Crossbreeding: Breed Help or Hindrance?

For some Canadians, straying from your breed is like changing your favorite hockey team during the playoffs - you just don't go there. Other producers think crossbreeding is the solution to their herd's greatest problems, while others still don't know what to think about the practice. The truth is, depending on your herd goals, it can be any of these things. Let's take a look at some reasons why some dairy producers crossbreed, alternatives to crossbreeding, as well as the amount of crossbreeding taking place in Canada.

Why Crossbreed?

A consequence of genetic selection is that superior animals in future generations are more likely to be genetically related to elite animals of today. This comes as no surprise since the underlying goal of genetic selection is to shift the gene frequencies in the population towards those that are more desired and profitable.

However, as animals get more related to each other, inbreeding depression occurs for certain traits, meaning performance is lower than expected. High levels of inbreeding can be particularly detrimental to fitness traits, which include reproduction and survival.

The opposite phenomenon of inbreeding depression, referred to as hybrid vigor or heterosis, is the tendency of crossbred individuals to show qualities superior to the average of their parents. Hybrid vigor is maximized, and losses due to inbreeding depression are recovered, when two unrelated animals or lines are crossed to create a first generation (i.e.: F1) offspring, which will have 100% hybrid vigor and 0% inbreeding. Hybrid vigor yields its greatest advantages in first generation crosses but is not transmitted from generation to generation without continued crossbreeding.

Currently, the average level of inbreeding for Canadian Holsteins born in recent years is slightly over 6 percent. Average inbreeding levels are, however, highly variable from herd to herd and are dependent on the recorded pedigree information for each animal. To benefit from hybrid vigor as a tool for promoting fertility, health and longevity improvement in their herds, a small portion of Canadian producers have turned to crossbreeding.

Recently, a group of researchers at the University of Guelph examined the performance of crossbred dairy cattle in Canada resulting from mating Holstein dams to sires from other dairy breeds. Over the five year period studied, the resulting crossbreds (F1) were shown to produce less milk, but higher fat and protein in first lactation, compared to their purebred Holstein herd mates. These F1s also reproduced more efficiently than Holsteins with fewer calving problems and stillbirths. Conformation-wise, they were smaller in stature and overall size, a possible advantage for longevity, but had deeper udders and narrower, lower rear udder attachments than Holsteins.

In the study, all dams were Holstein so performance results of the crossbreds were highly variable, depending on the breed of the sire. Since management issues and complications in maintaining high hybrid vigor arise in later generations, it is very difficult to predict the results of crossbreds in later generations, both in average performance and their variability.

Options to Address Concerns Without Crossbreeding

Crossbreeding isn't the only way to genetically improve health, fertility and longevity. With Holsteins, one of the benefits of having such a large global population is the ability to identify individuals within the breed that excel for traits of interest. For improvement without

crossbreeding, producers can select standout bulls for fitness traits according to their herd goals. They can also accelerate genetic progress by selecting genomically tested females excelling for these traits.

Table 1 shows trait averages in Holsteins for the top 10 genomic young bulls and the top 10 active progeny proven sires based on their evaluation for Daughter Fertility (DF) or Herd Life (HL) published by Canadian Dairy Network (CDN) in April 2013. Using Relative Breeding Values (RBV), it is possible to relate bull proofs to the expected daughter performance for each trait (see CDN article: New Proof Expression for Functional Traits, November 2007). According to Table 1, the top 10 genomic young bulls for Daughter Fertility (average RBV DF=112) offer 10 fewer days open and the top 10 for Herd Life (average RBV HL=117) produce daughters that are expected to have 0.68 lactations more than daughters of an average sire in the population (RBV=100). The top 10 for Daughter Fertility among active progeny proven sires (average RBV DF=109) offer 8 fewer days open, and the top 10 for Herd Life (RBV HL=113) have daughters lasting 0.52 lactations more than daughters of average bulls. Table 1 shows that whether using genomic young bulls, proven sires, or a combination of both, genetic progress can be made for these fitness traits without sacrificing production, functional conformation or any other functional trait.

