

Recent Developments in the Canadian Swine Improvement Program

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Introduction

The pork industry is of major importance to the Canadian agriculture sector. In 2001, about 26 M hogs were produced, or about one pig per inhabitant (3 times more than in the US comparatively). Production has increased by 40% in the last 4 years. About half of this production is exported to more than 70 different countries, making Canada the second largest pork exporter after Europe.

The national swine improvement program has been an important component of this success during the last 20 years, providing the Canadian pork industry with pigs that grow faster and are leaner and more efficient year after year. However, the program must continually adapt to changes in the pork industry, the breeding industry, and the use of new technologies. The purpose of this paper is to illustrate this by describing, after a brief overview of the program, some recent developments designed to increase the value of the program.

Overview of the Canadian Swine Improvement program (CSIP)

In 2001, there were about 125 nucleus herds on the CSIP, including traditional breeders, breeder alliances and breeding companies. Together, these herds represented 9,400 nucleus sows, in three major breeds (4,600 Yorkshire; 2,970 Landrace and 1,825 Duros sows).

The strength of the program resides in the fact that all herds collect data in a standard manner, have their animals evaluated collectively, and exchange a significant amount of genetics among themselves. In this manner, selection is not limited to each herd, but takes place in a large population for each breed.

About 90,000 pigs are tested in program herds each year, for age to 100 kg, real-time loin and backfat depths and sow productivity traits. In addition, some herds have started providing individual feed intake and some meat quality data. The number of pigs tested in the program has been fairly constant from year to year, even though the number of breeders and companies has decreased, because these businesses have each been testing an increasing number of animals.

The CSIP includes a test station program, now limited primarily to one station in Quebec. Its purpose is mostly the comparison of sire lines (from the program or from outside genetic suppliers) and research on growth, feed intake, carcass quality and meat quality. About 780 pigs are tested each year in this station.

Genetic evaluations are calculated once a month at the national level using an across-herd BLUP animal model. In addition, evaluations are calculated on-farm using a BLUP micro-computer module linked to the national system through the EBVs of the parents. Correlations between national EBVs and on-farm EBVs are 0.96 to 0.98, depending on the trait. EBVs are provided for age at 100 kg, backfat thickness, lean yield, loin eye area, loin muscle depth, feed conversion and litter size. In Ontario, evaluations are also calculated for age at first farrowing, farrowing interval and weaning weight.

A program named “breeding for profit” allows users to compare the effectiveness of different selection schemes, develop customized selection indices, select male and female replacements in their herds, plan matings based on expected EBVs and inbreeding levels, and predict the resulting genetic change for each trait. The same program, by accessing information for each herd in the national data base via the Internet (www.ccsi.ca), can also analyze selection intensities, selection differentials, generation intervals, and realized genetic gains in terms of EBVs and indices.

The 5-year research and development strategy for the CSIP addresses four areas: genetic evaluation methods for existing and new traits, evaluation and optimization of selection schemes, use of molecular genetics, and optimal use of genetics at the commercial level. To illustrate new developments in the program, the results from four specific projects in the strategy are briefly described here.

New developments for feed efficiency

Feed efficiency is one of the most important traits in pork production, from an economic standpoint. Substantial progress for feed efficiency has been obtained in the program through indirect selection for lean, fast growing pigs. However, equipment to measure feed intake is now widely available and could provide additional information for the selection of nucleus animals. This equipment is expensive, so research was carried out to answer several questions:

- if individual feeders are used only for part of the finishing period in order to decrease costs, what is the best period to test the pigs?
- how much more progress for feed efficiency can be obtained by recording individual feed intake compared to using indirect selection?
- how much more progress for feed efficiency can be obtained by increasing the accuracy of estimation of the relationship between feed efficiency and lean growth rate?

The analysis of individual feed intake records from 1,277 pigs tested for a three month period (from 27 kg to 112 kg liveweight) at the Quebec test station has led to the following conclusions:

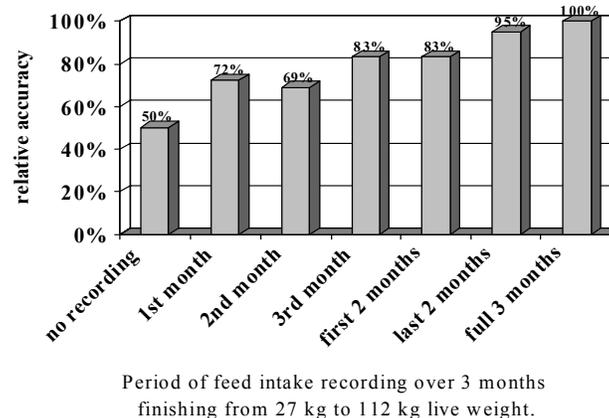
- measuring individual feed intake is most informative in the latter part of the growing period (Table 1); when combined with indirect selection from production traits, partial recording of feed intake for one month starting at 80 kg liveweight, or for two months starting at 25 kg liveweight, resulted in a selection accuracy for feed conversion ratio (FCR) that was 80% to 90% as high as when recording feed intake for the full finishing period.

