JUVENILE GENETIC EVALUATION AND SELECTION FOR DAIRY GOATS

INTRODUCTION

Traditional genetic improvement schemes for dairy animals involve progeny testing of sires. This traditional approach can give accurate evaluations on individual sires, but can take many years for each round of selection. Further, because a large number of daughters must be tested from each sire, relatively few sires can be evaluated. An alternative approach is to evaluate and select a larger number of sires at a very young age, based on the performance of their dams and other female relatives. Young females can also be selected the same way. Selection decisions can be made very rapidly and many more sires are evaluated. This leads to more rapid progress than is possible under the progeny-testing scheme. It is expected that genetic progress can be four times faster than existing traditional approaches based on progeny testing.

WHAT IS A JUVENILE SELECTION SCHEME?

With a juvenile selection scheme, both males and females are evaluated when they are very young. In fact, it is possible to evaluate them even before they are born. The evaluations are based on performance of female relatives such as the mother, aunts and grandmothers. Evaluations have low accuracy, but every male and female get evaluated and selection is done as quickly as biologically possible.

A comparison between juvenile selection and a progeny-testing scheme is shown in table 1. This example is for a nucleus population of 1000 females, similar to the number of Alpine does on milk test in Canada. There would be approximately 1000 bucks and 1000 doe kids born per year in this case. In a typical progeny-testing scheme, the aim would be to get between 50 and 100 milking daughters per buck to get an accurate evaluation. Thus, even if all 1000 mature does were mated to the young sires, only 10 to 20 bucks could be tested per year. In the juvenile scheme, each individual buck will only produce between 10 and 15 daughters. However, we don't need to wait for milk records on the daughters before we select the bucks. Thus, all 1000 bucks that are born will be evaluated and considered for selection, with selection and breeding taking place before the buck is one year of age. In the case of the progeny test, tested bucks will be 3 years old before the daughters have all completed their first lactations. After 3 years, one might select the best 5 or 10 bucks to return to service, which means selection of the top 50% of sires tested. With the juvenile scheme, 70 to 100 bucks would be selected from the 1000 that are born, which means selection of the top 10% of bucks that are evaluated. Thus, the juvenile scheme has 3 rounds of selection for each round of selection in a progeny-testing scheme, and each round is based on the top 10% compared to only the top 50%. Even though each individual buck is evaluated with relatively low accuracy, the fast turn over and more intense selection will result in much faster genetic progress. Another important advantage of the juvenile scheme is that inbreeding is no longer a concern, even for relatively small populations. This is because so many sires are being

used.   Conversely, inbreeding is commonly a very serious limitation in traditional progeny testing schemes.

Table 1. Juvenile selection versus progeny test for a nucleus population of 1000 females

	Progeny Test	**Juvenile Selection**
Daughters per sire	50 to 100	10 to 15
Sires evaluated	10 to 20	1000
Age when selected	3 years +	1 year or less
Sires selected	5 to 10 (top 50%)	70 to 100 (top 10%)
Inbreeding	Problem	No Problem

One of the most successful genetic improvement programs for goats can be found in France.   This program is based on a progeny-testing scheme with several hundred thousand goats on milk recording. Genetic improvement for milk has been about 8 kg per lactation per year. A juvenile scheme similar to the one described above could be expected to increase milk yield by 30 kg per year or more. Figure 1 illustrates how the cumulative effect of genetic improvement makes such annual gains very important. With 30 kg improvement per year, herds that currently average 900 kg per lactation can expect to be over 1000 kg in just 4 years.

