

Implications of inbreeding on the dairy industry

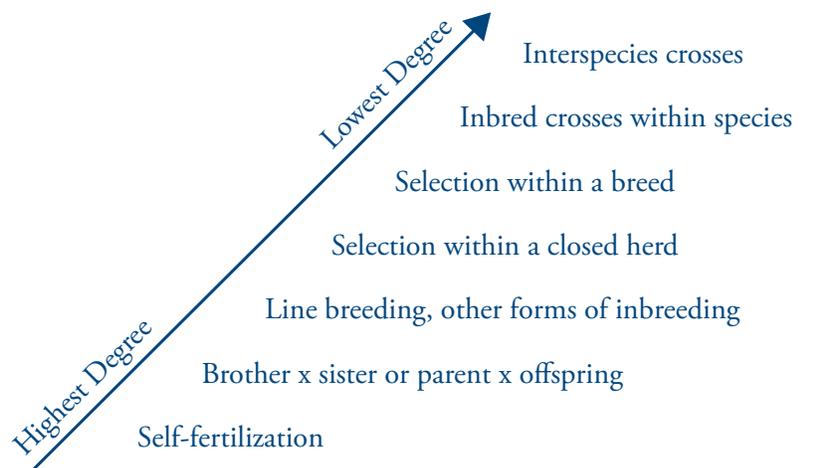
Where we are today and its long-term impact on the industry

Defined as the mating of related individuals, inbreeding has been a longstanding struggle dairy producers have faced over the years. Dairy cows have been bred for similar goals—more milk production per cow, greater on-farm profits—which has led to the proliferation of prominent genetics throughout the industry. Over time families not consistently offering these desirable traits have been removed from the population, creating a more condensed, less diverse gene pool. The long-term effect of this decision-making over multiple generations can reduce genetic diversity and negatively impact performance and health traits, raising awareness about the need to minimize inbreeding in the future.

The basics of inbreeding

Inbreeding comes in many different forms and varying degrees. As the chart below outlines, the greatest degree of inbreeding is self-fertilization, which is an issue in organisms that can self-pollinate. For dairy animals, the highest degree of inbreeding is mating siblings or a parent to their offspring. Other breeding practices can also increase inbreeding in varying degrees.

Figure 1. Varying Degrees of Inbreeding

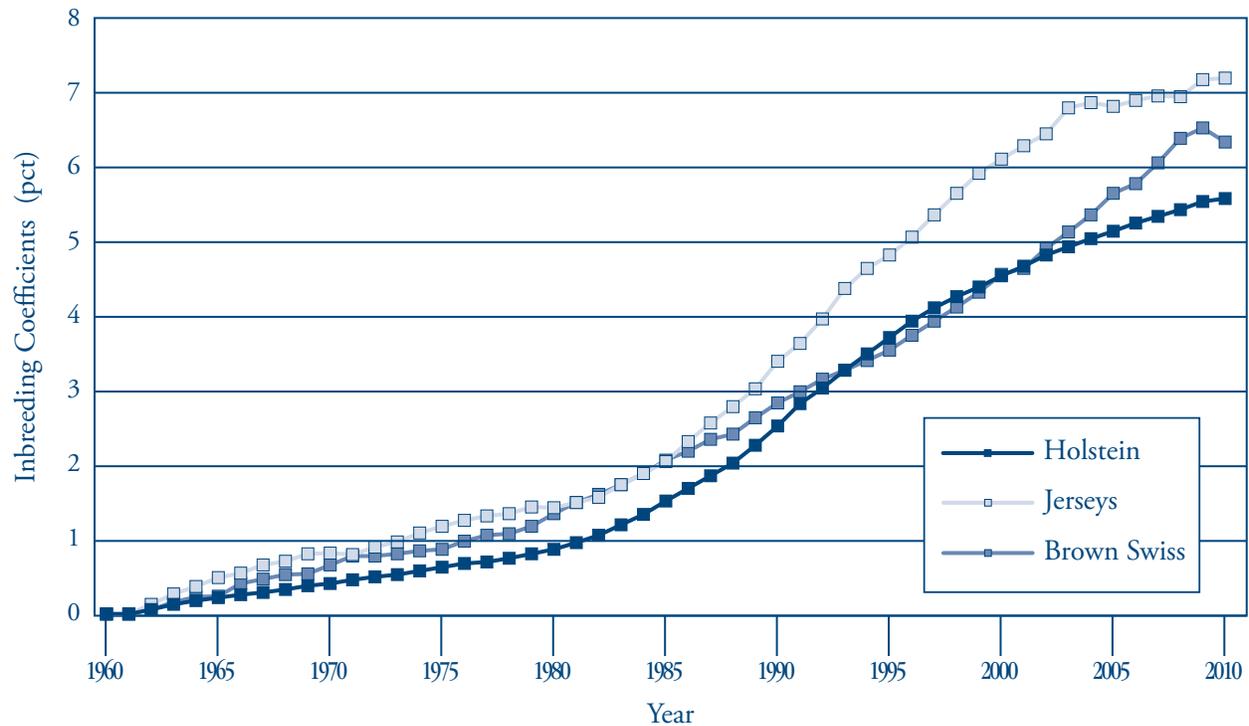


The varying degrees of inbreeding can have a direct impact on genes transmitted to offspring. When parents of an offspring are related, some of the genes that are transmitted may be copies of the same gene from common ancestors. The more closely the two animals are related, the more frequently the same genes can be passed on to their offspring.

