USE OF SMALL NUMBER OF SIRES IN SWINE POPULATIONS

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INTRODUCTION

Genetic selection in a national program allows access of exceptionally good sires to several herds within the country. In the last decade, there has been also a wide spread use of artificial insemination (AI) in swine populations. This increases the chance that some sires are used more extensively compared to those that are used only through natural mating. This is especially the case also if some sires are imported from other countries. The importing AI centre may promote the usefulness of the sire and it may get very widely used.

The trend of using small numbers of sires is rather widely observed in most farm animal species nowadays. A recent study in Danish dairy cattle has revealed the use of small number of sires (Sorensen et al., 2005). Three sires contributed 33.2 % of genes in Danish Holstein population. The most important sire in Danish Red had a contribution of 9.4% while a single ancestor in Danish Jersey breed contributed 12.1% of the genes. Similar but not so intense use of small number of sires was observed in Spanish beef cattle where eight breeds behaved as if they were founded by only 25 to 163 ancestors (Gutierrez et al., 2003).

The main problems with excessive use of certain sires are the reduction in genetic variability, increase in rate of inbreeding and availability of very few sires and dams for the subsequent generation. The sires may have a large impact on the genetic improvement as well. One or few sires can bring significant improvement in some traits for which they have been selected but can reduce the rate of progress in some other traits. Further, if the sires are carriers of a genetic defect, the defect may get propagated very widely in the population.

A study was conducted to evaluate the use of sires in the pigs tested on the Canadian swine improvement program and to evaluate the effect of excessive uses of some of them in the current population.

MATERIAL AND METHOD

In the Canadian swine improvement program about 90,000 pigs are tested every year. These are from 9400 nucleus sows from about 100 herds. The major breeds are Yorkshire, Landrace and Duroc. The national database has performance and pedigree records on over 3 million

pigs. The data on purebred pigs tested during the recent years were used. Inbreeding coefficients were computed using full pedigrees, with the PEDIG software package (Boichard et al, 1997). The degree of connectedness among all herds on the Canadian Swine Improvement Program was estimated through Connectedness Rating (CR) based on variances and covariance among the estimates of contemporary group effects (Mathur et al., 2002).

RESULTS

Sire use in Canadian purebred pigs

The pedigrees of purebred pigs tested during year 2004 were analyzed to evaluate the number and concentration of use of certain sires. Table 1 shows some general statistics about boar use based on purebred pigs tested in 2004. The number of sires used by breed ranges from 372 to 864 and the average number of litters produced by sire ranges from 7 to 10.2, however the use of boars is very unequal for all breeds, with a few boars widely used.

Table 1. Use of sires in Canadian purebred pigs tested in 2004

	Duroc	**Landrace**	**Yorkshire**
Number of sires	372	687	864
Number of purebred litters	2592	6282	8803
Litters:sires ratio	7.0	9.1	10.2
Litters sired by the most used boar	97	330	271
Litters sired by the 10 most used boars	617	1104	1643
Litters sired by the 50 most used boars	1439	2497	3428

Two examples of very popular boars used widely over the past few years in Yorkshire and Duroc breeds are given in Table 2. Boar A was used in Yorkshire maternal line. It had exceptionally good estimated breeding value (EBV) for total pigs born. The EBVs for age and feed conversion ratio were also better than average. Therefore, the boar had a good dam line index and improved the sow productivity in the progeny. However, its EBVs for backfat, loin depth, loin eye area and lean yield were below average. Boar B was used in a Duroc sire line. It had exceptionally good EBV for age to 100 kg and very good EBVs for other sire line traits as well. These two boars have a large impact on their populations, especially through their progeny that was kept for reproduction as breeding sows or AI boars. With the pyramidal scheme of swine production, a boar like boar A could easily influence about 5,000 hybrids and 200,000 commercial hogs in about two generations.