Figure 1. Genetic progress from a progeny test versus juvenile scheme
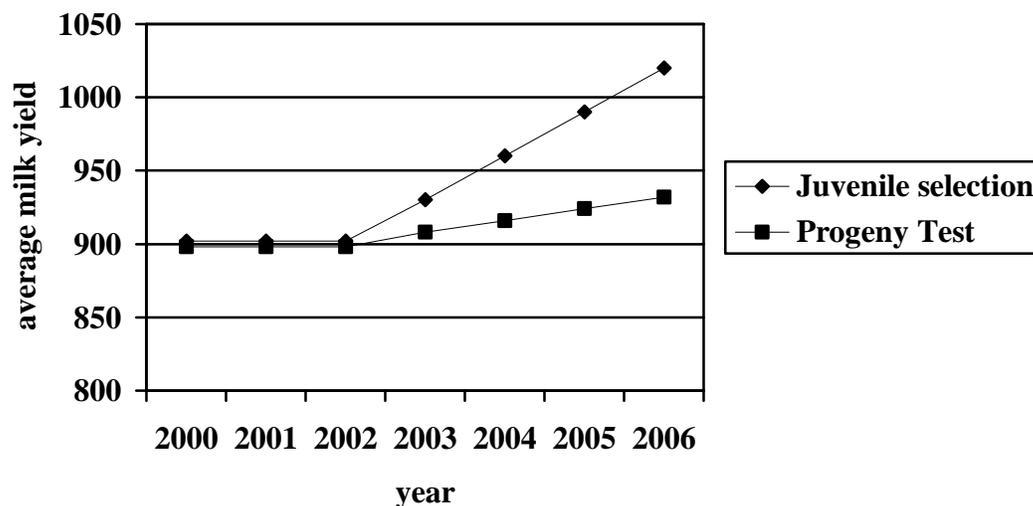

MILK RECORDING IN CANADA

Milk recording has been available to goat breeders in Canada since 1987. Until recently, there have been about 1000 milking goats tested per year. In the last few years, however, the number of goats tested has more than doubled, with just over 2000 goats tested in the past year. The increase in testing activity has all been in the province of Quebec, where the Quebec Goat Breeders Society has put an incentive program in place. Having more goats tested is essential to a successful genetic improvement program. Implementation of a sire evaluation and selection program is the next step in the Society's plans.

Milk yield for goats on test has averaged about 900 kg in a 10-month lactation. The averages vary greatly, depending on such things as breed, stage of lactation and lactation number. Figure 2 shows the average daily milk yield in each month of lactation. The Saanen breed had the highest average production, and Nubians had the lowest production, while the other three breeds had very similar production.

Figure 2. Average daily milk yield by month of lactation
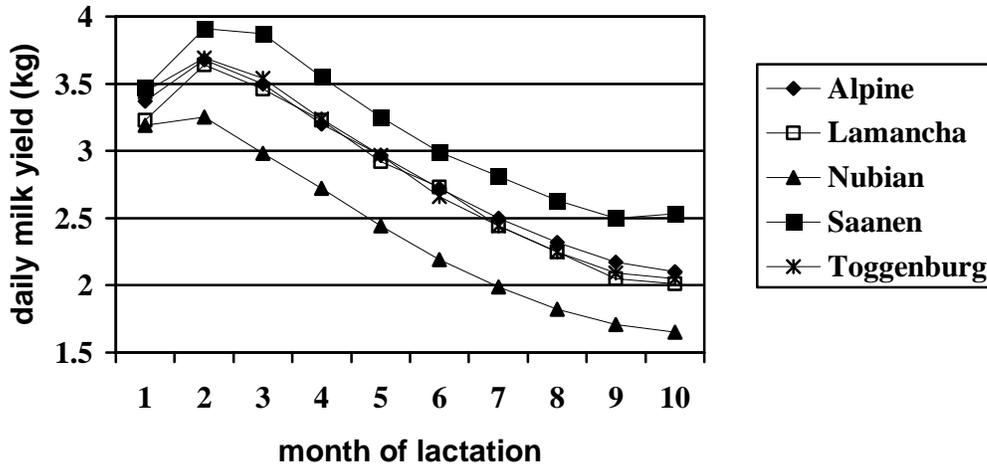
Many factors other than breed have large effects on milk yield; so simply looking at these averages can be misleading. Figure 3, for example, shows milk yield by lactation number in Alpines. The difference between 1st and 2nd parity is larger than most breed differences.

