



FIGURE 1: Possible outcomes when two known carriers are mated

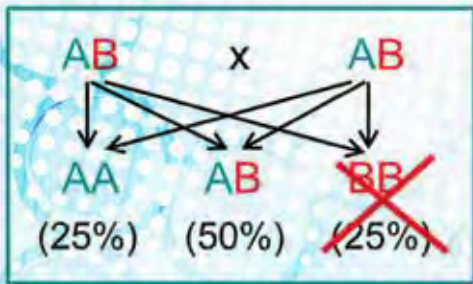
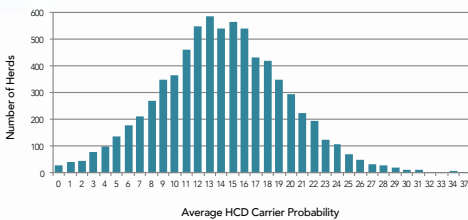


Figure 1 illustrates the possible outcomes when two known carriers are mated together. Using HCD as an example, in this situation, 25% of offspring will be homozygous dominant (AA) and unaffected, 50% will be heterozygous (AB) and unaffected but able to pass on the recessive gene, while another 25% will be homozygous recessive (BB) and die, likely before weaning.

FIGURE 2: Distribution of Holstein Herds by Average HCD Carrier Probability



Herds made up of more carriers than average likely have a higher proportion of daughters sired by HCD carrier bulls listed in Table 1. If bloodlines listed in Tables 1 and 2 make up a significant portion of your herd, you'll want to read on.

MANAGING RECESSIVES & HAPLOTYPES

Does it feel like dairy cattle breeding has gotten more complicated? Truthfully... in some ways it has. We now know about many genetic recessives and haplotypes that negatively affect profitability, and in the future, we're sure to find more. In this article, learn how these genetic anomalies work, how their impact can vary from one herd to another, and how you can manage them effectively.

How do Recessives & Haplotypes work?

An animal carries two copies of a gene or haplotype (i.e.: short section of DNA strand), one inherited from their dam and the other from their sire. An animal is said to be either "homozygous" for a gene or haplotype, meaning they inherited the same DNA section from both sire and dam, or "heterozygous", meaning the DNA section inherited from the sire and dam are different. Heterozygous animals are usually referred to as "Carriers". Most genetic anomalies in dairy cattle are controlled by genes that are recessive in nature, rather than dominant, which is the case of all of the known haplotypes affecting fertility as well as HCD, the haplotype associated with cholesterol deficiency. For genetic recessives, only homozygous animals, which have inherited two copies of the gene or haplotype, are affected. For the fertility haplotypes, affected animals die from early embryonic loss while HCD results in early calf mortality.

Breed Frequency vs Herd Frequency

Haplotypes affecting fertility work in the same manner outlined above, only a lost early pregnancy is the result. There are five haplotypes known to affect fertility in Holstein, two known in both Jersey and Brown Swiss, and one known in Ayrshire. These haplotypes are particularly of concern for coloured breeds as the percentage of carriers within breed tends to be high (10-25%), depending on the haplotype in question. In the Holstein breed, less than 5% of animals carry a haplotype affecting fertility. However, 12% of Holstein females are carriers of the more recently discovered, more costly, and more complex HCD.

Overall carrier frequencies can help paint a picture of the scale of a problem in a given breed. Carrier frequencies can, however, be highly variable from herd to herd, meaning a genetic recessive or haplotype can be much more impactful in one herd than another. For example, Figure 2 shows the distribution of Holstein herds based on the average HCD carrier probability of the heifers and cows currently active in each herd. Although the overall frequency of HCD in Canadian Holsteins born in 2015 is 12%, we can see that many herds have higher frequencies and some are much higher! In fact, roughly 1,200 herds are made of at least 20% that are HCD carriers.

