Inbreeding in the Genomic Era

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Selecting only the top percentage of animals in traits useful to humans has allowed dairy farmers to mold the dairy cow into the highly efficient, excellent producer that it is today. However, this intensity and speed of selection causes close genetic relatives to produce offspring, which is known as inbreeding. Inbreeding can lead to a reduced production, known as inbreeding depression. Dairy breeders have been combating inbreeding for decades, but it has continued to rise. Now, as genomic selection becomes more popular, it is important to consider the implications for inbreeding of this new component to dairy selection. Genomics could help to reduce inbreeding using changes in genomic breeding programs, alternative measures of inbreeding, and selection against inbreeding depression.

Since the first official genomic evaluation in 2009, genomic selection in the dairy industry has increased exponentially. The main advantage to this type of selection is that bull calves can be tested for their genetic merit before they even reach sexual maturity, which drastically decreases the generation interval as compared to traditional breeding programs. Although this has led to a much faster rate of genetic gain overall, shorter generation intervals has also meant a steep rise in inbreeding. However, Boichard et al. (2014) proposed that both high-density genomic, and low-density genomic selection are effective measures for reducing inbreeding with minimal effect on genetic gain.

There are two mechanisms by which inbreeding creates inbreeding depression, the recessive deleterious alleles and overdominance. Both of these stem from having a pair of identical alleles, otherwise known as homozygosity. But, homozygosity is not detrimental for every allele. In fact, most of a cow's DNA is made up of alleles in common with every other cow. To identify the specific genomic regions associated with inbreeding depression, Pryce et al. (2014) ran genome wide association studies to find specific genomic regions associated with inbreeding depression. Using this knowledge, inbreeding depression could be avoided by selecting against homozygosity in these specific regions. This would theoretically
Upcoming Events
See VTDairy for details.

April 1, 2017
VA Spring Holstein Show
Rockingham Co. Fairgrounds

April 25-26, 2017
Grazing School
McComb Farm

May 13-14, 2017
Show Like a Pro Workshop
Frederick, MD

May 15, 2017
Hokie Cow Classic
Blacksburg Country Club

May 20, 2017
Dairy Judging Workout
New Market, VA

May 27, 2017
Breakfast on the Farm
Arbogast Farms

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allow for dairy breeders to benefit from inbreeding without the detrimental effects of inbreeding depression.

In conclusion, genomics is a growing area of dairy breeding. Currently, the sharp reduction it produces in generation interval has led to an increase in inbreeding. However, through increased bull testing, decreased offspring per bull, genomic measures of inbreeding, and selection against inbreeding depression, genomics has the potential to combat inbreeding’s detrimental effects.

REFERENCES:

Reflections on International Dairy Federation World Summit

“...the good, the bad, and the ugly, as well as the resultant improvements and future directions. Similar to European animal rights and environmental groups, their American counterparts tend to portray the large farms as ‘industrialized’ agriculture, both harmful to animals and the environment. An immediate and proactive response by America’s agricultural community would provide an opportunity to shape future legislation and cultural beliefs. The American agricultural community must immediately consider undertaking a social media campaign and public education programs detailing the story of production agriculture in America through time...”

The leaders of milk producers organizations, the farmers’ union, feed suppliers and farm accountants signed on to the ANCA model, making it mandatory for all Dutch farms. Beginning in January 2017, the penalty for non-compliance on a particular farm means milk cooperatives will not buy that farm’s milk.

What Implications Might This Have For American Dairy Farmers? The compulsory compliance of Dutch dairy farmers to the ANCA model provides an important lesson to American agriculture. As succeeding generations have become more removed from the experience of their farming ancestors, a large disconnect has emerged between the nostalgic vision of the Old MacDonald family farm and realities of large, technology-driven, commercial farms. Similar to European animal rights and environmental groups, their American counterparts tend to portray the large farms as "industrialized" agriculture, both harmful to animals and the environment. An immediate and proactive response by America’s agricultural community would provide an opportunity to shape future legislation and cultural beliefs.

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In October 2016, I attended the International Dairy Federation World Dairy Summit held in Rotterdam, Netherlands. Over 1,200 participants from every continent attended including many heads of government agencies, research institutes and national dairy organizations... seven percent were dairy farmers...few were American. Presentations addressed a wide range of topics important to the dairy industry ranging from animal well welfare, food safety, economics, nutrition, marketing, environmental challenges and sustainability. Not surprisingly, the issue of environmental quality was a "hot" topic of great interest.

Environmental regulations focusing on greenhouse gas emissions are significantly impacting financial and production decisions implemented on Dutch dairy farms. For example, in the Netherlands all manure lagoons are required to be covered to limit greenhouse gas emissions. In 2016, the Annual Nutrient Cycling Assessment (ANCA) model was implemented in the Dutch dairy sector. The goal of the ANCA model is to produce more milk and pollute less. The inputs for the ANCA model are milk produced per cow, manure, animals and land. A national database is used to aggregate inputs and outputs for each farm per year. Follow-up includes the potential for motivational calls.

The American agricultural community needs to define itself proactively in a positive, plausible light. Otherwise, animal rights and environmental groups will promote and encourage the public to approve the passage of legislation that will...