Figure 3. Average daily milk yield by parity in Alpines
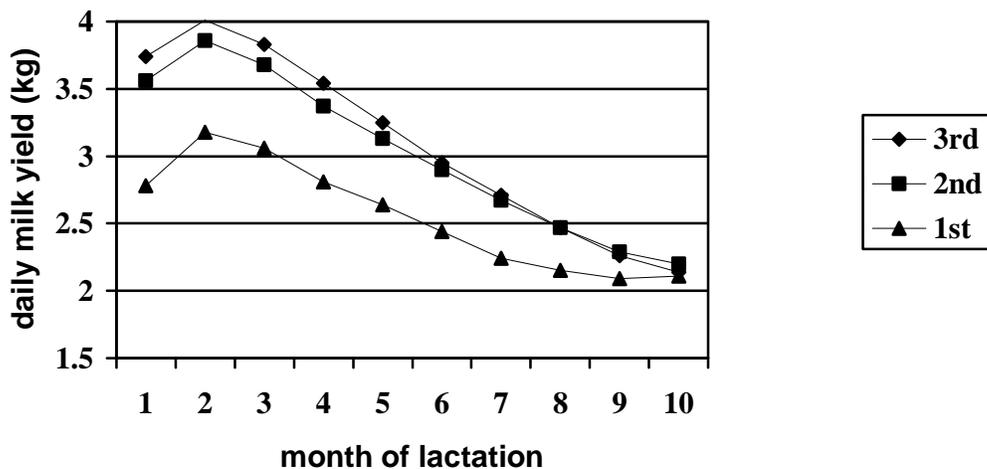
Environmental and management differences can also have very large effects. This is illustrated in Figure 4, which shows average milk yield by year of testing. From this we

can see that differences among breeds have decreased substantially in recent years. This is especially true for the Saanen breed, and is probably due to management differences in herds with Saanens today compared to Saanen breeders 10 years earlier. So, although there are likely some important genetic differences among the breeds, how the goats are managed is more important for the short term, than which breed is chosen. However, how the breed is improved genetically is critical in the long term, regardless of which breed is chosen.

Figure 4. Average annual milk yield
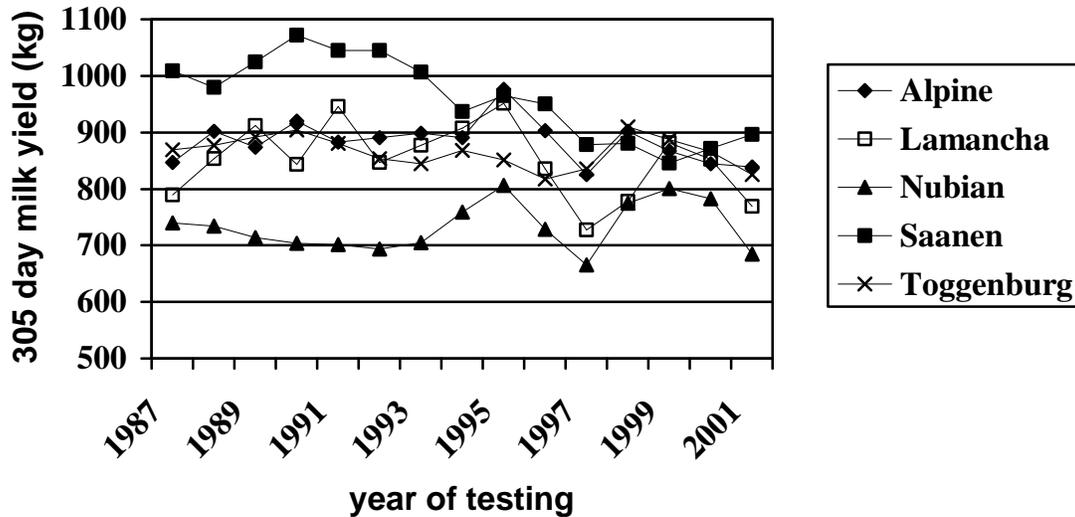
POTENTIAL FOR GENETIC IMPROVEMENT

The objectives for genetic improvement are simple: to increase milk yield while maintaining or increasing milk solids, and while maintaining or improving body conformation. The selection tools available to breeders are based on genetic evaluations for milk, fat and protein yield, fat%, protein% and 8 linear type traits. These genetic evaluations are combined into a selection index in such a way that milk yield will increase rapidly while the other traits will show modest improvements at the same time.

The progress that can be made depends on how intensely animals are selected, and how long the generation interval is. Figure 5 shows the progress in milk yield that can be expected per generation, depending on selection intensity. For example, selection in the top 5% would give about 130 kg improvement per generation. Selection in the top 40% would give about 60 kg improvement per generation.