Table 1: Trait Averages in Holsteins for the Top 10 Genomic Young Bulls and Top 10 Active Progeny Proven Sires Based on Daughter Fertility or Herd Life (April 2013)

Trait	Top 10 Genomic Young Sires for:		Top 10 Active Proven Sires for:	
	Daughter Fertility	Herd Life	Daughter Fertility	Herd Life
LPI	2839	2907	2553	2650
Milk Yield	1076	1387	879	1140
Fat Yield	62	46	45	50
Protein Yield	45	49	32	35
Conformation	6	11	6	9
Mammary System	7	11	5	8
Feet & Legs	5	7	6	8
Dairy Strength	-1	2	2	2
Rump	3	3	3	6
Herd Life	114	117	111	113
Somatic Cell	2.68	2.64	2.75	2.74
Daughter Fertility	112	108	109	106
Milking Speed	103	102	101	101
Milking Temperament	101	101	103	104
Calving Ability	105	103	104	104
Daughter Calving Ability	109	108	108	109

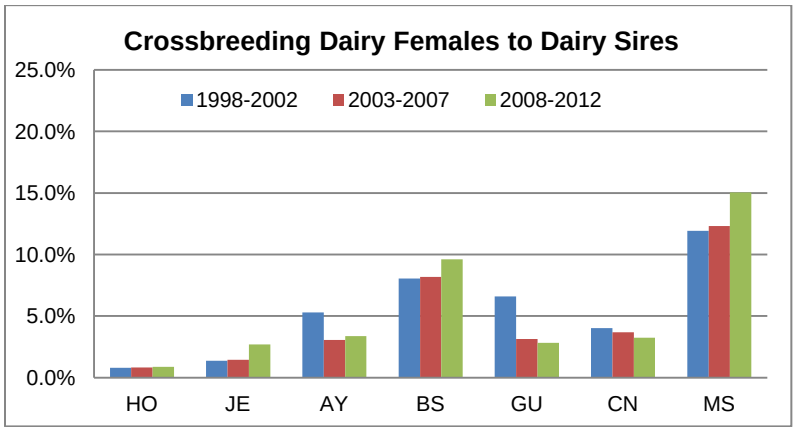
From an overall breed improvement viewpoint there would be much more concern about possible negative effects of inbreeding if the industry wasn't measuring and actively selecting for traits like Daughter Fertility, Herd Life and Somatic Cell Score. However, since these traits already have direct emphasis within the LPI formula, positive genetic gains are currently being realized. Even traits such as calving ease and calf survival (i.e.: stillbirth rate) are genetically improving in Canadian Holsteins due to their positive correlation with LPI without directly being in the formula. In addition, mating programs offered by A.I. organizations are an excellent tool for controlling the average level of inbreeding in herds that have participated in herdbook registration for pedigree recording over generations.

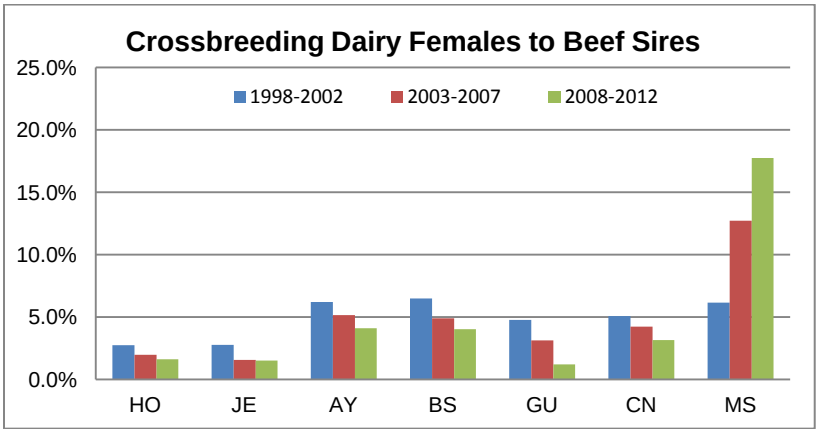
For producers that do, however, opt to use crossbreeding within their dairy herd, there are some very important considerations to keep in mind:

