br>2003<br>2004 |
| Hen Welfare | **Feddes** | Alberta Livestock Industry Development Fund | $ 23,000 | 2002 |
| Odour literature review | **Feddes** | Manitoba Livestock Manure Management Initiative | $ 22,000 | 2002 |
| Spent Hen | **Feddes** | Alberta Livestock Industry Development Fund | $ 40,000 | 2002 |
| Odour emission | **Feddes** | Pig Improvement Corporation Canada / Livestock Environmental Initiative | $ 10,400<br>$ 10,400 | 2002<br>2002 |
| Worker Health | **Feddes** | Alberta Heritage Foundation for Medical Research | $ 18,000<br>$ 14,000<br>$ 28,000 | 2002<br>2003<br>2004 |
| Gestation stalls | **Feddes** | Alberta Livestock Industry | $ 20,000 | 2003 |

| | | | | |
|---|---|---|---|---|
| | | Development Fund | $ 20,000<br>$ 20,000 | 2004<br>2005 |
| Odour control tech | **Feddes** | Alberta Livestock Industry Development Fund / Alberta Agricultural Research Institute / Alberta Agriculture, Food & Rural Development | $ 100,000<br>$ 100,000 | 2003<br>2004 |
| Odour control | **Feddes** | National Sciences and Engineering Research Council of Canada | $ 23,500<br>$ 23,500 | 2004<br>2005 |
| Worker Health | **Feddes** | Alberta Chicken Producers | $ 15,000 | 2004 |
| Odour Control | **Feddes** | Alberta Agriculture, Food & Rural Development | $ 20,000 | 2005 |
| $H_2S$ Safety | **Feddes** | Canadian Council on Health Services Accreditation | $ 5,500 | 2005 |
| Swine Reproductive Physiology | **Foxcroft** | National Sciences and Engineering Research Council of Canada, Research | $ 103,950 | 2001 |
| Swine Reproduction/Development Program | **Foxcroft** | Alberta Pork | $ 55,000<br>$ 80,000 | 2001<br>2002 |
| Swine Reproduction/Development Program & Canada Research Chair | **Foxcroft** | Genex Swine Group<br><br><br><br><br><br>Alberta Agricultural Research Institute | $ 50,000<br>$ 50,000<br>$ 50,000<br>$ 75,000<br>$ 75,000<br><br>$ 65,000 | 2001<br>2002<br>2003<br>2004<br>2005<br>2001 |
| Gilt development and breeding performance (gilt management strategies) | **Foxcroft** | Sask Pork & Saskatchewan Agriculture Development Fund | $ 50,000<br>$ 47,000 | 2001<br>2002 |
| Canada Research Chair in Swine Reproductive Physiology | **Foxcroft** | Canada Research Chairs Program | $ 200,000 | 2001 |
| Equipment and space for Swine Research Technology Centre | **Foxcroft** | Canada Research Chair/Canadian Foundation for Innovation Equipment Program | $ 159,085 | 2001 |
| Equipment and space for Swine Research Technology Centre | **Foxcroft** | Canada Research Chair/Canadian Foundation for Innovation Equipment Program/Innovation & Science Research Investments Program | $ 159,085 | 2001 |
| Blood flow measurement | **Foxcroft** | National Sciences and Engineering Research Council of Canada, Equipment | $ 31,196 | 2001 |
| Surgical laparoscope | **Foxcroft** | National Sciences and Engineering Research Council of Canada, Equipment | $ 79,231 | 2001 |

| | | | | |
|---|---|---|---|---|
| Centrifuge | **Foxcroft** | Alberta Heritage Foundation for Medical Research | $ 20,000 | 2001 |

| | | | | |
|---|---|---|---|---|
| Swine Reproduction | **Foxcroft** | National Sciences and Engineering Research Council of Canada Group Discovery | $ 149,725<br>$ 149,725<br>$ 149,725<br>$ 149, 725 | 2002<br>2003<br>2004<br>2005 |
| Swine Reproduction, Physiology | **Foxcroft** | Canada Research Chair (Tier 1) | $ 200,000<br>$ 200,000<br>$ 200,000<br>$ 200,000 | 2002<br>2003<br>2004<br>2005 |
| Swine Reproduction/Development Program | **Foxcroft** | Alberta Agricultural Research Institute | $ 225,000<br>$ 225,000<br>$ 225,000<br>$ 19,000 | 2002<br>2003<br>2004<br>2005 |
| Split-weaning strategies in sows | **Foxcroft** | Sask Pork | $ 36,000<br>$ 36,000 | 2002<br>2003 |
| Swine Reproduction/Development Program | **Foxcroft** | Alberta Pork | $ 85,000<br>$ 85,000<br>$ 85,000 | 2003<br>2004<br>2005 |
| Gilt management strategies | **Foxcroft** | Sask Pork | $ 36,000<br>$ 36,000 | 2003<br>2004 |
| Agricultural Genomics & Proteomics Unit | **Foxcroft** | Canadian Foundation for Innovation/ Innovation & Science Research Investments Program/ Industry | $3,122,858 | 2004 |
| Swine Reproduction/Development Program research Collaborations | **Foxcroft** | PIC Tech Services (USA) | $ 26,000 | 2005 |
| Screening of sow types | **Foxcroft** | Alberta Pork | $ 7,500 | 2005 |
| Immune aspects of fetal development | **Foxcroft** | Saskatchewan Agriculture Development Fund | $ 60,000 | 2005 |
| Gamma counter | **Foxcroft** | National Sciences and Engineering Research Council of Canada, Equipment | $ 80,262 | 2005 |
| Gel system | **Foxcroft** | National Sciences and Engineering Research Council of Canada, Equipment | $ 65,000 | 2005 |
| Phytase supplementation | **Sauer** | DSM-Gistbrocades, NL | $ 76,500 | 2001 |
| Nutritive value of rice bran | **Sauer** | Agribrands, ON | $ 22,000 | 2001 |
| Benzoic acid and mineral retention | **Sauer** | DSM, NL. | $ 37,000 | 2001 |
| Mucus secretion in pigs | **Sauer** | Alberta Agricultural Research Institute / Alberta Pork | $ 34,000 | 2001 |
| Xylanase supplementation | **Sauer** | Finnfeeds International, United Kingdom | $ 25,000 | 2001 |
| Research Support | **Sauer** | Alberta Agriculture, Food & Rural Development | $ 12,000 | 2001 |