Managing Recessives & Haplotypes

CDN calculates Carrier Probability values for every animal in its database for all haplotypes and publicly displays them on the website as part of each animal's "Pedigree" page. These values reflect the likelihood an animal carries a given haplotype and provide producers with the opportunity to manage these potentially problematic attributes in their herd. Strategies for managing genetic recessives and haplotypes could include:

- Using an AI mating program that incorporates CDN carrier probabilities for recessives and haplotypes. Verify that your AI representative is avoiding mating potential/known carrier females to known carrier sires.
- Determine potential carrier animals based on CDN carrier probabilities. Genomic test these animals to determine true carrier status. Subsequently, avoid mating carrier males to known carrier females. Again, this could be done with help from AI via a mating program that incorporates carrier probabilities since genotyped animals will have a probability of either "1%" (Free) or "99%" (Carrier).
- Create a user account on the CDN website and subscribe to the Data Management Service called "Evaluations by Prefix". Canadian breeders pay an annual subscription fee of \$100 for access to query tools and files specific to their herd for the next 12 months. Recessive and haplotype carrier probabilities for all females, genotyped or not, are available for subscribers upon download of a detailed spreadsheet that can be opened with software like Excel. This file also contains genetic evaluations for all traits. When logged in, producers can run mates via the Inbreeding Calculator. The output file from this calculator contains a probability of being affected for all potential progeny of the mating, helping producers make more informed decisions.

Avoiding carrier sires altogether is not a recommended strategy. A sire remaining in AI despite a positive carrier status for any single genetic recessive or haplotype means his genetic offering likely outweighs the fact that he may pass on a recessive gene. These sires simply need to be used appropriately on females known to be non-carriers.

Negative genetic anomalies can be difficult to keep track of and add a new complexity to breeding dairy cattle. Utilize the strategies presented in this article to minimize their impact in your herd. CDN services are there to help you do exactly this. 🐄

AUTHORS: Lynsay Beavers, Industry Liaison Coordinator, CDN and Brian Van Doormaal, General Manager, CDN - June 2016.

Table 1: Carrier Sires with the Most Active Daughters in Canada

HCD	FERTILITY HAPLOTYPE (HH1 – HH5)
GILLETTE WINDBROOK	MAINSTREAM MANIFOLD (HH3)
LIRR DREW DEMPSEY	VAL-BISSON DOORMAN (HH5)
GILLETTE STANLEYCUP	PICSTON SHOTTLE-ET (HH5)
COMESTAR LAUTHORITY	MS ATLEES SHT AFTERSHOCK-ET (HH5)
BRAEDALE GOLDWYN	O-BEE KRUSADER-ET (HH1)
COMESTAR LAVANGUARD	LINCOLN-HILL SHOT LASER-ET (HH5)
LARCREST CONTRAST-ET	DUDOC MR BURNS (HH2)
GILLETTE WINDHAMMER	REGANCREST DESIGN-ET (HH3)
GOLDEN-OAKS ST ALEXANDER-ET	CLAYNOOK TENNESSEE (HH2)
DUDOC MR BURNS	CHARPENTIER LFG SPECTRUM (HH1)

Table 2: Coloured Breed Carrier Sires with the Most Active Daughters in Canada

JERSEY (JH1 & JH2)	AYRSHIRE (AH1)	BROWN SWISS (BH1 & BH2)
LENCREST ON TIME - ET (JH1)	JELYCA OBLIQUE	R N R PAYOFF BROOKINGS ET (BH2)
SHF CENTURION SULTAN (JH1 & JH2)	DES CHAMOIS POKER - ET	SUN - MADE VIGOR ET (BH1)
LENCREST BLACKSTONE - ET (JH1)	DES FLEURS PERFECT - ET	HILLTOP ACRES GOLDMINE (BH1 & BH2)
ALL LYNS LOUIE VALENTINO - ET (JH1)	DE LA PLAINE PRIME	TOP ACRES C WONDERMENT ET (BH2)
HAWARDEN IMPULS PREMIER (JH1)	ST CLEMENT EDMOUR	JOBO WONDER BOSEPHUS ET (BH2)
TOLLENAARS IMPULS LEGAL 233 - ET (JH1)	KILDARE JUPITER - ET	KULP GEN PRONTO DALLY ET (BH1)
UNIQUE VS HABIT (JH1)	KAMOURASKA BIGSTAR - ET	SWISS FANTASY FERRARI ET (BH1)
LENCREST TYLER - ET (JH1)	PALMYRA BINGO - ET	SCH-RZ BS PRESID ALIBABA (BH1)
SUNSET CANYON DICE - ET (JH1)	DUO STAR POKERSTARS	PAYSSLI ET (BH2)
COMESTAR JDF BEAUTIFULL - ET (JH1)	DES COTEAUX WARNER	TOP ACRES JCS SHEBANG (BH2)