Climate change and cattle: Genetics may hold answer to heat stress tolerance

October 3 2023, by Anna Zarra Aldrich

Dairy cows along Horsebarn Hill on June 22, 2016. Credit: Sean Flynn/UConn Photo

How do farmers decide which cows to breed and which to put out to pasture?

Historically, farmers have selected cows with genetics for better milk production and quality. More milk means more supply and more money in the farmer's pocket.

But due to rising temperatures around the globe, cows that can handle the heat are becoming more desirable.

"Animals with high milk production tend to be worse at dealing with heat stress," says Breno Fragomeni, assistant professor of animal science in the College of Agriculture, Health and Natural Resources. "We need to start selecting animals also for heat tolerance or else that selection for high production is not going to work," Fragomeni says.

Fragomeni is using cutting edge genomic research to determine how to make dairy cattle better adapted to heat stress.

Failing to select for heat tolerance could result in lower food production which will increase food prices and food insecurity. Additionally, cows that are naturally better able to bear the heat will be more comfortable, ensuring increased animal welfare.

To conduct his research, Fragomeni and his team collect more than 20 kinds of data including how much milk the cows produce, protein and fat yields, cell count, and when and how often cows reproduce. They compare these data with temperature and humidity data.

When cattle are stressed, one of the first observable impacts is a decrease in milk production. This is likely because eating and digesting generates a lot of heat in cows' bodies. So, when cows get heat stressed, they eat less and hence produce less milk.

Fragomeni has found that for every degree above 65 on the temperature humidity index (THI), milk production at the Kellogg Dairy Center

decreases by 0.2 pounds of milk per cow. On an extremely hot day, this could cause a total loss of 500 pounds of milk in the facility.

"When you talk about heat stress, people usually imagine animals dying from the heat," Fragomeni says. "But in dairy farms, the animals are slightly stressed. It's not that they're suffering in such a way that they can't cope anymore. They're still producing milk, it's just a little bit less."

This estimated 5% drop in production during the summer could mean ending the year at a loss rather than a profit for dairy farmers, who operate with very narrow profit margins. The dairy industry loses an estimated $1.2 billion from heat stress annually.

Additionally, when the cows are heat stressed in the summer months, they don't want to conceive. They wait until temperatures drop in fall to get pregnant. This means calves are born in the heat of summer. On top of the stress of giving birth and producing milk at their maximum for their calves, the cows experience more and more heat stress.

"That's when the cow needs more comfort, but it's also when the cow is being most stressed by the high milk production and recovering from the delivery," Fragomeni. "It becomes a cycle."

There is no single gene that alone solves the heat stress problem. Fragomeni looks at the complete genomes of bulls that have hundreds of daughters and sees whose daughters are better suited to handle the heat.

"Heat stress tolerance is a very complex trait. We have hundreds if not thousands of genes involved," Fragomeni says. "At the end of the day, selecting for a single or a few markers is not going to make a lot of difference."

Using a sophisticated statistical model, Fragomeni and his team associate

milk production with temperature using a national database of bull genetics. The model creates an estimate of how much milk a cow is expected to lose relative to the national average based on their sire.

Without using genomics, it would take approximately five years for scientists to be able to determine if a bull is genetically well-suited for heat.

"If you're not using genomics, we can only tell if the bull is good or not after we have so many daughters with complete lactation records and that takes a while," Fragomeni says.

Passing this information along to farmers helps them decide which bulls to seek as sires so their offspring are better suited for heat while still being high milk producers.

While some farms do have cooling systems in their barns, for many, installing expensive air conditioning systems is not feasible, making genetic solutions much more sustainable.

"Some of these environmental interventions may be a challenge or cost prohibitive for some farms," Fragomeni says. "However, we're going to spread heat tolerant genetics across the whole population and hopefully on the long-term we're going to have better animals for that."

Fragomeni is currently working on a study using milk and fecal samples from cattle at the Kellogg Dairy Center to determine if heat stress changes the animals' microbiomes.

This study is part of an effort to develop better non-invasive measurements for heat stress. Currently, the most accurate measures require scientists to take blood samples, respiration rate, or vaginal temperature. These methods are hard to scale up for large farms and can

further stress animals.

"When you're talking about specific farms, we can only tell the animals are heat-stressed after they show symptoms and it's too late for an intervention," Fragomeni says. "So, we're trying to come up with some better methods that are non-invasive."

Fragomeni is also working on a study comparing cattle in Wisconsin and Texas, two of the largest dairy producers in the U.S. These two states have radically different management systems and climates which could correspond to differences in the animals' genetics.

In Connecticut, animals experience an average of 100 days of heat stress per year. Down south, this number can be as high as 250 days a year.

"Sometimes you can cope with a cow being heat stressed less than a third of the year," Fragomeni says. "So we can keep animals that are sensitive to heat stress. While in the South, if the animal is sensitive, they just have to get rid of it. So maybe animals in the cooler regions are actually more sensitive than animals in the hotter regions. That is our hypothesis."

The long-term goal of this work is to identify the best genetics for cows in each climatic region of the U.S.

A core part of Fragomeni's research is ensuring his solutions are sustainable for farmers, consumers, and the environment.

"The sustainability must be economical, environmental, and social—people must be able to afford food," Fragomeni says. "We're not trying to come up with things that are unrealistic for the farmers."

Provided by University of Connecticut