

# SWINE GENOMICS RESEARCH WORKSHOP

**ORGANIZED BY:**  
WESTERN SWINE TESTING ASSOCIATION (WSTA)  
CANADIAN CENTRE FOR SWINE IMPROVEMENT (CCSI)



**SEPTEMBER 11, 2007**  
EXECUTIVE ROYAL INN,  
LEDUC, ALBERTA

# **Swine Genomics Research Workshop**

Tuesday, September 11  
Lancaster A Room, Executive Royal Inn, Leduc, Alberta

The Swine Genomics Research Workshop was held in Lacombe, Alberta in September 2007. It was organized by the Western Swine Testing Association and coordinated by Alfred Wahl. The program of the workshop and a list of the participants are found in Appendix A & B, respectively.

## **WELCOME**

The meeting was chaired by John Vande Glind, Chair WSTA and CCSI board of Directors. Alfred Wahl, Director and Project Coordinator, Western Swine Testing Association welcomed the participants and described the main purpose of the meeting.

## **INTRODUCTION**

Dr. Pramod Mathur, Chief Geneticist, Canadian Centre for Swine Improvement

Canada has been a world leader in Swine genetics. Genetics produced in Canada is exported to many countries around the world. Canadian pigs are known internationally for their quality, efficiency and health status.

In Western Canada, there has been a steady increase in the pigs tested on CCSI's program over the last few years. Very good genetic progress has been made in growth, feed efficiency and carcass leanness. CCSI and WSTA conducted several research projects with support from ALIDF such as the evaluation of the meat quality in western Canadian pigs and molecular markers. There were two ongoing research projects mentioned: one on the effect of IGF2 gene on sow productivity and another project on genetic markers for pork color. The groups of breeders in Western Canada have a proven track of record of producing good genetics and keeping Canada ahead.

However, it was explained that it is becoming more and more challenging for Canada to maintain its competitive position and that having lean, fast growing pigs was no longer enough. An increase in global competition and higher consumer expectations is observed. The Canadian pork industry is highly vulnerable to any disease outbreaks. There are increasing requirements of animal health, quality of pork (not only the attributes that are measured and improved but also the nutritive value of pork to meet the needs of aging population and addressing social, welfare and environmental issues). These issues need to be addressed quickly by means of genomics combined with traditional genetic selection methods.

There have been a number of developments in genomics recently. Technology is evolving quickly and will significantly change swine selection and breeding methods over the coming years. The bovine genome has been sequenced and pig genome sequencing is underway. CCSI has reviewed the progress of molecular genetics around the world and developed a strategic road map of how this can be used for the Canadian swine industry. Genome Canada was approached by CCSI about a year ago and several discussions ensued with them to invest in swine genomics research. A meeting was held in Quebec City in October 2006 and was followed up by a Genome Canada – Industry workshop in May 2007 in Toronto. The topics of discussion were the industry's needs and how genomics research can help. A report from the meeting was presented by Dr. David Bailey, President and CEO of Genome Alberta, discussed the next steps in answering the emerging needs of the swine industry.

How can the industry move further ahead?

University of Alberta is known internationally for the research in bovine genomics. Dr. Steve Moore presented on his experiences with the Alberta Bovine Genome Program. Dr. George Foxcroft, Dr. Mike Dyck and their group elaborated on the development of a program for Transcriptome of Healthy Embryo Research network.

After the presentations, a general discussion ensued on how resources and funds can be gathered to support the good work researchers are doing. How can producers interact with researchers? With progresses made in genomics, an increasing need for phenomics and bioinformatics exists. Thousands of SNPs on an individual pig can be collected but what does a producer do with that information? Working with WSTA and western producers, CCSI has a national database with over 3.5 million performance and pedigree records. How to use the data and genotypic information to the best of CCSI's ability to help the breeders to do the actual selection of pigs remains the question. How does CCSI provide better genetics to the producers and strengthen their competitiveness to meet the market requirements?

The main question to be discussed at the workshop was how the resources and funds can be gathered for swine genomics?

## **PRESENTATIONS**

### **1. ALBERTA BOVINE GENOMICS PROGRAM**

Dr. Stephen Moore, Chair Bovine Genomics University of Alberta and Scientific Director Alberta Prion Research Institute

The research focus of the Alberta bovine genomics program is in the areas of structural and function genomics. The research in structural genomics includes: sequencing of bovine genome, genome mapping, study of population structure, polymorphisms with respect to genes and markers and study of genome wide linkage disequilibrium. The research in functional genomics includes: gene mapping and mapping of Quantitative

Trait Loci (QTL), analysis of gene expression, rumen Metagenomics and Transcriptomics, marker assisted selection and marker assisted management.