Table 2. Examples of sires with recent large contributions to their breed

	Boar A (Yorkshire)	Boar B (Duroc)
# purebred litters sired	545	162
# total tested progeny	2755	1047
# sons in AI studs	15	48
# daughters kept in selection herds	673	128
# herds	41	34
EBVs and indices (March 2006)		
Age to 100 kg (mm)	-3.3	-5.6
Backfat at 100 kg (mm)	+1.81	-0.77
Loin depth (mm)	-2.06	+4.97
Loin eye area (cm2)	-1.22	+4.73
Feed conversion ratio (kg/kg)	-0.020	-0.096
Lean Yield (%)	-0.67	+1.01
Total born (piglets/litter)	+3.53	-0.47
Sire line Index (pts)	104	152
Dam Line Index (pts)	177	120

Rate of inbreeding

The overall rates of inbreeding in Canadian pig populations are given in Figure 1. There has been an increase in the overall rate of inbreeding over the past years considering year 1980 as the base. However, the increase has slowed down during the past ten years especially in white breeds. This is mostly a consequence of the import and use of foreign boars from highly prolific lines. Because of pedigree incompleteness in these foreign lines, inbreeding might be slightly underestimated in the recent years, to some extent. At the same time this is an example of how the rate of inbreeding can be reduced in few generations.

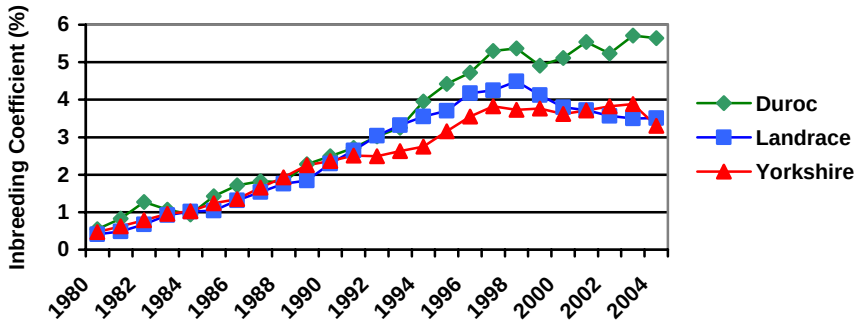

Figure 1. Trends in inbreeding in Canadian purebred pigs

Genetic improvement

In a large population the rate of inbreeding may not necessarily correlate with the rate of genetic improvement. Genetic trends on two traits evaluated in the Canadian Swine Improvement program are presented in Figure 2. Tremendous progresses have occurred on litter size in Landrace and Yorkshire breeds since 1996 when BLUP was introduced for genetic evaluation of this trait. A large part of these gains originate from the use of a few exceptional animals like Boar A. Duroc being the typical sire line in Canada, it was not selected for litter size and the trend does not show much signs of genetic change. An interesting trend has been observed in lean depth recently. It has improved very fast in the Duroc sire line as a result of stronger selection. There is a trend of improvement in the Landrace as well. However, there is little change or rather a slight reduction in the loin depth of Yorkshires which can be attributed in part due to excessive use of small number of sires like Boar A. It is interesting to observe how much influence few boars can have on the genetic improvement in a national program. Since Yorkshire is mainly a dam line, the change in loin depth is not an important goal and has very little effect on the productivity of the market hogs. A major part of the improvement in lean depth in market hogs is due to the terminal boar from Duroc sire line.

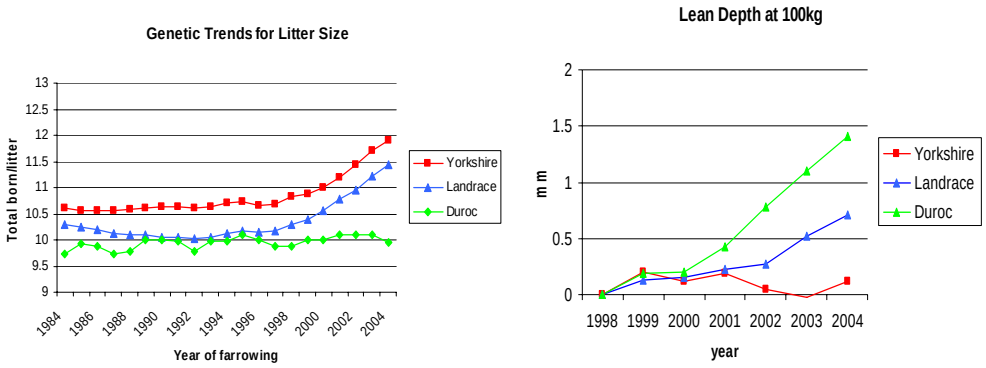

Figure 2. Effect on genetic trends in Canadian purebred populations (number born and lean depth)

Change in the level of connectedness among herds

A positive effect of the use of small number of AI boars in several herds is the improvement in connectedness among the herds. Table 3 presents examples of connectedness ratings of AI boars. Boars widely used across the program bring some connectedness between herds, therefore improving the accuracy of genetic evaluations as well as the efficiency of selection.