| | | | | |
|---|---|---|---|---|
| Digestible phosphorus supply in pigs | **Sauer** | Ontario Pork | $ 82,000 | 2001 |
| Nutritive values of liquid mycelium feed product | **Sauer** | DSM-Food Specialties, NL | $ 64,505 | 2002 |
| Dietary factors…pancreatic secretions | **Sauer** | National Sciences and Engineering Research Council of Canada | $ 43,000<br>$ 43,000 | 2002<br>2003 |
| Effect of dietary protein on interaction…digestive function… | **Sauer** | Degussa AG, F. R. G. | $ 26,290<br>$ 26,290<br>$ 26,290 | 2002<br>2003<br>2004 |
| Strategic approaches to reduce phosphorus pollution… | **Sauer** | DSM-Food Specialties, NL<br>Alberta Agricultural Research Institute / Alberta Livestock Industry Development Fund | $ 75,498<br>$ 64,000<br>$ 62,000<br>$ 62,000<br>$ 62,000 | 2002<br>2003<br>2002<br>2003<br>2004 |
| Alternatives to antibiotics in feedstuffs for pigs | **Sauer** | BASF, F. G. R. | $ 45,000 | 2003 |
| Research Program Donation | **Sauer** | BASF Canada | $ 3,000 | 2004 |
| Nutritional value of sorghum for both non-ruminants and ruminants | **Sauer** | Federal Government of Mexico ($120,000 US) | $ 146,000 | 2004 |
| Value of flax and flax fractions as antibiotic replacement. Government and industry | **Zijlstra** | Government of Saskatchewan / Sask Pork / Flax Council of Canada | $ 40,000 | 2004 |
| Characterization and improvement in the nutritional quality of wheat by-products using enzymes | **Zijlstra** | Private Industry | $ 40,000 | 2004 |
| NE Pea | **Zijlstra** | Saskatchewan Pulse Growers | $ 15,000<br>$ 15,000 | 2004<br>2005 |
| Validation of in-vitro method to determine energy digestibility | **Zijlstra** | Funding Consortium Flax 2015 | $ 55,000<br>$ 55,000 | 2004<br>2005 |
| Feed Industry Research Chair | **Zijlstra** | Alberta Agriculture, Food & Rural Development | $ 175,000 | 2004 |
| Potential of Cereal By-Products from Ethanol Production as Feed Ingredients for Swine Production. | **Zijlstra** | Government of Saskatchewan | $ 40,000 | 2004 |
| Distiller's grain | **Zijlstra** | Saskatchewan Agriculture and Food - Research | $ 40,0000 | 2005 |
| By-products | **Zijlstra** | Danisco Animal Nutrition | $ 40,000 | 2005 |
| Centre for Agri-Industrial Technology | **Zijlstra** | Alberta Science & Innovation | $ 2,000,000 | 2005 |

| | | | | |
|---|---|---|---|---|
| By-products | **Zijlstra** | Danisco Animal Nutrition | $ 80,000 | 2005 |

***Funding received as either the applicant, the major applicant with co-applicants or as a co-applicant**

# Appendix B: Current or Planned Collaborative Research Projects with Industry

| Year | Project | Collaborators | Active Planning Phase | Start Date |
|---|---|---|---|---|
| 2005 | Commercial scale-up Gilt Development Unit Project; | Bruce & Meredith VanDijk, Barrhead, Alberta. E. Beltranena, J. Patterson, G. Foxcroft, Frank Marshall (Marshall Vet Services), Intervet Canada | | July -05 |
| 2005 | 2 gilt dev. feeding regimens x 2 gestation feeding regimens x 3 gestations/lactations; | Maschhoffs, Illinois, E.Beltranena (AAFRD), G. Foxcroft (UofA), J. Lowe (Maschhoffs), S. Dritz & M. Tokach (KSU) | 5-Jun | |
| 2005 | Company request for muscle fibre analysis | Elite Swine, Manitoba; P. Schneider (Elite), G. Foxcroft, E.T. Putman & W. Dixon (UofA) | Deferred by agreement with Maple Leaf Foods | |
| 2005 | Carnitine, chromium to sows –effect on fetal development; | SRTC, Edmonton. G. Foxcroft (UofA), J. Woodworth (Lonza), E.Beltranena (AAFRD) | 5-Aug | |
| 2005 | SRTC, Darcy Penner, Acme, AB – Pre-natal programming effects on post-natal growth performance. Linked to provision of re-bred first parity sows under an collaborative agreement. | E. Beltranena (AAFRD), D. Penner., G. Foxcroft, J. Willis (UofA), B. van Haandle (Hypor) | 5-May | March-06 |
| 2005 | Hormonal induction & synchronization of puberty (3 exps); Elstow, PSCI, SK; | E. Beltranena (AAFRD), G. Foxcroft (UofA), R. Culbert (Bioniche), R. Kirkwood (Michigan State University) | 5-November | |
| 2005 | Hormonal control of fixed-time AI; SRTC- Edmonton; | E. Beltranena (AAFRD), G. Foxcroft (UofA), C. Rae (Intervet), R. Culbert (Bioniche), Ceva (N. Bridaux) | 5-Aug | |
| 2005 | Application of non-surgical embryo transfer in swine – | on-farm (TBA); M. Dyck (UofA), W. Hazeleger (Wageningen University); B. van Haadel (Hypor), Hypor Commercial Customer TBA | | April-05 |
| 2005 | Evaluation of efficacy of 7 vs. 14d altrenogest (Matrix) use for estrus synchronization in gilts on a 2,300 sow farrow to wean farm; | Hawkeye Farms, Fairmont, Minnesota. J. Patterson, G. Foxcroft (UofA), E. Beltranena (AAFRD), C. Francisco (Intervet), N. Williams (PIC), G. Spronk (Pipestone Vet Clinic) | | July-05 |
| 2005 | Determination of Growth and Feed Intake Curves in terminal line pigs; | Hypor Canada; J. Patterson, G. Foxcroft, J. Willis (UofA), B. van Haandel (Hypor) | | July-05 |
| 2005 | Cryopreservation of Porcine Gametes and Embryos - | M. Dyck (UofA), Dr. Locksley McGann (Division of Cryobiology, Dept of Laboratory Medicine and Pathology, UofA) and Minitube of America (Madison, Wisconsin) | | January-05 |
| 2005 | Evaluation of Effective Techniques for Predicting Relative Boar Fertility | M. Dyck (UofA), R. O'Donoghue (UofA) & Alberta Swine Genetics Centre | | April-05 |
| 2004 | Application of non-surgical embryo transfer in swine; | SRTC – Edmonton; M. Dyck (UofA), W. Hazeleger (Wageningen University); B van Haandel (Hypor) | | April-04 |
| 2004 | 14d altrenogest in gilts; | Hawkeye Farms, Fairmont, Minnesota; J. Patterson, G. Foxcroft (UofA), E. Beltranena (AAFRD), C. Francisco (Intervet), N. Williams (PIC), G. Spronk (Pipestone Vet Clinic) | | May-04 |
| 2004 | Commercial scale-up Gilt Development Unit Project; | Hawkeye Farms, Fairmont, Minnesota; J. Patterson, G. Foxcroft (UofA), E. Beltranena (AAFRD), C. Francisco (Intervet), N. Williams (PIC), G. Spronk (Pipestone Vet Clinic) | | May-04 |
| 2003 | The impact of first breeding weight irrespective of age on long-term reproductive performance of sows | Prairie Swine Centre; J. Patterson (UofA), G. Foxcroft (UofA), E. Beltranena (AAFRD). | | August-01 |
| 2005 | Swine Research & Technology Centre Website Development, | J. Willis (UofA), http://www.afns.ualberta.ca/Hosted/SRTC/ | | on-going |
| 2004 | SRTC Third Party Semen Evaluation, | M. Dyck (UofA), R. O'Donoghue (UofA), Hypor, two industry boar studs (confidential) | | August-04 |
| 2005 | Improved GDU Management | Big Sky; John Harding, Darryl Possberg | | January-02 |

