Beefing Up Herefords With Line 1

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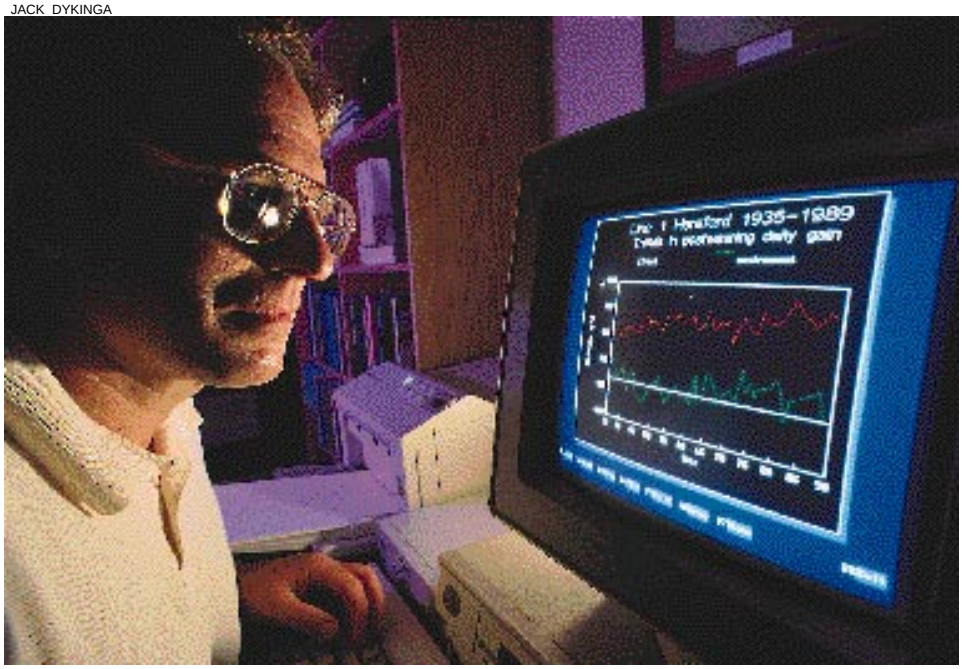

Geneticist Mike MacNeil reviews Line 1 Hereford breeding data collected since 1934. (K3910-14)

In 1934, genetics was a young field and some considered our research to be quite radical," says retired ARS geneticist Ray R. Woodward. He was referring to the beginning of the nation's first long-term studies on genetic selection and linebreeding at the ARS Fort Keogh Livestock and Range Research Laboratory in Miles City, Montana.

The studies were expected to improve performance in Hereford cattle. And they did.

Today at least two-thirds of the U.S.-registered Herefords used as breeding or seed stock trace part of their ancestry to the most successful ARS herd, known as Line 1. And the ongoing experiment has laid a solid foundation for improving and evaluating beef cattle genetics and performance. Hereford and Angus breeds make up most of the 40 million beef cattle in this country.

The project started with 14 lines of genetically diverse cattle at Miles City and 34 more at other agricultural experiment stations throughout the western United States.

Each line, says ARS geneticist Michael D. MacNeil, was to be the beef cattle equivalent of the parent stocks used in development of hybrid seed corn. Two half-brother bulls and 50 cows were the foundation of the Line 1 cattle. Since then, no new cattle have been added to the herd, so all the animals are related to each other and ultimately back to the two bulls.

The lanky, angular Line 1 cattle didn't conform to the shorter, compact standards of the day, says Woodward, so the herd wasn't popular with the beef industry.

Two challenges reversed that opinion: dwarfism and the producer's need for faster animal growth.

Dwarfism is caused by a recessive gene. Individuals may carry the gene for dwarfism but appear normal, because the gene is overruled by the dominant gene for normal size.

Before 1940, dwarfism was not recognized as a problem in the Hereford breed. Less than 10 years later, it was a serious issue. Mature weights of normal cattle were about 1,800 pounds, while dwarfs reached only about 600.

"Some very popular herd sires had this gene, but Line 1 cattle did not," says Woodward.

Line 1 became a pure new resource for breeders to use to purge dwarfism in their Herefords, he says. Thanks to Line 1, along with careful recordkeeping and breeding in the beef industry, dwarfism was no longer a problem by the mid-1970's.

In 1969, cattle breeders placed new emphasis on the weight and corresponding body frame size of newly weaned and yearling animals. Scientists had recently proved that larger-framed cattle were more profitable than smaller ones.

Among other traits, ARS geneticists had from the beginning selected Line 1 cattle for rapid growth rate, making Line 1 a suddenly valuable source of genetic material for the beef industry. Ever since, Line 1 sires and bull calves have commanded the highest average prices—some have sold for more than $100,000—at Hereford auctions.

After 13 generations of selection, the growth rate of Line 1 cattle has increased about two-thirds of a pound per day. For comparison, a yearling born in 1935 might have reached 750 pounds. Today, given the same conditions, the genetic improvement would result in a 900-pound yearling.

"Our results to date provide no evidence that we are anywhere near a limit, even after 60 years of continuous selection for postweaning growth," says MacNeil.

"The 60-year progression of research is more important than the individual animals. Many of the principles that we now take for granted in

genetic improvement programs were first established in Line 1," he says.

For example, this research shows the value of progeny testing, or evaluating bulls by the performance of their young. Such studies also produced the first estimates of heritability—the degree to which a bull or cow's characteristics are passed on to progeny—and confirmed that frozen semen could be used decades later to measure genetic change.

One of the station's latest findings is that inheritance of many economically important traits depends equally on both parents. This contradicts the assumption among some breeders that calves are more like their mothers than their fathers.

Such a circumstance can occur because at conception, there is extra DNA from the calf's mother in the mitochondria of the egg. The mitochondrial DNA—separate from the chromosomal DNA that is passed on by both parents—has been shown to affect milk yield in dairy cattle.

"Our results confirm that standard genetic evaluation and selection methods, which rely on information about both parents, offer a more reliable way to predict calf genetic value than over-valuing the maternal lineage," MacNeil says.

Recently, he and geneticist Warren Snelling used Line 1 to study methods for national cattle evaluation. In these evaluations, weaning weight records for calves with young mothers are routinely adjusted to make their weights comparable to those of calves from mature cows.

However, the researchers found a flaw in the common practice of using standardized adjustments in all herds. In some herds, this practice caused errors in the genetic evaluation for a mother's ability to raise a calf with a high weaning weight—called maternal ability.

"Correcting weaning weight records for the Line 1 cattle at Miles City greatly improves our ability to reliably identify genetic differences in maternal ability," says MacNeil.

The potential downside to the long-term inbreeding of the Line 1 cattle is that overall fertility and calf survival have decreased. This increases the cost of production over non-inbred, or crossbred cattle. However, says MacNeil, when Line 1 cattle are bred with non-Line 1 animals, performance is restored to normal levels. Any animals sold by the station are evaluated for reproductive soundness and guaranteed.

Molecular geneticist Michael Grosz, MacNeil, and others are now searching for the genetic markers, or DNA sequences, associated with economically important traits like growth rate, carcass leanness, and meat tenderness. These markers could be key to improving cattle for traits that are difficult to measure or that can only be measured late in life.

"In the future," says MacNeil, "such markers may routinely be used to identify the best animals to keep for breeding."—By **Kathryn Barry Stelljes**, ARS.

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Line 1 Hereford cattle at ARS' Fort Keogh Livestock and Range Research Laboratory in Miles City, Montana. (K3910-15)