Table 1. Correlations between feed conversion ratios (FCR) based on full and partial recording of feed intake

FCR based on	Correlation with FCR for the full three months
1 st month	0.53
2 nd month	0.55
3 rd month	0.79
first 2 months	0.79
last 2 months	0.93

- recording of individual feed intake can theoretically double the rate of genetic progress for FCR (Figure 1). However, practical selection systems entailing the recording of males only for one or two months could increase progress for FCR by about 50%, i.e. result in an additional saving of about one kg of feed per pig per year of selection. Since the gains are permanent and cumulative, when applied to a large number of commercial hogs, the benefits largely exceeds the cost of purchasing and maintaining individual feeders in nucleus herds.

Figure 1. Accuracy of genetic evaluation of FCR with partial feed intake recording



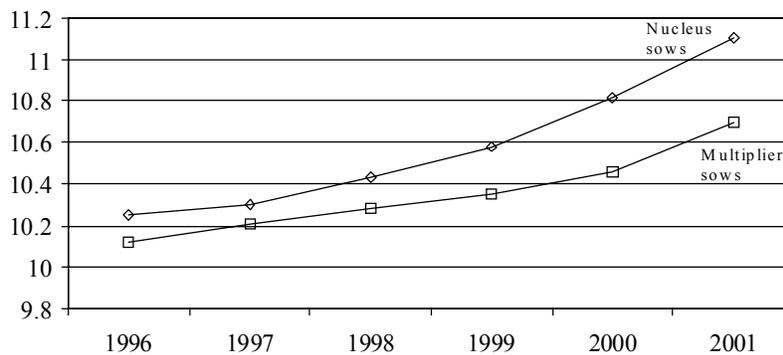
- using appropriate genetic correlations between feed efficiency and production traits is important. In this study, using correlations derived from the data increased the accuracy of indirect selection for feed efficiency by 44%, compared to using correlations derived from an older study.

On the basis of these results, programs have been developed in CSIP for multiple trait evaluation of feed intake, age and backfat thickness, for use when individual feed intake data are available. In addition, recommendations have been formulated on the use of individual feed intake equipment for nucleus selection.

New developments for litter size

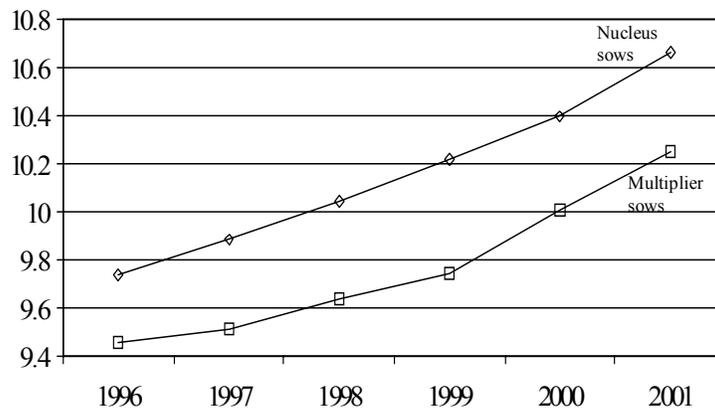
Until the early 1990's, the rate of genetic improvement for litter size in most swine selection programs around the world had been very small. However, this situation has changed markedly. From 1996 to 2001, genetic gains for litter size for Yorkshire herds in the program have been +0.9 pigs born per litter in nucleus herds and +0.6 in multiplier herds (Figure 2).

Figure 2. Yorkshire litter size genetic trend



For the Landrace breed, the gains were +0.9 pigs born per litter in nucleus herds and +0.8 in multiplier herds (Figure 3).

Figure 3. Landrace litter size genetic trend



The higher figure for multiplier herds in the Landrace breed reflects the fact that the trend started sooner. Both type of herds have been progressing at the same rate in the last 5 years, with a genetic lag of about 0.4 pigs born per litter. In the Yorkshire breed, the genetic lag between nucleus and multiplier herds has been increasing as the rate of progress in nucleus herds increased, and has stabilized recently.

The economic impact of these gains is very large. In a 600 sow herd, for example, with 2.2 litters per year and a survival rate to weaning of 80%, each increase by half a pig born is worth an estimated 10,000 US\$ in net revenue, based on average prices for weaned pigs (B Sullivan, 2002).

The higher genetic trends can be attributed to the use of better evaluation techniques for litter size, such as BLUP, combined with the systematic selection of young animals for economic indices which place a high weight on litter size. In some herds, the use of boars or semen from high-prolificacy lines (for example from France) has also been a factor.