# Appendix C: Quantitative Tables for Prarie Swine Research.George Morris Centre Model

## Table 1 Value of Sow Amino Acid Research

| **Revenues:** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Market Hogs | 2,063,899 | $148.04 | 2,164,363 | $149.03 | **$1.00** |
| Number of Hogs Marketed | 13,942 | | 14,523 | | |
| Weaners/weanlings | | $0.00 | | $0.00 | $0.00 |
| Cull Sows | 49,575 | $3.56 | 49,575 | $3.41 | **-$0.14** |
| Cull Boars | 420 | $0.03 | 420 | $0.03 | **$0.00** |
| Manure Sales | 10,660 | $0.76 | 11,023 | $0.76 | **-$0.01** |
| | | $0.00 | | $0.00 | $0.00 |
| Total Revenues | 2,138,495 | $153.39 | 2,239,904 | $154.23 | **$0.85** |

| **Capital Asset Values:** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Farrowing Facilities | 1,766,885 | $126.73 | 1,770,015 | $121.88 | **$4.85** |
| Nursery Facilities | 814,344 | $58.41 | 814,344 | $56.07 | **$2.34** |
| Grower Facilities | 925,048 | $66.35 | 925,048 | $63.70 | **$2.65** |
| Finisher Facilities | 1,265,993 | $90.81 | 1,265,993 | $87.17 | **$3.63** |
| Sows | 244,000 | $17.50 | 244,000 | $16.80 | **$0.70** |
| Boars | 13,800 | $0.99 | 13,800 | $0.95 | **$0.04** |
| Total Value of Assets | 5,030,069 | $360.79 | 5,033,199 | $346.57 | **$14.22** |

| **Size of Operations (Sows)** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Sow and Boar Diets | 130,939 | $9.39 | 123,946 | $8.53 | **$0.86** |
| Nursery Diets | 198,861 | $14.26 | 209,091 | $14.40 | **-$0.13** |
| Grower Diets | 170,889 | $12.26 | 180,005 | $12.39 | **-$0.14** |
| Finisher Diets | 306,776 | $22.00 | 323,179 | $22.25 | **-$0.25** |
| Total Feed | 807,465 | $57.92 | 836,221 | $57.58 | **$0.34** |

| | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| **Misc. Costs:** | | | | | |
| Replacement Gilts | 104,920 | $7.53 | 104,920 | $7.22 | **$0.30** |
| Replacement Boars | 6,900 | $0.49 | 6,900 | $0.48 | **$0.02** |
| Veterinary, Medicine & Supplies | 34,855 | $2.50 | 36,307 | $2.50 | $0.00 |
| Maintenenace & Repairs | 50,469 | $3.62 | 52,572 | $3.62 | $0.00 |
| Utilities | 88,047 | $6.32 | 88,047 | $6.06 | **$0.25** |
| Office Supplies | 3,485 | $0.25 | 3,631 | $0.25 | $0.00 |
| Marketing & Transportation | 69,709 | $5.00 | 72,614 | $5.00 | $0.00 |
| AI Supplies | 6,274 | $0.45 | 6,535 | $0.45 | $0.00 |
| Barn Supplies | 20,913 | $1.50 | 21,784 | $1.50 | $0.00 |
| Management and Consulting Fees | 22,028 | $1.58 | 22,946 | $1.58 | $0.00 |

| | | | | | |
|---|---|---|---|---|---|
| Other Misc Costs | 697 | $0.05 | 726 | $0.05 | $0.00 |
| Total Misc & Supplies | 408,297 | $29.29 | 416,982 | $28.71 | **$0.57** |
| | | | | | |
| **Labour:** | 82,883 | $5.94 | 82,883 | $5.71 | **$0.24** |
| | | | | | |
| Manure Handling | 31,660 | $2.27 | 32,740 | $2.25 | **$0.02** |
| Water Consumption | 17,687 | $1.27 | 18,331 | $1.26 | **$0.01** |
| Water and Manure Handling: | 49,347 | $3.54 | 51,071 | $3.52 | **$0.02** |
| | | | | | |
| **Fixed Costs:** | | | | | |
| Interest and Deprec: Farrowing | 210,955 | $15.13 | 211,283 | $14.55 | **$0.58** |
| Interest and Deprec: Nursery | 93,785 | $6.73 | 93,785 | $6.46 | **$0.27** |
| Interest and Deprec: Grower | 106,877 | $7.67 | 106,877 | $7.36 | **$0.31** |
| Interest and Deprec: Finisher | 145,917 | $10.47 | 145,917 | $10.05 | **$0.42** |
| Management Salaries | 94,723 | $6.79 | 94,723 | $6.52 | **$0.27** |
| Insurance | 53,713 | $3.85 | 54,053 | $3.72 | **$0.13** |
| Property tax | 16,033 | $1.15 | 16,701 | $1.15 | $0.00 |
| Total Fixed Costs | 722,003 | $51.79 | 723,340 | $49.81 | **$1.98** |

| **Summary of Financial Results** | | | | |
|---|---|---|---|---|
| Size of Operations (Sows) | Default | | Research Project | |
| Operating Interest | 23,909 | $1.71 | 24,604 | $1.69 |
| Total Operating | 1,371,902 | $98.40 | 1,411,760 | $97.21 |
| Total Costs | 2,093,905 | $150.19 | 2,135,100 | $147.02 |
| | | | | |
| Gross Margin | 766,594 | $54.99 | 828,144 | $57.02 |
| Net Earnings | 44,591 | $3.20 | 104,804 | $7.22 |
| EBITDA | 618,158 | | 679,368 | |
| ROA | 0.89% | | 2.08% | |
| EBITDA/Sales | 28.91% | | 30.33% | |
| Net Earnings per Hog | $3.20 | | $7.22 | |
| | | | | |
| Hog pool price/ckg | $140.00 | | $140.00 | |

**Difference $4.02/hog**

## Appendix C PSC/GMC Model Continued Table 2 Value of Net Energy System for Pigs

| **Revenues:** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Market Hogs | 2,063,899 | $148.04 | 2,100,298 | $150.65 | **$2.61** |
| Number of Hogs Marketed | 13,942 | | 13,942 | | |
| Weaners/weanlings | | $0.00 | | $0.00 | $0.00 |
| Cull Sows | 49,575 | $3.56 | 49,575 | $3.56 | $0.00 |
| Cull Boars | 420 | $0.03 | 420 | $0.03 | $0.00 |
| Manure Sales | 10,660 | $0.76 | 10,660 | $0.76 | $0.00 |
| | | $0.00 | | $0.00 | $0.00 |
| Total Revenues | 2,138,495 | $153.39 | 2,174,894 | $156.00 | **$2.61** |

| **Capital Asset Values:** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Farrowing Facilities | 1,766,885 | $126.73 | 1,766,885 | $126.73 | $0.00 |
| Nuresery Facilities | 814,344 | $58.41 | 814,344 | $58.41 | $0.00 |
| Grower Facilities | 925,048 | $66.35 | 925,048 | $66.35 | $0.00 |
| Finisher Facilities | 1,265,993 | $90.81 | 1,265,993 | $90.81 | $0.00 |
| Sows | 244,000 | $17.50 | 244,000 | $17.50 | $0.00 |
| Boars | 13,800 | $0.99 | 13,800 | $0.99 | $0.00 |
| Total Value of Assets | 5,030,069 | $360.79 | 5,030,069 | $360.79 | $0.00 |

| **Size of Operations (Sows)** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Sow and Boar Diets | 130,939 | $9.39 | 130,939 | $9.39 | $0.00 |
| Nursery Diets | 198,861 | $14.26 | 203,492 | $14.60 | **-$0.33** |
| Grower Diets | 170,889 | $12.26 | 174,674 | $12.53 | **-$0.27** |
| Finisher Diets | 306,776 | $22.00 | 312,786 | $22.44 | **-$0.43** |
| Total Feed | 807,465 | $57.92 | 821,891 | $58.95 | **-$1.03** |

| | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| **Misc. Costs:** | | | | | |
| Replacement Gilts | 104,920 | $7.53 | 104,920 | $7.53 | $0.00 |
| Replacement Boars | 6,900 | $0.49 | 6,900 | $0.49 | $0.00 |
| Veterinary, Medicine & Supplies | 34,855 | $2.50 | 34,855 | $2.50 | $0.00 |
| Maintenenace & Repairs | 50,469 | $3.62 | 50,469 | $3.62 | $0.00 |
| Utilities | 88,047 | $6.32 | 88,047 | $6.32 | $0.00 |
| Office Supplies | 3,485 | $0.25 | 3,485 | $0.25 | $0.00 |
| Marketing & Transportation | 69,709 | $5.00 | 69,709 | $5.00 | $0.00 |
| AI Supplies | 6,274 | $0.45 | 6,274 | $0.45 | $0.00 |
| Barn Supplies | 20,913 | $1.50 | 20,913 | $1.50 | $0.00 |
| Management and Consulting Fees | 22,028 | $1.58 | 22,028 | $1.58 | $0.00 |
| Other Misc Costs | 697 | $0.05 | 697 | $0.05 | $0.00 |
| Total Misc & Supplies | 408,297 | $29.29 | 408,297 | $29.29 | $0.00 |

| | | | | | |
|---|---|---|---|---|---|
| **Labour:** | 82,883 | $5.94 | 82,883 | $5.94 | $0.00 |
| Manure Handling | 31,660 | $2.27 | 31,660 | $2.27 | $0.00 |
| Water Consumption | 17,687 | $1.27 | 17,687 | $1.27 | $0.00 |
| Water and Manure Handling: | 49,347 | $3.54 | 49,347 | $3.54 | $0.00 |
| **Fixed Costs:** | | | | | |
| Interest and Deprec: Farrowing | 210,955 | $15.13 | 210,955 | $15.13 | $0.00 |
| Interest and Deprec: Nursery | 93,785 | $6.73 | 93,785 | $6.73 | $0.00 |
| Interest and Deprec: Grower | 106,877 | $7.67 | 106,877 | $7.67 | $0.00 |
| Interest and Deprec: Finisher | 145,917 | $10.47 | 145,917 | $10.47 | $0.00 |
| Management Salaries | 94,723 | $6.79 | 94,723 | $6.79 | $0.00 |
| Insurance | 53,713 | $3.85 | 53,713 | $3.85 | $0.00 |
| Property tax | 16,033 | $1.15 | 16,033 | $1.15 | $0.00 |
| Total Fixed Costs | 722,003 | $51.79 | 722,003 | $51.79 | $0.00 |

| **Summary of Financial Results** | | | | |
|---|---|---|---|---|
| Size of Operations (Sows) | Default | | Research Project | |
| Operating Interest | 23,909 | $1.71 | 24,165 | $1.73 |
| Total Operating | 1,371,902 | $98.40 | 1,386,584 | $99.45 |
| Total Costs | 2,093,905 | $150.19 | 2,108,587 | $151.24 |
| | | | | |
| Gross Margin | 766,594 | $54.99 | 788,311 | $56.54 |
| Net Earnings | 44,591 | $3.20 | 66,307 | $4.76 |
| EBITDA | 618,158 | | 639,875 | |
| ROA | 0.89% | | 1.32% | |
| EBITDA/Sales | 28.91% | | 29.42% | |
| Net Earnings per Hog | $3.20 | | $4.76 | |
| Hog pool price/ckg | $140.00 | | $140.00 | |
| | | Difference | **$1.56** | |

## Appendix C PSC/GMC Model Continued Table 3 Value of Phytase and Xylanase Addition to Finisher Pig Diets

| **Revenues:** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Market Hogs | 2,063,899 | $148.04 | 2,106,846 | $151.12 | **$3.08** |
| Number of Hogs Marketed | 13,942 | | 13,942 | | |
| Weaners/weanlings | | $0.00 | | $0.00 | $0.00 |
| Cull Sows | 49,575 | $3.56 | 49,575 | $3.56 | $0.00 |
| Cull Boars | 420 | $0.03 | 420 | $0.03 | $0.00 |
| Manure Sales | 10,660 | $0.76 | 9,594 | $0.69 | **-$0.08** |
| | | $0.00 | | $0.00 | $0.00 |
| Total Revenues | 2,138,495 | $153.39 | 2,180,376 | $156.39 | **$3.00** |

| **Capital Asset Values:** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Farrowing Facilities | 1,766,885 | $126.73 | 1,766,885 | $126.73 | $0.00 |
| Nuresery Facilities | 814,344 | $58.41 | 814,344 | $58.41 | $0.00 |
| Grower Facilities | 925,048 | $66.35 | 925,048 | $66.35 | $0.00 |
| Finisher Facilities | 1,265,993 | $90.81 | 1,265,993 | $90.81 | $0.00 |
| Sows | 244,000 | $17.50 | 244,000 | $17.50 | $0.00 |
| Boars | 13,800 | $0.99 | 13,800 | $0.99 | $0.00 |
| Total Value of Assets | 5,030,069 | $360.79 | 5,030,069 | $360.79 | $0.00 |

| **Size of Operations (Sows)** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Sow and Boar Diets | 130,939 | $9.39 | 130,939 | $9.39 | $0.00 |
| Nursery Diets | 198,861 | $14.26 | 198,861 | $14.26 | $0.00 |
| Grower Diets | 170,889 | $12.26 | 180,467 | $12.94 | **-$0.69** |
| Finisher Diets | 306,776 | $22.00 | 324,156 | $23.25 | **-$1.25** |
| Total Feed | 807,465 | $57.92 | 834,422 | $59.85 | **-$1.93** |

| | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| **Misc. Costs:** | | | | | |
| Replacement Gilts | 104,920 | $7.53 | 104,920 | $7.53 | $0.00 |
| Replacement Boars | 6,900 | $0.49 | 6,900 | $0.49 | $0.00 |
| Veterinary, Medicine & Supplies | 34,855 | $2.50 | 34,855 | $2.50 | $0.00 |
| Maintenenace & Repairs | 50,469 | $3.62 | 50,469 | $3.62 | $0.00 |
| Utilities | 88,047 | $6.32 | 88,047 | $6.32 | $0.00 |
| Office Supplies | 3,485 | $0.25 | 3,485 | $0.25 | $0.00 |
| Marketing & Transportation | 69,709 | $5.00 | 69,709 | $5.00 | $0.00 |
| AI Supplies | 6,274 | $0.45 | 6,274 | $0.45 | $0.00 |
| Barn Supplies | 20,913 | $1.50 | 20,913 | $1.50 | $0.00 |
| Management and Consulting Fees | 22,028 | $1.58 | 22,028 | $1.58 | $0.00 |
| Other Misc Costs | 697 | $0.05 | 697 | $0.05 | $0.00 |
| Total Misc & Supplies | 408,297 | $29.29 | 408,297 | $29.29 | $0.00 |

| | | | | | |
|---|---|---|---|---|---|
| **Labour:** | 82,883 | $5.94 | 82,883 | $5.94 | $0.00 |
| | | | | | |
| Manure Handling | 31,660 | $2.27 | 28,494 | $2.04 | **$0.23** |
| Water Consumption | 17,687 | $1.27 | 13,266 | $0.95 | **$0.32** |
| Water and Manure Handling: | 49,347 | $3.54 | 41,760 | $3.00 | **$0.54** |
| | | | | | |
| **Fixed Costs:** | | | | | |
| Interest and Deprec: Farrowing | 210,955 | $15.13 | 210,955 | $15.13 | $0.00 |
| Interest and Deprec: Nursery | 93,785 | $6.73 | 93,785 | $6.73 | $0.00 |
| Interest and Deprec: Grower | 106,877 | $7.67 | 106,877 | $7.67 | $0.00 |
| Interest and Deprec: Finisher | 145,917 | $10.47 | 145,917 | $10.47 | $0.00 |
| Management Salaries | 94,723 | $6.79 | 94,723 | $6.79 | $0.00 |
| Insurance | 53,713 | $3.85 | 53,713 | $3.85 | $0.00 |
| Property tax | 16,033 | $1.15 | 16,033 | $1.15 | $0.00 |
| Total Fixed Costs | 722,003 | $51.79 | 722,003 | $51.79 | $0.00 |

