Hannah Dairy Research Foundation

Produced in association with Scottish Dairy Growth Board

Research Paper Summary

Quantification of the effect of in-utero events on lifetime resilience in dairy cows

Short title: **Lifetime resilience and in-utero events**

Key words: **dairy cow resilience; developmental origins; health and disease; heat stress**

Ref No 24/3

Practical point

Increasing cow resilience could improve sustainability of the dairy industry. Resilient cattle can be defined as those that have a long productive lifespan, good reproductive performance, and milk yield. While resilience itself cannot be quantified these indicative traits can be combined into a quantitative score for lifetime resilience. This study found that stresses on the dam can impact calf lifetime resilience.

Background

With the challenges faced by the dairy industry, including climate change and public perception, there is an interest in increased cow resilience as a way to increase sustainability of dairying. Resilience refers to the ability of an animal to cope with environmental, social and disease challenges. Resilient cows are more likely to complete many lactations with good fertility and fewer health problems. Resilient cows cope well with farm management and environmental conditions and are less likely to be culled early.

An individual's lifetime health and performance (and therefore resilience) is influenced by the environment they experience in-utero, also known as the Development Origins of Health and Disease (DOHaD). For example, it has been demonstrated in cattle that in-utero heat stressed heifers have mammary glands with smaller alveoli (Skibiel et al., 2018). Therefore, being able to identify resilient animals based on the events experienced by their mother during pregnancy could help inform farm management

decisions. Given increased risk of extreme weather events through climate change, the effects of heat-stress on foetus development is of particular interest to the dairy industry. Understanding the effects of heat-stress on the foetus creates a stronger evidence base to support the importance of reducing the impacts of heat-stress.

Work undertaken

This research aimed to identify cow and farm-level maternal stressors in dairy cattle that may alter lifetime resilience in their offspring. The study explored the effects of a variety of stressors experienced by the mother during specific stages of pregnancy on individual cow lifetime resilience scores in two data sets, one large data set consisting of cows born over a 10-year period from 83 farms and a smaller, more detailed data set from 293 animals in the Langhill research herd at SRUC over a 12-year period. Environmental stressors included health-related stress in the dam (mastitis, lameness, diseases requiring use of antibiotics/anti-inflammatories) and environmental stresses associated with heat-stress events defined using data from national weather stations.

A lifetime resilience score (LRS) was calculated for cows, where resilience was based on a cumulative score of the cow's ability to re-calve, whilst correcting for her age at first calving, 305-d milk yield and calving interval. The score includes a baseline equal to the calving interval of the herd, and each new lactation adds 300 points. Each cow loses or gains additional points for the following parameters:

- For every day shorter or longer their date of first calving was from 730 days
- For the number of days the calving interval is shorter or longer than the herd average
- For the percentage that the 305-d milk yield is higher or lower than the herd average
- Points are lost if the cow exits the herd before 100 days in milk.

Stressor events were identified from lameness records, mobility scores, treatments given, and climate data. Health events included clinical lameness, clinical mastitis, mobility scores which identified the animal as lame and treatment with any product registered with the Veterinary Medicines Directorate Product Information Database. Products were identified as anti-microbial, anti-inflammatory (or both), or vaccines. Milk quality records were collected, and included fat, protein and lactose

percentage, and somatic cell count (SCC) at each recording. Climate data was utilised to class days using their maximum recorded temperature and minimum humidity to create a maximum thermal discomfort index (THImax). The mother's lifetime resilience score and season of birth for each calf was also considered in the modelling, to account for any confounding influence of season and/or heritability of traits such as milk yield.

The study showed that a higher mean daily THImax in the first and third trimester of pregnancy was associated with lower lifetime resilience scores (LRS).

Calves that were born to older dams (in their third or higher pregnancy compared with dams in their second pregnancy) had lower lifetime resilience scores. Higher mother LRS scores were associated with higher LRS scores of their calf.

Calves whose mothers had a maximum locomotion score ≥ 4 in the third trimester of pregnancy had lower LRS than calves whose mothers had maximum locomotion scores <4 in the third trimester of pregnancy.

Milk yield and quality variables over the dam's pregnancy were associated with daughter LRS scores. Daughter LRS scores were lower where milk yields were low in trimester 1 (>0–20L compared with >20–30L), where median fat percentages in trimester 1 were 0–3% compared with >3–5%, and when milk yields were high (>40L compared with >20–30L) in trimester 3.

Conclusions

This study is the first to explore the associations between lifetime resilience scores in dairy cows and the events that occurred in-utero in a large, longitudinal dataset and a separate, smaller more granular dataset from a research herd. Key findings include that lower lifetime resilience score was found in cows that:

- experienced higher THImax values in the first or last trimester of pregnancy.
- were born to multiparous dams compared with primiparous dams.
- were born to cows with the lowest milk yields and fat percentages in the first trimester.
- were born to cows with high milk yields in the third trimester.

- were born to dams with high locomotion scores in the third trimester.

This research highlights the importance of the in-utero environment on lifelong calf performance. Given the increasing risk of heat stress events in Scotland and the UK, with increasing climate change, the negative effect of high temperature humidity index on the lifetime resilience score of calves is of key importance. The impacts of poor locomotion scores in the third trimester on calf lifetime resilience also highlights the need to monitor dams more closely throughout pregnancy.

Reference

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