Developments for new sow productivity traits

There are many sow productivity traits besides litter size which have a substantial economic value. They include, for example, age at first farrowing, farrowing or weaning to conception interval, litter or individual pig birth weight, survival rate post-partum and to weaning, litter weight at weaning, and maternal behaviour traits.

These traits generally have low heritabilities and are correlated to each other. Deciding what traits are the most important for selection is generally a challenge.

In a study carried out at the University of Guelph (M. Quinton, 2002), profit functions were developed to determine the relative economic impact at the producer level of including some of the above traits in selection indices. Two functions were calculated, one for the commercial market (slaughter pigs) and one for the feeder market. Since the effect of litter size on profit is non-linear, a mean value of 12.5 pigs born per litter was used to approximate the situation of herds with good genetics and sow management. The economic gains from index selection based on an increasing number of sow productivity traits were then estimated. The results are shown in Tables 2 and 3.

In both types of market, the most important trait after litter size is % mortality to 24 h (with a 10% to 12% increase in returns). The next most important trait is % mortality to weaning in the commercial market (3% increase in returns) and weaning weight in the feeder pig market (12% increase). The other traits add substantially less economic value if the most important traits are already in the index. As a result of this work, the development of genetic evaluations for % survival to 24 h, a trait which is currently recorded in the CSIP, is under consideration in Canada.

Table 2. Economic value of new sow traits, for the commercial market*

Traits in the index	%
1) Litter size	100
2) % mortality to 24 h + 1)	110
3) % mortality to weaning + 2)	113
4) Age at first service + 3)	114
5) Days weaning to conception + 4)	114

* adapted from M. Quinton, 2002

Table 3. Economic value of new sow traits, for the feeder pig market*

Traits in the index	%
1) Litter size	100
2) % mortality to 24 h + 1)	112
3) Weaning weight + 2)	124
4) % mortality to weaning + 3)	127
5) Days weaning to conception + 4)	129
6) Age at first service + 5)	132

* adapted from M. Quinton, 2002

Developments regarding the RN gene

The existence of a major swine gene responsible for “acid meat” and for high cooking losses has been suspected since 1985. In 2000, the RN or Napole gene was finally isolated by a European team, which developed a corresponding gene probe.

The gene causes an increase of 75% in the glycolytic potential of pork muscle, and increases drip loss by 90% on average. Since it is dominant, all the progeny from a double carrier boar, and half the progeny from a single carrier boar will exhibit the full effect of the gene when mated with non-carrier sows. The average economic loss per carrier pig has been estimated at \$14. The gene is primarily associated with the Hampshire breed, however, its presence has been detected at lower frequencies in other breeds. In order to evaluate the situation in Canadian breeds, a sample of boars from 9 AI centres were tested for the RN gene, along with animals from several Hampshire herds. The results are shown in table 4.

Table 4. Results from the Canadian RN gene study

Breed	m+/m+ (free)	RN-/m+ (single carrier)	Rn-/RN- (double carrier)
Hampshire	19 (21%)	31 (35%)	39 (44%)
Duroc	116	0	0
Yorkshire	110	0	0
Landrace	79	0	0

Source: Food Research and Development Centre, Canadian Centre for Swine Improvement Inc., Institut National de la Recherche Agronomique

No carrier boars were found in either the Duroc, Yorkshire or Landrace breeds. As expected, the frequency of the RN gene was high in the Hampshire breed (79% carriers). Since the testing took place, the decline of the Hampshire breed in Canada has accelerated, to the point where very few sows of that breed are now enrolled in the program. Major breeds may be tested for the RN gene at regular intervals to ensure the gene is not introduced in the Canadian breeding herd. Since many of Canada's markets require high quality pork, freedom from the halothane and RN genes is an important issue for the pork industry.

Other projects

Among the projects that are starting or on-going in the program, I will mention three more.

One, started two years ago, is the use of genetic evaluations from other countries. The evaluations computed in France are now routinely used in Canadian genetic evaluations in order to give a more accurate assessment of the value of semen or boars from hyperprolific lines imported into Canada. A conversion formula between the two countries has been calculated for

this purpose. Since genetic exchanges between Canada and the US are significant, the same approach could also be used to more accurately assess genetic material evaluated by the STAGES program, for example.

Another project is the development of a system for the recording and the computation of genetic evaluations for conformation traits. I will not expand on this topic, since it will be addressed by the next speaker, but will only say that it addresses two objectives: increase the effectiveness of selection for those conformation traits that are economically important, and ensure that selection for production and conformation traits is balanced adequately.

Finally, we have recently started a project on the integration of molecular genetics discoveries into swine selection programs. The objectives are to review the current situation with respect to molecular genetics, identify the genes or markers that are the most promising for use by the Canadian pork industry, assess the long-term and short-term benefits of their integration, and develop strategies for using them in selection programs.

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