| **Summary of Financial Results** | | | | |
|---|---|---|---|---|
| Size of Operations (Sows) | Default | | Research Project | |
| Operating Interest | 23,909 | $1.71 | 24,253 | $1.74 |
| Total Operating | 1,371,902 | $98.40 | 1,391,615 | $99.82 |
| Total Costs | 2,093,905 | $150.19 | 2,113,618 | $151.60 |
| | | | | |
| Gross Margin | 766,594 | $54.99 | 788,761 | $56.58 |
| Net Earnings | 44,591 | $3.20 | 66,758 | $4.79 |
| EBITDA | 618,158 | | 640,326 | |
| ROA | 0.89% | | 1.33% | |
| EBITDA/Sales | 28.91% | | 29.37% | |
| Net Earnings per Hog | $3.20 | | $4.79 | |

| | | |
|---|---|---|
| Hog pool price/ckg | $140.00 | $140.00 |
| Difference | | **$1.59** |

## Appendix C PSC/GMC Model Continued Table 4 Value of Low Protein Sow Diets

| **Revenues:** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Market Hogs | 2,063,899 | $148.04 | 2,190,600 | $148.02 | **-$0.02** |
| Number of Hogs Marketed | 13,942 | | 14,799 | | |
| Weaners/weanlings | | $0.00 | | $0.00 | $0.00 |
| Cull Sows | 49,575 | $3.56 | 49,575 | $3.35 | **-$0.21** |
| Cull Boars | 420 | $0.03 | 420 | $0.03 | **$0.00** |
| Manure Sales | 10,660 | $0.76 | 11,163 | $0.75 | **-$0.01** |
| | | $0.00 | | $0.00 | $0.00 |
| Total Revenues | 2,138,495 | $153.39 | 2,266,557 | $153.15 | **-$0.23** |

| **Capital Asset Values:** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Farrowing Facilities | 1,766,885 | $126.73 | 1,766,885 | $119.39 | **$7.34** |
| Nuresery Facilities | 814,344 | $58.41 | 814,344 | $55.03 | **$3.38** |
| Grower Facilities | 925,048 | $66.35 | 925,048 | $62.51 | **$3.84** |
| Finisher Facilities | 1,265,993 | $90.81 | 1,265,993 | $85.54 | **$5.26** |
| Sows | 244,000 | $17.50 | 244,000 | $16.49 | **$1.01** |
| Boars | 13,800 | $0.99 | 13,800 | $0.93 | **$0.06** |
| Total Value of Assets | 5,030,069 | $360.79 | 5,030,069 | $339.88 | **$20.91** |

| **Size of Operations (Sows)** | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| Sow and Boar Diets | 130,939 | $9.39 | 130,939 | $8.85 | **$0.54** |
| Nursery Diets | 198,861 | $14.26 | 210,484 | $14.22 | **$0.04** |
| Grower Diets | 170,889 | $12.26 | 181,400 | $12.26 | $0.00 |
| Finisher Diets | 306,776 | $22.00 | 325,645 | $22.00 | $0.00 |
| Total Feed | 807,465 | $57.92 | 848,469 | $57.33 | **$0.59** |

| | Default | | Research Project | | **Difference** |
|---|---|---|---|---|---|
| **Misc. Costs:** | | | | | |
| Replacement Gilts | 104,920 | $7.53 | 104,920 | $7.09 | **$0.44** |
| Replacement Boars | 6,900 | $0.49 | 6,900 | $0.47 | **$0.03** |
| Veterinary, Medicine & Supplies | 34,855 | $2.50 | 36,998 | $2.50 | $0.00 |
| Maintenenace & Repairs | 50,469 | $3.62 | 53,574 | $3.62 | $0.00 |
| Utilities | 88,047 | $6.32 | 88,047 | $5.95 | **$0.37** |
| Office Supplies | 3,485 | $0.25 | 3,700 | $0.25 | $0.00 |
| Marketing & Transportation | 69,709 | $5.00 | 73,997 | $5.00 | $0.00 |
| AI Supplies | 6,274 | $0.45 | 6,660 | $0.45 | $0.00 |
| Barn Supplies | 20,913 | $1.50 | 22,199 | $1.50 | $0.00 |
| Management and Consulting Fees | 22,028 | $1.58 | 23,383 | $1.58 | $0.00 |
| Other Misc Costs | 697 | $0.05 | 740 | $0.05 | $0.00 |
| Total Misc & Supplies | 408,297 | $29.29 | 421,117 | $28.46 | **$0.83** |

| | | | | | |
|---|---|---|---|---|---|
| **Labour:** | 82,883 | $5.94 | 82,883 | $5.60 | **$0.34** |
| Manure Handling | 31,660 | $2.27 | 33,155 | $2.24 | **$0.03** |
| Water Consumption | 17,687 | $1.27 | 18,524 | $1.25 | **$0.02** |
| Water and Manure Handling: | 49,347 | $3.54 | 51,679 | $3.49 | **$0.05** |
| **Fixed Costs:** | | | | | |
| Interest and Deprec: Farrowing | 210,955 | $15.13 | 210,955 | $14.25 | **$0.88** |
| Interest and Deprec: Nursery | 93,785 | $6.73 | 93,785 | $6.34 | **$0.39** |
| Interest and Deprec: Grower | 106,877 | $7.67 | 106,877 | $7.22 | **$0.44** |
| Interest and Deprec: Finisher | 145,917 | $10.47 | 145,917 | $9.86 | **$0.61** |
| Management Salaries | 94,723 | $6.79 | 94,723 | $6.40 | **$0.39** |
| Insurance | 53,713 | $3.85 | 54,174 | $3.66 | **$0.19** |
| Property tax | 16,033 | $1.15 | 17,019 | $1.15 | $0.00 |
| Total Fixed Costs | 722,003 | $51.79 | 723,450 | $48.88 | **$2.90** |

| **Summary of Financial Results** | | | | |
|---|---|---|---|---|
| Size of Operations (Sows) | Default | | Research Project | |
| Operating Interest | 23,909 | $1.71 | 24,905 | $1.68 |
| Total Operating | 1,371,902 | $98.40 | 1,429,053 | $96.56 |
| Total Costs | 2,093,905 | $150.19 | 2,152,503 | $145.45 |
| | | | | |
| Gross Margin | 766,594 | $54.99 | 837,504 | $56.59 |
| Net Earnings | 44,591 | $3.20 | 114,054 | $7.71 |
| EBITDA | 618,158 | | 688,607 | |
| ROA | 0.89% | | 2.27% | |
| EBITDA/Sales | 28.91% | | 30.38% | |
| Net Earnings per Hog | $3.20 | | $7.71 | |

| | | | |
|---|---|---|---|
| Hog pool price/ckg | $140.00 | $140.00 | |
| Difference | | **$4.51** | |