Table 3. Effect on genetic ties and Connectedness

Sire	AI Center	Progeny		Weighted connectedness rating	Index	
		Herds	Pigs		Sire line	Dam line
A	ON 2	34	859	194.31	152	120
B	ON 2	7	162	51.00	115	100
C	ON 2	6	66	42.50	131	108
D	ON 14	6	241	36.10	80	63
E	PQ 7	9	61	34.63	132	129
F	ON 14	5	72	32.44	119	111
G	ON 2	5	57	31.93	107	99
H	PQ 7	6	60	30.55	105	140

Table 3 is an example of the type of reports the breeders are provided through internet with respect to connectedness rating of AI boars. This allows them to choose sires for bring up the connectedness to desired level, monitor use of sires and to choose the sires that are most useful for bringing up genetic improvement in sire line or dam line as it is appropriate for the given breed.

DISCUSSION

Improvements of genetic evaluation and selection methods have lead to increase in selection response. At the same time there is an increase in the level of inbreeding especially due to use of small number of superior sires through AI. There are a number of ways to control the rate of inbreeding while still keeping up higher rates of genetic improvement. The possible methods could be avoiding matings between closely related individuals, reducing the number of close relatives selected, use of assortative mating, use of higher than true heritability estimates in the genetic evaluation, adjusting the EBVs for the relationship between already selected individuals etc.. However, it is difficult to fully compensate for the losses due to inbreeding using a small fixed number of sires (Quinton and Smith, 1995).

There may also be some advantages of intensive use of some exceptionally good sires. This might be especially useful in case of traits of resistance to certain diseases e.g. a small number of rams may be useful to quickly develop a line of sheep resistance to scrapies (Luehken et al., 2002). It is also useful to increase the rate of connectedness swine populations (Mathur et al., 2002) to maintain and improve the accuracy of genetic evaluations in a national program, especially when some breeders might resort to more closed within herd breeding. This has to be done in such a way that it does not lead to substantial increase in the rate of inbreeding and helps in maintaining or increasing the rate of genetic progress. The genetic trends in litter size (Figure 2) coincide very well with the trends in the connectedness rating (Figure 3) for sow

productivity. This is an example how a small number of sires can be used to increase connectedness and rate of genetic improvement in desired traits.

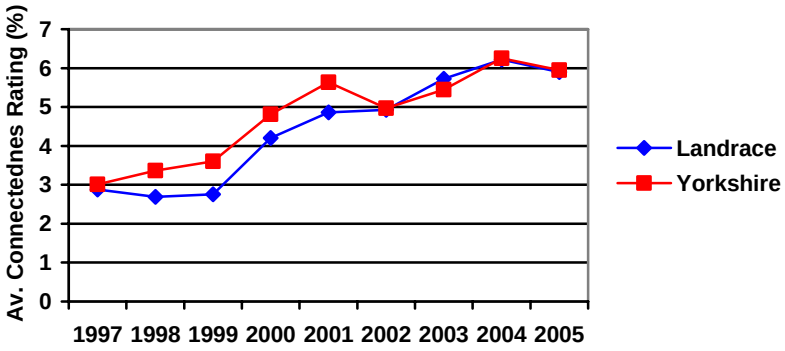

Figure 3. Trends in Connectedness among herds in Canadian purebred populations for sow productivity

In their constant search for maximizing short-term genetic progress, breeders might not always see the long-term effects of using intensively a small number of boars. There are several methods to manage the rate of inbreeding and optimize genetic improvement in desired traits. A deterministic approach to predict the rate of inbreeding based on long-term genetic contributions and to consider both the rate of inbreeding and the rate of genetic gain when optimizing livestock improvement schemes has been suggested by Bijma et al (2001). Some computer programs have been developed to help breeders in their selection decisions such as Total Genetic Resource Management, or TGRM (Kinghorn et al., 2002).

In order to inform breeders about the inbreeding levels and probabilities of gene origin in their herds and in the whole population, several web tools have been developed. These include reports showing sire usage, inbreeding trends in their herd compared to national average, information about effective population size and main ancestors contributing to their herd.

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