One tool that indicates the level of inbreeding is the inbreeding coefficient, which indicates the probability that two alleles for any gene are identical by descent. The inbreeding coefficient theoretically ranges from 0 to 100 percent and tells what portion of the traits an animal is homozygous for (BB or bb, for example) are due to inbreeding. The calculation is a function of the number and location of the common ancestors on a pedigree, and only indirectly based on the inbreeding of the parents. For example, if two dairy animals that are highly inbred are mated, but share very little common ancestry, their resulting offspring will have a low inbreeding coefficient.

In the dairy industry the inbreeding coefficient has continued to increase since the 1960s, which is further outlined in the chart below. In 1960 the inbreeding coefficient of Holsteins, Jerseys and Brown Swiss was “0,” but has continued to climb over the past 50 years. In all three breeds the inbreeding coefficients are the highest they have ever been.

Figure 2. Inbreeding Coefficients by Breed from 1960 – 2010



Linking inbreeding and performance

The long-term effects of inbreeding have been shown to negatively impact performance and health traits of resulting offspring. Inbreeding depression represents the decline in performance of inbred animals.

Research¹ from the late 1990s examined the effects of inbreeding on lifetime performance of dairy cattle pertaining to production and reproductive traits that directly impact herd profitability. The study concluded that all traits were negatively impacted as the incidence of inbreeding depression increased. Table 1 below further outlines the research findings.



Table 1. Effects of inbreeding on production and health traits in Holstein cows

Trait		Inbreeding depression per 1% increase in inbreeding
Milk production	First lactation	-59.4 pounds
	Lifetime production	-389.4 pounds
Milk fat production	First lactation	-1.98 pounds
	Lifetime production	-13.2 pounds
Milk protein production	First lactation	-1.76 pounds
	Lifetime production	-12.1 pounds
Age at first calving		+0.55 days
Days of productive life		-6 days
Days in milk		-6 days

Researchers noted that the effects of inbreeding were cumulative, and lifetime profit functions were relatively larger than the effects on lactation traits.

A more recent study² in Ireland investigated the effect of inbreeding on production, reproduction and milk quality traits. The study found that a 12.5 percent inbred first-lactation Holstein:

- Produced 136 fewer pounds of milk, 11.7 fewer pounds of fat and 2.64 fewer pounds of protein over the lactation.
- Had a 0.03 increase in somatic cell score.
- Experienced a two percent greater incidence of dystocia and a one percent greater incidence of stillbirths.
- Had an 8.8-day longer calving interval and increased age at first calving by 2.5 days.
- Reduced its survival to second lactation by four percentage units.

While an inbreeding coefficient of 12.5 percent is higher than commonly seen in the U.S. dairy populations today, these results can be on the horizon for herds that may not closely monitor the issue. This means even greater declines in production and health traits can be experienced beyond what is seen today.

Moving forward with inbreeding

To help move your herd forward in the midst of inbreeding, use the tools and information available to make proper breeding decisions as they will directly impact herd production and reproductive performance.

- **Be aware of the effects.** Knowing and understanding inbreeding and the negative effects it can have on your herd is the first step to reversing the negative trend. Keep in mind that the degree of inbreeding will determine its effect on an animal's performance. Avoid matings that will produce unacceptable amounts of inbreeding rather than eliminating a useful bull from the breeding program altogether.
- **Know your animals' pedigrees.** Inbreeding can best be avoided with sound recordkeeping of an animal's pedigree and ancestry. Since the loss from inbreeding can occur from ancestors three or more generations back, recording and keeping a full pedigree is the only way to prevent inbreeding.
- **Use the inbreeding coefficients.** Inbreeding coefficients can help determine the level of inbreeding in your herd and how related your cows may be to potential sires. Use this information to move your breeding program forward while focusing a concerted effort toward minimizing inbreeding.



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The effects of inbreeding can be a blind cost to your herd as production, breeding pen performance and potential profitability may never fully be realized. By focusing attention on inbreeding as you make mating decisions, you can ensure productivity and profitability are maximized.

1 Smith LA, Cassell BG, Pearson RE. The Effects of Inbreeding on the Lifetime Performance of Dairy Cattle. *J Dairy Sci* 1998;81:2729-2737.

2 Mc Parland S, Kearney JF, Rath M, Berry DP. Inbreeding Effects on Milk Production, Calving Performance, Fertility and Confirmation in Irish Holstein-Friesians. *J Dairy Sci* 2007;90:4411-4419.