Bovine Genome Sequencing Project involved full Length cDNA sequencing. About 10,000 bovine full length cDNAs were sequenced. All the libraries, clones and sequences are publicly available. The project was funded by AARI (\$500,000) and by Genome Canada (\$US 5,000,000 less \$500,000).

The development and verification of 9000 putative SNPs was conducted. Three thousand SNP assays were developed and optimized, which identified SNPs in genes and non-synonymous coding SNPs. The high density SNP Analysis Platform had ABGP, the University of Missouri, USDA and Illumina Inc. working together. The group found approximately 50, 000 SNPs evenly spaced across the genome. The genotyping of SNPs started in August 2007.

The research in functional genomics included the development of predictive markers for production and quality traits (efficiency, quality and reproduction), the development of predictive markers for health traits (BSE) and the examination of the interaction between genotype of the animal and the environment (plane of nutrition, management, health etc.). Additionally, the development of predictive markers for residual feed intake was also undertaken. The residual feed intake is the difference between the actual feed intake and the predicted feed intake (metabolic weight and growth).

In the beef industry, fat related carcass traits are amongst the major determinants of value. Therefore, to determine the underlying molecular pathways of fat development in meat, the expression of transcription factor genes was analyzed.

In addition, there is a strong Bioinformatics component. The outcomes for bioinformatics are:

- i) to develop new methods for predicting animal performance (phenotype) using sequence, gene function and genotype information
- ii) to create software systems to facilitate the management of biological data and analysis in agricultural research
- iii) Provide bioinformatics training to students and scientists

The incorporation of genetic marker technologies into breeding programs could benefit breeding programs which includes providing genotypic EPDs and allow for genome wide selection.

Future research goals of the Alberta Bovine Genomics Program include developing a genomic database for dairy sire genetic evaluation, developing innovative methods for genetic prediction through genomic selection, to study the interaction between genes on the genome and to enhance research collaborations worldwide.

## 2. THE HEALTHY EMBRYO RESEARCH NETWORK

Dr. Michael Dyck and Dr. George Foxcroft, Canada Research Chair in Swine Reproductive Physiology, Leader, Swine Reproduction-Development Program University of Alberta

Dr. Dyck presented the concept of the Healthy Embryo Research Network (THERN) program. This is a joint initiative by researchers from University of Laval Dr. Marc-André Sirard and Dr. Claude Robert and University of Alberta, Dr. George Foxcroft and Michael Dyck. The main aim is to study the health of bovine and swine embryo. The research on swine embryo will be mainly carried out at University of Alberta.

The major determinants of litter size in the uterus during gestation are: ovulation rate, embryonic loss and fetal loss. The research network will be assessing the impact of two classes of stresses e.g. assisted reproductive technologies (ART) and the metabolic/nutritional status of the female, on the subsequent embryos in bovine and swine. Dr. Dyck elaborated on the research program for transcriptome of healthy embryo. A transcriptome is the set of all messenger RNA (mRNA) molecules, or “transcripts” produced in one or a population of cells. A transcriptome can vary with environmental conditions. The study of transcriptomics examines the expression levels of mRNA in a cell population using high-throughput techniques based on DNA microarray technology. The project also involves epigenetics which is the study of heritable changes in gene expression which does not alter gene sequence (via DNA methylation).

The scientific goals of THERN are as follows:

- i) to determine the normal gene expression patterns of the early swine and cattle embryo
- ii) to develop tools which evaluates embryo specific gene expression
- iii) the characterization of environmental factors that influence gene expression patterns, such as nutritional factors and reproductive technologies.

In swine, the project will look at the impact of *in vitro* production, cloning procedures and transgenesis etc. The goal is to first define the concept of a good embryo and then assess the extent of impact of the proposed stresses. These will lead in a better understanding of the embryonic plasticity and metabolic needs that will be instrumental for the improvement of these methods. The other stress that will be addressed is the impact of the nutritional status of the female on the subsequent quality of the oocytes and embryos. It is well known that feed restriction affects litter size and selection on reduced weaning to conception interval also affects ovarian functions. However, it is not clear how that works and what kind of impacts it has on the gametes and the embryos. Most of the porcine tissues will be produced by the group in Alberta. The group will use and develop genomics platform to compare these tissues. The comparisons will also be done at the epigenome level.

THERN is expected to benefit the swine industry by the creation of research based tools that define a normal porcine embryo, which provides a diagnostic tool to evaluate factors that can affect the embryo and resulting offspring. Moreover, THERN will help the swine industry by determining how maternal status affects the embryo and to increase the efficiency of assisted reproductive technologies in swine, including hormonal stimulation, in vitro cultures, cryopreservation of embryos and IVM/IVF. An annual budget of 1.1 million dollars (CDN) has been proposed for the network.