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Figure 5. Expected progress in milk yield per lactation
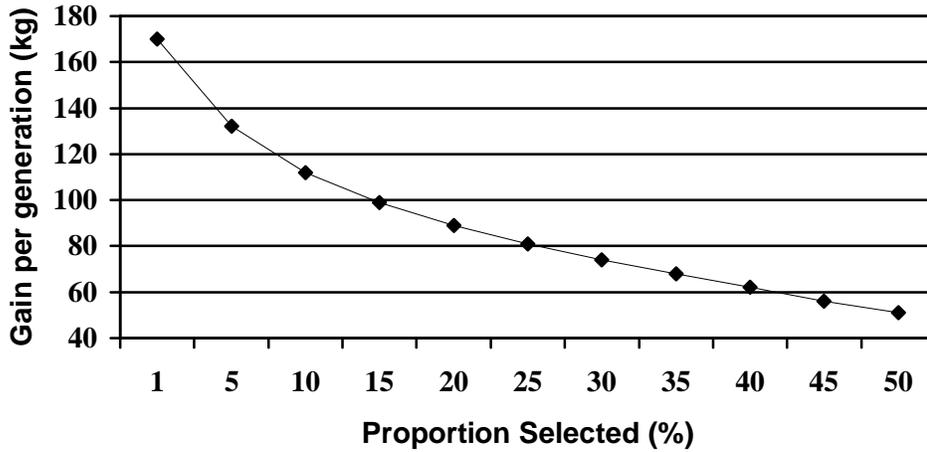
These results are based on using the selection index to identify the top animals. Thus, improvements are also expected in other traits. Figure 6 shows the improvements expected for fat and protein yield in kg per lactation. Similar, but more modest improvements would also take place for the type traits.

Figure 6. Expected progress in fat and protein yield per lactation

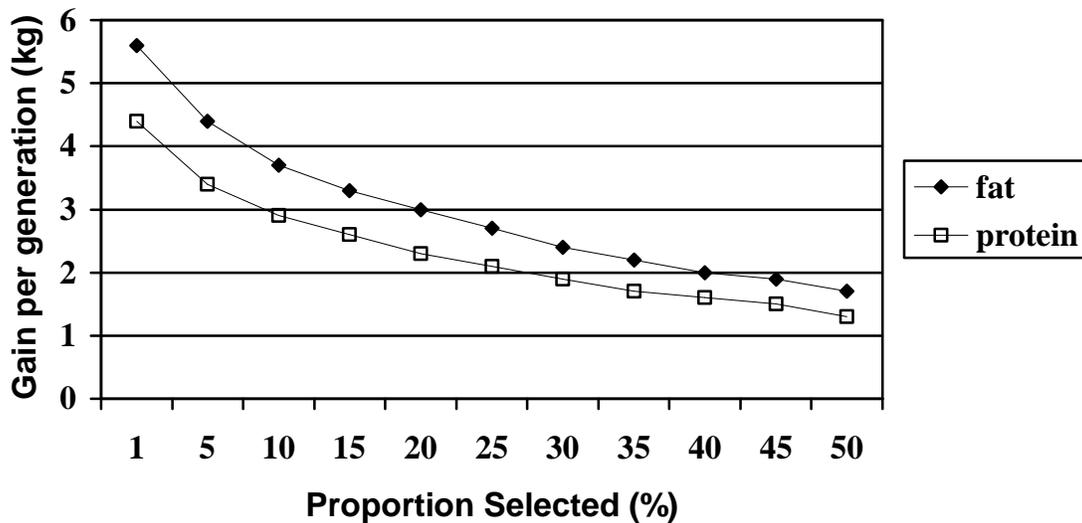

Figure 7 shows an example of the value of genetic improvement. It is based on a payment system of $7 per kg of fat and $15.55 per kg of protein. Selection in the top 40% would be worth an extra $40 per goat for each generation of selection. If the herd was turned over every two years, that would be $20 per year. This is cumulative, so after 10 years of selection, each goat would be producing an extra $200 worth of fat and protein.