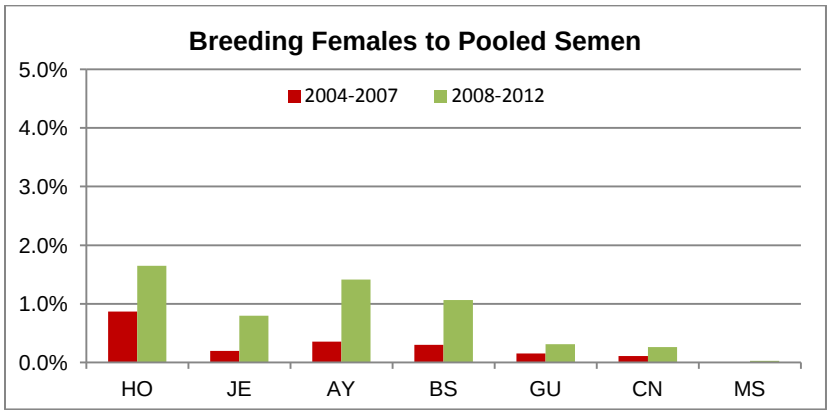
- **Hybrid Vigor and Heifer Replacements:** In terms of hybrid vigor, the ultimate female is the first generation result (F1) from mating two purebreds from different dairy breeds together. Ideally, producers practicing crossbreeding would have an entire herd of F1 females. The challenge, however, is the need to maintain a continuous supply of F1 crossbred heifers as future herd replacements. To do this, a purebred parent population would need to be maintained or replacements would need to be purchased elsewhere - two options most producers would be reluctant to exercise.
- **Simplicity:** Crossbreeding systems should be relatively simple. Systems requiring very high levels of management are unlikely to remain in place for very long. In beef breeding programs, most crossbreeding strategies include a well structured rotation of two or three breeds in order to sustain the benefits of hybrid vigor across generations. Such systems therefore require very accurate pedigree recording in order to monitor the true breed composition of each animal in the herd.
- **Breed Complementarity:** Sires should be chosen for traits that complement those traits that are lacking in the herd while paying attention not to sacrifice other traits of economic importance.
- **Consistency of Performance:** Ideally, a crossbreeding system should produce a consistent product. It is easier to manage a uniform herd of females compared to a more variable one that often results with crossbreeding due to the need to maintain purebred animals and various generations of crossbreds at the same time.
- **Accuracy of Genetic Selection and Mating Decisions:** Be careful when using genetics to select animals in crossbreeding systems. In Canada, and most other countries, genetic evaluations for dairy cattle are not comparable across breeds. For example, a Holstein LPI is not comparable to LPI values for coloured breeds and the same is also true for genetic evaluations for each specific trait, including all production, conformation and functional traits.

Dairy Crossbreeding in Canada

CDN investigated the frequency of crossbreeding in Canada over the past 15 years in the seven major dairy breeds. Any recorded breeding or insemination performed using a sire of a breed different than that of the dam, as well as any insemination using pooled semen from different sires, was considered a crossbreeding attempt. The graphs below illustrate the results in terms of the proportion of all breedings in each dairy breed that were some form of crossbreeding attempt.







As seen in the three charts, the Canadian Holstein population remains very purebred, representing 96% of all breedings. Over the last 15 years, less than 1% were bred to sires from another dairy breed and less than 3% were to bred to a beef sire. Holsteins were the breed most frequently bred to pooled semen, which is a mixture of semen from three different sires usually of differing breeds. While the popularity of pooled semen has increased each year since it became available in 2004, the frequency is still relatively low at less than 2%.

In the coloured breeds, dairy crossbreeding is relatively high, and rising, in the Brown Swiss and Milking Shorthorn breeds. In the last five years, nearly 10% of Brown Swiss and 15% Milking Shorthorn were bred to a sire from another dairy breed. During the same time period, a larger percentage (18%) of Milking Shorthorns was bred to beef breeds. The percentage of purebred breedings during the past five years for Brown Swiss and Milking Shorthorn were 85% and 67%, respectively. Apart from Milking Shorthorn, very little crossbreeding to beef sires takes place among dairy breeds.

Summary

Over the past 15 years, a very small proportion of dairy females were bred to sires from other dairy or beef breeds. For Holsteins, these types of crossbreeding represent less than 1% and 3% of all breedings, respectively. Milking Shorthorn and Brown Swiss breeds experienced the most crossbreeding. As animals get more related to each other, inbreeding depression can affect some traits (particularly fitness) meaning performance may be somewhat lower than expected. While this is not ideal, it must be weighed against genetic gain. Crossbreeding is one avenue that some producers have opted to use to promote health and fertility in their herds. Another option to achieve improvement is to select the highest sires within breed for traits like Daughter Fertility and Herd Life, according to the herd's breeding goals.

Authors: Lynsay Beavers, Industry Liaison Coordinator, CDN
Brian Van Doormaal, General Manager, CDN

Date: July 2013