# Appendix C PSC/GMC Model Continued Table 5 Value of Improved Gilt Management

| Revenues: | Default | | Research Project | | Difference |
|---|---|---|---|---|---|
| Market Hogs | 2,061,807 | $147.89 | 2,085,547 | $149.59 | $1.70 |
| Number of Hogs Marketed | 13,942 | | 13,942 | | |
| Weaners/weanlings | | $0.00 | | $0.00 | $0.00 |
| Cull Sows | 49,575 | $3.56 | 49,778 | $3.57 | $0.01 |
| Cull Boars | 420 | $0.03 | 420 | $0.03 | $0.00 |
| Manure Sales | 10,660 | $0.76 | 10,668 | $0.77 | $0.00 |
| | | $0.00 | | | |
| Total Revenues | 2,136,403 | $153.24 | 2,160,354 | $154.95 | $1.72 |

| Capital Asset Values: | Default | | Research Project | | Difference |
|---|---|---|---|---|---|
| Farrowing Facilities | 1,766,885 | $126.73 | 1,768,158 | $126.82 | -$0.09 |
| Nuresery Facilities | 814,344 | $58.41 | 814,344 | $58.41 | $0.00 |
| Grower Facilities | 925,048 | $66.35 | 925,048 | $66.35 | $0.00 |
| Finisher Facilities | 1,265,993 | $90.81 | 1,265,993 | $90.81 | $0.00 |
| Sows | 244,000 | $17.50 | 245,000 | $17.57 | -$0.07 |
| Boars | 13,800 | $0.99 | 13,800 | $0.99 | $0.00 |
| Total Value of Assets | 5,030,069 | $360.79 | 5,032,342 | $360.95 | -$0.16 |

| Size of Operations (Sows) | Default | | Research Project | | Difference |
|---|---|---|---|---|---|
| Sow and Boar Diets | 130,939 | $9.39 | 131,478 | $9.43 | -$0.04 |
| Nursery Diets | 198,861 | $14.26 | 198,861 | $14.26 | $0.00 |
| Grower Diets | 170,889 | $12.26 | 170,889 | $12.26 | $0.00 |
| Finisher Diets | 306,776 | $22.00 | 306,776 | $22.00 | $0.00 |
| Total Feed | 807,465 | $57.92 | 808,005 | $57.96 | -$0.04 |

| | Default | | Research Project | | Difference |
|---|---|---|---|---|---|
| Misc. Costs: | | | | | |
| Replacement Gilts | 104,920 | $7.53 | 105,350 | $7.56 | -$0.03 |
| Replacement Boars | 6,900 | $0.49 | 6,900 | $0.49 | $0.00 |
| Veterinary, Medicine & Supplies | 34,855 | $2.50 | 34,855 | $2.50 | $0.00 |
| Maintenenace & Repairs | 50,469 | $3.62 | 50,469 | $3.62 | $0.00 |
| Utilities | 88,047 | $6.32 | 88,047 | $6.32 | $0.00 |
| Office Supplies | 3,485 | $0.25 | 3,485 | $0.25 | $0.00 |
| Marketing & Transportation | 69,709 | $5.00 | 69,709 | $5.00 | $0.00 |
| AI Supplies | 6,274 | $0.45 | 6,274 | $0.45 | $0.00 |
| Barn Supplies | 20,913 | $1.50 | 20,913 | $1.50 | $0.00 |
| Management and Consulting Fees | 22,028 | $1.58 | 22,028 | $1.58 | $0.00 |
| Other Misc Costs | 697 | $0.05 | 697 | $0.05 | $0.00 |
| Total Misc & Supplies | 408,297 | $29.29 | 408,727 | $29.32 | -$0.03 |
| | | | | | |
| Labour: | 82,883 | $5.94 | 82,883 | $5.94 | $0.00 |
| | | | | | |
| Manure Handling | 31,660 | $2.27 | 31,683 | $2.27 | $0.00 |
| Water Consumption | 17,687 | $1.27 | 17,696 | $1.27 | $0.00 |
| Water and Manure Handling: | 49,347 | $3.54 | 49,379 | $3.54 | $0.00 |
| | | | | | |
| Fixed Costs: | | | | | |
| Interest and Deprec: Farrowing | 210,955 | $15.13 | 211,089 | $15.14 | -$0.01 |
| Interest and Deprec: Nursery | 93,785 | $6.73 | 93,785 | $6.73 | $0.00 |
| Interest and Deprec: Grower | 106,877 | $7.67 | 106,877 | $7.67 | $0.00 |
| Interest and Deprec: Finisher | 145,917 | $10.47 | 145,917 | $10.47 | $0.00 |
| Management Salaries | 94,723 | $6.79 | 94,723 | $6.79 | $0.00 |
| Insurance | 53,713 | $3.85 | 53,735 | $3.85 | $0.00 |
| Property tax | 16,033 | $1.15 | 16,033 | $1.15 | $0.00 |
| Total Fixed Costs | 722,003 | $51.79 | 722,159 | $51.80 | -$0.01 |

| Summary of Financial Results | | | | |
|---|---|---|---|---|
| Size of Operations (Sows) | Default | | Research Project | |
| Operating Interest | 23,909 | $1.71 | 23,927 | $1.72 |
| Total Operating | 1,371,902 | $98.40 | 1,372,921 | $98.47 |
| Total Costs | 2,093,905 | $150.19 | 2,095,080 | $150.27 |
| | | | | |
| Gross Margin | 764,502 | $54.84 | 787,434 | $56.48 |
| Net Earnings | 42,498 | $3.05 | 65,274 | $4.68 |
| EBITDA | 616,066 | | 638,975 | |
| ROA | 0.84% | | 1.30% | |
| EBITDA/Sales | 28.84% | | 29.58% | |
| Net Earnings per Hog | $3.05 | | $4.68 | |
| | | | | |
| Hog pool price/ckg | $140.00 | | $140.00 | |
| | | | | |
| | | | Difference | $1.63 |

# Appendix D: Domestic Review of Swine R&D in Alberta: Interview Template

## *A: University of Alberta, Swine Research Programs*

1. Are you familiar with the University of Alberta's Swine Research and Technology Centre, particularly its Swine Reproduction and Development Program and/or the Swine Nutrition Program?

2. Are you familiar with any of the primary researcher's at the University of Alberta's Swine Research Technology Centre, including:
   - **Dr. Ron Ball**
   - **Dr. George Foxcroft**

3. Are you familiar with the some of the specific work that has been done at the University of Alberta in the Swine Reproduction and Development Program and/or the Swine Nutrition Program?
   a) What is your opinion of the quality of the research in these programs?
   b) What is your opinion of the intellectual rigor of the research?

4. Have you ever used the results from the research from either of Alberta's swine research programs in your own research? If so, please explain how and when.
   a) What is your opinion of the programs' efficacy?
   b) What is your opinion of the programs' ability to be either applied in further research or utilized by industry?

5. Is the University of Alberta Swine Research Program unique in what it provides to the industry? (i.e. are there other research programs or centres that are conducting similar research and is there overlap?)

6. In the future, should Alberta continue to build on the swine nutrition and swine reproduction expertise that now exists at the University of Alberta?

## *B: Interviewee's Current Research and Future Research Needs*

1. What are your areas of expertise?

2. How did you determine your current research priorities? Please explain.

3. Who funds your research?

4. What is your relationship with the provincial ministry of Agriculture? Do they help fund the research you conduct (what share of your funding), do they use the research and if so in what way, and do they participate in the research?

5. What do you see as the future needs and priorities in swine research?

# Appendix E: International Review of Swine R&D in Alberta: Interview Template

***A: University of Alberta, Swine Research Programs***

1. Are you familiar with the University of Alberta's Swine Research and Technology Centre, particularly its Swine Reproduction and Development Program and/or the Swine Nutrition Program?