Figure 7. Value of increased fat and protein yield
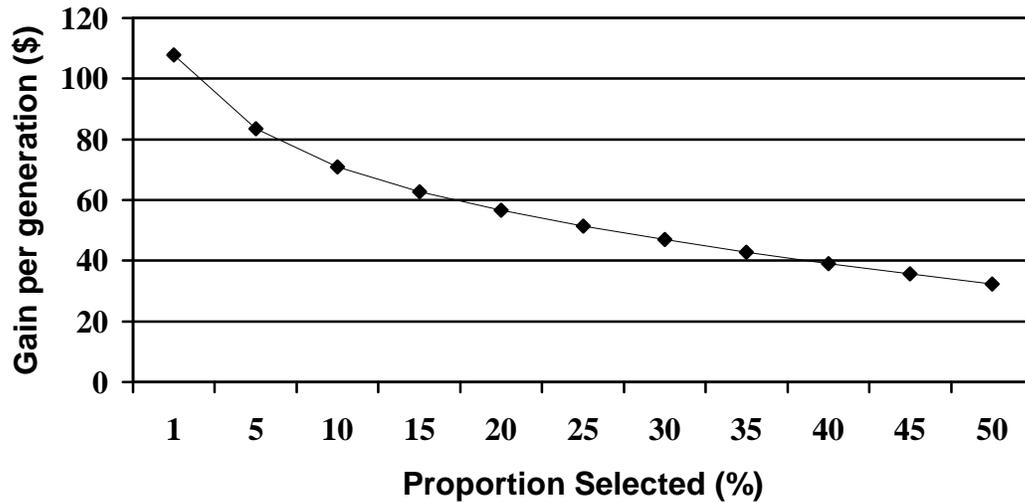
We can illustrate the above concepts using an example herd with 100 milking does. Assume in this case that 20 does are bred to AI sires from other cooperating herds, and 80 are bred to within herd young bucks. From the 100 buck kids born, the top 20 are identified based on selection index and the breeder selects the best 8 of these, taking into account other factors that are not included in the index. For the females, 25% of the milking does are replaced each year from young does in the top 40% of the herd. Based on this scheme, the 8 young bucks will be genetically 85 kg above the current herd average for milk, while the average young replacement doe will be 60 kg above average. The expected progress per year is calculated as the superiority of the parents divided by their average age. Bucks will all be 1 year old, while does will range from 1 to 5 years old, or be 3 years old on average. The average superiority is (85+60)/2 = +72.5 kg. The average age is (1+3)/2 = 2 years. The expected improvement rate is therefore 72.5/2 = +36 kg per year. In practice, the accuracy of evaluations for young animals will be lower than assumed in the above example. The superiority of selected sires and does would therefore be somewhat lower than this, but we could still expect at least +30 kg improvement per year under such a scheme.

SPECIFICS ABOUT THE PROPOSED JUVENILE SCHEME

The current genetic evaluation program available to breeders provides evaluations for does that had milk records in the previous year, as well as their sires and dams. Evaluation of young animals born last year, as well as new kids from this year can be done by taking the average genetic evaluation of their parents. In some cases, it may be necessary to use the average of the grandparents if one or both parents are not already evaluated.

In order for this to happen, breeders must identify all the young animals in their herd, including registration numbers for their parents. Ideally, service sires should be recorded and submitted through the milk-recording program whenever a doe is bred, and no later than the time of kidding. This is to allow time for genetic evaluations to be computed and the recommendations returned to the breeder quickly enough to cull young bucks.

Animals with the highest selection index will be identified for selection, as in the example shown above. Selected bucks will be used for 15 to 20 matings, with a goal of 10 to 15 pregnancies per young sire. Recommendations for selection will be provided over the Internet, and made available to participating breeders through the Quebec Goat Breeders Society. This will include an application that estimates inbreeding level of potential matings.

Annual averages for all traits will be charted against recent averages. This will include separation of averages into genetic and environmental parts, since environmental changes can have a big effect, especially over a short period of time. Separation of environmental and genetic effects is a by-product of genetic evaluations.

CONCLUSIONS

The proposed juvenile selection scheme could increase average milk yield by 300 kg per lactation in the next 10 years. This means that herds currently averaging about 900 kg per year (or 3 kg per day) can expect to see herd averages of 1200 kg. This is the improvement from genetics alone, so any management improvements would be on top of this. The tools are in place for genetic evaluations, and effective use of these tools can be expected to increase production by 30 kg per year, while at the same time improving other important traits.

A key element to the success of this program is limited use of any individual young sire, and therefore use of a relatively large number of young sires. Because individuals sires are evaluated with very low accuracy, we won't ever know which sires are truly the best. However, we will know that some of the best are among the group selected, and the daughters of the best bucks will tend to perform well in the next generation.

The juvenile scheme avoids problems due to inbreeding, which would otherwise be a serious limitation in smal populations with few sires selected.

Breeders must work now to identify young animals in their herd and their parents. The Canadian Centre for Swine Improvement is developing evaluations and a reporting system. Access to the reports and more information will be available on the Internet at www.ccsi.ca/goats. The system will be tested with a few of the participating breeders over the next few months, and should be available for all participating breeders shortly thereafter.