### **3. GENOME-CANADA INDUSTRY SWINE GENOMICS WORKSHOP**

**Dr. David Bailey**

**President and CEO, Genome Alberta.**

The swine genomics workshop held on May 4, 2007 in Toronto was supported by Genome Canada in partnership with the Canadian Pork Industry, through the Canadian Centre for Swine Improvement. The workshop gathered leading researchers from the animal genomics, animal genetics, and biomedical research communities as well as stakeholders throughout the pork value chain to discuss how to best consolidate Canada's strengths in the area of swine genomics. Participation in this workshop was excellent with 48 people attending and expressing their commitment to a role of swine genomics in the swine industry.

Overall, a Canadian participation through Genome Canada in the International Swine Genome Sequencing Consortium (ISGSC) effort was supported by workshop participants. It was suggested that regional and national genomic organizations along with industry should be engaged in these discussions to determine the level of interest and potential for shared contributions. Canadian contributions to the ISGSC effort should be part of a Canadian swine genomics strategy. A committee of champions was put in place to help move forward a Canadian swine genomic strategy and it was suggested that this group should be expanded in the near future.

It was recommended that the committee should meet to develop a global Canadian swine industry strategy for genomics research in order to:

**First** – To be a player in the swine genomics sequencing effort

- Genome Canada should make a financial contribution to the International Swine Genome Sequencing Consortium in 2007/08;
- Federal and provincial genomic organizations should be engaged to make a similar contribution;
- These contributions would be part of the initial contribution made by these organizations to a national Canadian swine genomic research strategy led and supported financially by the Canadian swine industry.

**Second** – To support research and development making use of the investment in swine genome sequencing for allowing Canadian swine breeding companies a rapid access, for in-house competitive research using SNP panels

**Third** - To support funding for one or several provincial, national or participation in international swine genomics based research projects beneficial to the entire Canadian pork value chain. This support could be obtained from Industry, Provincial Governments, or through funding for the Genome Canada Agriculture-Animal Theme. A position paper entitled Aquatic and Terrestrial Genomics was prepared and submitted to Genome Canada on July 3<sup>rd</sup> 2007. If successful, genomics funding in this area could become available in 2008 with an opportunity for funding large scale genomics projects in 2009.

## **SUMMARY AND RECOMMENDATIONS**

### **Main issues**

The key priority areas were similar to those identified by the Science and Innovation Strategy of the national Pork Value Chain Roundtable for the Canadian swine industry. These include animal health, meat quality, food safety, production efficiency, environmentally responsible production and biodiversity. It was suggested that Genomic research in Alberta offers the greatest potential to address the issue of meat quality.

### **What do we need?**

- Genome wide markers, SNP discovery, functional genomics and epigenomics research
- Phenotypic information and genotypic data from Canadian breeding herds
- Methods for effective selection using the molecular information for traits of importance to the Canadian swine industry

### **Meeting resolution**

Be it resolved that there is an urgent need for funds to support swine genomic research. These funds should be directed towards immediate investment opportunities for applied genomics research in Alberta, collection of additional phenotypic records by western breeders and producers, for the development of selection methods and tools for the use of the information by breeders.

## **APPENDIX A**

### **Swine Genomics Research Workshop**

**Tuesday, September 11**

**Lancaster A Room**

**Executive Royal Inn, Leduc, Alberta**

- 9:00 Welcome - John Vande Glind and Alfred Wahl
- 9:15 Introduction - Pramod Mathur
- 9:30 Bovine Genomics Program at U of A – Steve Moore
- 10:15 Break
- 10:30 The Healthy Embryo Research Network (THERN) – Mike Dyck/George Foxcroft
- 11:00 Genome Canada – Industry Swine Genomics Workshop update – David Bailey
- 11: 20 General discussions on funding swine genomic research
- 12:30 Lunch
- 13:30 Continue discussions
- 14:15 Concluding remarks – Pramod Mathur
- 14:30 Adjourn

## APPENDIX B

### Workshop participants

Bailey, David	Genome Alberta
Bell, John	Alberta Livestock and Industry Development Fund (ALIDF)
Blade, Stan	Alberta Agricultural Research Institute (AARI)
Dixon, Walter	University of Alberta
Dyck, Michael	University of Alberta
Fournier, Brad	Alberta Agricultural Research Institute (AARI)
Foxcroft, George	University of Alberta
Hodgman, Paul	Alberta Pork
Mathur, Pramod	Canadian Centre for Swine Improvement (CCSI)
Moore, Steve	University of Alberta
Pontarollo, Reno	Genome Prairies
Charlotte Shipp	Alberta Pork
Van Berkel Wim	Western Swine Testing Association (WSTA)
Vande Glind, John	Western Swine Testing Association (WSTA) and CCSI
Wahl, Alfred	Western Swine Testing Association (WSTA)
Williams, Kim	Alberta Pork