2. Are you familiar with any of the primary researcher's at the University of Alberta's Swine Research Technology Centre, including:
   - **Dr. Ron Ball**
   - **Dr. George Foxcroft**

3. Are you familiar with the some of the specific work that has been done at the University of Alberta in the Swine Reproduction and Development Program and/or the Swine Nutrition Program?
   a. What is your opinion of the quality of the research in these programs?
   b. What is your opinion of the intellectual rigor of the research?

4. Have you ever used the results from the research from either of Alberta's swine research programs in your own research? If so, please explain how and when.
   a. What is your opinion of the programs' efficacy?
   b. What is your opinion of the programs' ability to be either applied in further research or utilized by industry?

***B. Interviewee's Current Research and Future Research Needs***

1. What are your areas of expertise?

2. How did you determine your current research priorities? Please explain.

3. What do you see as the future needs and priorities in swine research?

# Appendix F: Interviewee Responses

| **Q3a: What is your opinion of the quality of the research in these programs?** |
|---|
| The quality of the work is above average and in some cases quite innovative. There is however quite a bit of arrogance that comes out from the researchers and they give the impression that everything is done by them when in fact they have followed up on other's ideas. |
| A few of the studies have been novel. |
| They are definitely above average and the quality experimental design - scientific process is solid. |
| Fine, good, well-respected in their disciplines. |
| Very good and beneficial to the swine industry. |
| Very high. |
| Good nutrition work in relation to reproductive performance. |
| Excellent quality in both programs. |
| I think the quality is very high and very well respected among fellow researchers. |
| The work is of high quality and relevant to the needs of the pig industry. |
| Some very good work |
| I hold the research efforts of those programs in high regard. |
| The program is excellent and has been a leading program in this area. The quality of the research is very good. |
| Excellent |
| Extremely high |
| Excellent, prompt, novel, impacting. |
| Good overall quality. Dr. Foxcroft is well recognized as a expert in reproduction. Dr. Ball has less work that is known. |
| Both researchers have quality programs because they have good ideas and explore the ideas that they have and apply them. |

| **Q3b: What is your opinion of the intellectual rigor of the research?** |
|---|
| Good |
| Somewhat out dated, the University of Missouri would be a good model for you to compare. |
| The rigor is high - a good mixture of basic and applied. |
| Very good. |
| Very high, soundness of science, repeatability . |
| Acceptable. |
| Excellent rigor in both programs. |
| I think the intellectual rigor is high as well and worthy. |
| Excellent. |
| Very good. |
| I am mostly familiar with those publications from the swine nutrition research. And for those peer-reviewed papers which I have read, the scientific rigor, relevance, and scope of the work appears appropriate. |
| Very high |
| Excellent |
| Extremely high |
| Always thorough and cutting edge. |
| Foxcroft: Excellent topic areas. Continues to emphasize applied research topics for producers. Ball: Less producer acceptance with research and topics or research. |
| Yes, I think that the research is reputable. Would like to see more peer-reviewed work come out of the programs, not sure how much is peer-reviewed, but it is an indicator of reputability of work. |

| **Q4: Have you ever used the results from the research from either of Alberta's swine research programs in your own research? If so, please explain how and when.** |
|---|
| Due to my own specific interests, the work I have used relates to the amino acid nutrition of the growing pigs. E.g. my team has used the information on this issue presented by Dr. Ball in the Journal of Nutrition very recently. This was for the purposes of the development of our pig growth model. |
| In general, all research is used by all of us in these areas of our research programs. The ovulation sequences, feeding programs are consistent with what others have demonstrated. |
| No |
| Yes, but not too often. My areas of research are with swine and everything that the scientists at this unit do not do. |
| Yes specifically Dr. Foxcroft's and colleagues information on gilt development |
| Yes, we have used their gilt development work to choose directions in how to change our gilt development programs. |
| No |
| I have not used the results to establish research treatments because my research is not exactly in their areas. I have, however, used the results of both programs in the design of standard procedures or diets to be used as controls for my studies. I have also used research publications from both programs for discussion with our graduate students and for teaching purposes. |
| We did use understanding of the reproductive axis in the sow in thinking about how stress could affect and be measured in the sow. |
| Yes, I have used it in extension programming and literature reviews. |
| Not directly, but work on low protein diets to minimize nutrient excretion and amino acid requirements of neonatal pigs is of great interest and relevant to my areas of interest. |
| I try to keep up especially with the gilt development work and the ovulation data. Although not the only source, the work at this facility is some of the seminal work being done in those two areas today. |
| No |
| I do not recall specifically using data/information from the Alberta Swine Research programs, as my work in swine nutrition took place primarily as a PhD student in the late 1980's and following that I moved more into antibiotic alternatives and antibiotic resistance (thus, not much overlap with the work from the Alberta Swine Research programs. |
| No |
| I have used the data, but primarily in giving talks to producers. I have always thought that the group are good at doing basic research, but then writing it up so that the applied nature of the research is evident. |
| I have used much of their research in extension presentations to other producers, and have used their data in designing experiments. |
| No |
| No |
| Yes. Nutritional and gilt development research at Alberta has influenced my own gilt development research and extension programming. |
| Yes, to help make decisions regarding own research |
| No, have not used their research as a start to my own, but have cited it in work, presentations or in extension programs. |

| **4a: What is your opinion of the programs' efficacy?**<br>**4b: What is your opinion of the programs' ability to be either applied in further research or utilized by industry?** |
|---|
| Efficacy appears good. |
| Don't know |
| I am not familiar with the inputs (animals, facilities, personnel) involved with that aspect of efficacy. However, commenting of the productivity side, the program is very visible to scientists in the reproductive discipline and that is a real plus for Canada. My impression is the program had more impact initially than some of the efforts more recently. Like many programs, that could be a product of reduced funding. Many of the experiments are obviously designed to be practical to the industry and Dr. Foxcroft should be complimented for those efforts. However, I am not familiar with the extent of their incorporation in Alberta or Canada. |
| The program puts out a good amount of applicable research to the swine industry.<br>The swine industry definitely uses the data. Dr Foxcroft is the only person in North American training good PhD's in advanced - applied swine reproduction management. Dr Ball has developed and applied new procedures to better estimate nutrient requirements. |
| As it is currently organized, my view is that its importance will fade unless a change of direction takes place. |
| Very good efficacy and excellent applicability to the industry. |
| Good efficacy. Yes, this research can be further applied |
| Very good efficacy and excellent applicability. |
| Very good efficacy and very good and applicable to production needs. |
| High efficacy and applicability. |
| Very good efficacy. Seems to have a good balance including material that can be used in designing future experiments and in problem solving for commercial operations. Would love to see more similar work at other institutions and with other genetics to help determine how broadly applicable some of the results may be. |
| The programs' appear to be relevant to the industry needs and are effectively addressing those research needs. My opinion is that the work of the Centre, including both the pig nutrition and the sow reproduction work have short- and long-term application at the producer and the industry level. Additionally, the work contains aspects of the more basic research that should promote application toward future issues. |
| I think it has become one of the leading programs in the world. I think this is an interesting question, and one that should be directed toward the industry who may need to provide financial support. For example if producers or industry decides they want research activity originating from this or these facility(ies), I think they should indicate so. |
| Outstanding efficacy. Both basic and applied research of excellent design. |
| I never doubt the research. I think the program is utilized by these and others. I think that the University of Alberta's efforts are very "industry and producer" responsive. They address both immediate and very long-term questions of importance. |
| Efficacy: Foxcroft: Excellent program and is used widely. I try to evaluate his work before making decisions on my own. Ball: Not familiar with any research I have evaluated to form opinions or to stimulate further research ideas. Applicability: Foxcroft: Excellent potential to be a world leader in reproduction. Only concern is becoming too commercialized with company products. Ball: Not sure I can comment. |
| The research that I have come across from George Foxcroft is ready to be applied. |

# Appendix G: Perceptions of Future Swine Research Opportunities and Needs

| |
|---|
| • Improving the health of the National herd and minimizing the impact of subclinical disease on pig performance.<br>• Development of alternatives to medication to control subclinical disease.<br>• Improving peri-natal mortality.<br>• Minimizing the incidence and consequences of tail biting<br>• Developing decision support systems for the management of performance. |
| • Although there is a need for basic research there is going to be a void in the number of students available to do animal work and to understand the real life biology of the pig. Although biology doesn't mean just text book material, it means what behavioral changes are reflective that can be observed by the researchers so that they understand more completely what is happening. To some extent this is an art or experience in the animal science area, not just in the lab. |
| • More applied research in all areas. |
| • Fetal crowding, selection for components of parturition (i.e. length of the farrowing period, umbilical cord length/strength, neonatal vigor),<br>• Selection of other components of reproduction ( i. e. sows with altered time to sperm capacitation so estrus detection/insemination timing is more flexible, selection for intensity of estrous behavior,<br>• Selection for how well embryos space themselves before attachment, or for those sows who's uterus changes the most to allow for more growth and more efficient placentation, selection for the pattern of how the oocytes are ovulated at estrus (not just number of ovulations)),<br>• Selection for nutritional-reproductive relationships (i. e. selection for post-lactational appetite, selection for longevity, selection for efficiency of calcium mobilization)<br>• Selection for lines with altered meat composition (i.e. cholesterol content, shelf life, taste, etc).<br>• We need to think more outside the box. |
| • We need a balance of applied reproduction and areas of nutrition, management and pork quality.<br>• It can not be just basic research.<br>• We need trained people in some areas of extension such as advanced applied swine reproduction and can't find an acceptable candidate in the United States. |
| • I believe centres that focus on traditional approaches (e.g. nutrition and reproduction) will continue to shrink while problem-oriented teams will flourish. As an example, the EU recently funded a multi-member project on animal welfare at $12 million Euro. I can not see that happening in "swine nutrition" or "swine reproduction". But they (and North America) will continue in this direction. That is not to say that we don't need discipline experts, we do, but the team is important. And, some new disciplines inside our teams are needed. |
| • Applied research – too many universities emphasizing basic research to generate overhead dollars. |
| • The real challenge for everyone is the financial resources required to conduct quality research. We need to increase repeatability in the field. Gilt development longevity is a key area, especially its application in the field. For nutrition, nutrition/health interactions, episodic disease outbreaks and nutrition links. |
| • Interaction of genomics with current research areas |
| • Reproduction issues (maintaining high production and well being with limiting inputs [an economic driver]) will always be an issue in the swine industry.<br>• Environmental pressures will push us to be increasingly efficient in our production; this will also result in a reduction in the size of operations at any given location.<br>• Ever-changing genetics (which are driven by search for increased prolificacy or some aspect of increased quality and quantity of lean) result in a continued need to evaluate the behavioral, environmental, and nutritional needs of these ever-changing animals. |
| • Genetic and environmental interactions in behaviour and health<br>• Quantitative welfare measures |
| • Nutrition and Health interactions on requirements<br>• Water quality effects on performance and nutrient requirements |

| |
|---|
| • Sow reproduction and productivity<br>• Sow longevity<br>• Re-assessing mineral requirements<br>• Reducing post-weaning growth check in the absence of antimicrobial products,<br>• Improving feed efficiency,<br>• Minimizing the environmental impact of pig production and<br>• Cost-effective re-use of nutrients in effluent |
| • Gilt development,<br>• Sow longevity, boars in general,<br>• Neonatal survival,<br>• Preservation of genetic resources<br>• Feeding issues (alternate sources, reduction of odor/nutrient etc.). |
| • Sow longevity/nutrition,<br>• alternatives to growth promoting antibiotics<br>• Young pig nutrition<br>• Disease resistance,<br>• Pork quality/consumer acceptance |
| • Obtaining and maintaining market share of sales<br>• Environmental issues related to odor and waste<br>• Maintaining profitability by reducing production costs, disease losses and feed costs. |
| • Multi-disciplinary research will be important and those that can adapt quickly will perform best |
| • Pork quality is currently of concern<br>• Waste management<br>• Reproduction and nutrition continue to be important. |
| • Must continue basic to applied transfer of research |
| • Greater collaboration among universities. The swine industry has undergone consolidation in recent years, and I think that university swine research programs will benefit and use resources more responsibly by collaboration, regionalization, and centers of excellence. |
| • Having direct ties with commercial research facilities.<br>• Being able to prove research that is repeatable in commercial settings is critical.<br>• Dependable antibiotic replacements<br>• Paylean usage<br>• Nursery feeding programs based on weaning age. |
| • Product quality (safety, taste, nutrition)<br>• Energy costs of meat production |
| • Vaccine and swine health<br>• Reproductive health<br>• Health as it relates to disease processes and infections |
| • The future research needs of the industry are difficult to determine and the priorities for sure will change. However, as the program is structured at the University of Guelph, we can shift when there is a need for a certain type of research needed. We do not get bogged down with a 'research need of the day' either. We need to have both basic and applied research. |
| • Whole operation approach to research<br>• Environmental impact of production strategies: for example, amino-acid-gut microbiology and how this impacts on manure quality<br>• Vomitoxin grain issues and the impact on growth/production and manure quality<br>• Production efficiency and sustainability in the long-term: sow longevity – what is the impact of housing and gilt management on this<br>• Housing differences: the new Centre has two different housing barns that will be used for various comparisons<br>• Economic viability of production<br>• Health and welfare through a standpoint of our global market |

| |
|---|
| • Economic efficiency<br>• Environmental sustainability |
| • Multi-disciplinary research will be important<br>• Cannot get bogged down in the research 'flavour' of the day |
| • Scientific evidence of codes of practice recommendations to guarantee livestock welfare in Canada<br>• Identification of strategies for assuring the production of uniform and consistent meat quality<br>• Development of tools for the early prediction of meat quality variation |
| • Producing pork that is good for your health<br>• Food safety<br>• Viral resistance<br>• Improving manure to have less impact on the environment |
| • Alternative production methods to respond to the increasing diversity of consumer demand (organic, animal welfare, environment, hormone free) |
| • Herd health<br>• Improved public perception of hog production<br>• Development of international markets<br>• Animal welfare<br>• Germplasm conservation<br>• Use of genetics to produce desired traits in the hog<br>• Environmental sustainability |
| • Continued research on vaccines |
| • For the genetics sector: Disease resistance, longevity, maternal swine quality and meat quality |
| • Viral disease resistance<br>• Alternative methods to antibiotics<br>• Environmental impact of hog production |
| • Animal health and how it relates to production enhancement<br>• Zoonoses risk control<br>• Food safety and management<br>• Manure management |
| • Management of bacteria and viruses<br>• Environmental management |
| • Nutrition and its effects on immunity<br>• Reproduction quality<br>• Animal welfare |
| • Environmental impact of hog production will become increasingly important<br>• Animal welfare will be a major player<br>• More than ever the research will be to be applicable<br>• The gap between basic and applied research is getting wider, right now money goes to basic research |