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Can biomarkers in the dam or calf be used for precision dairy calf rearing?

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- Metabolic stress leading to negative energy balance is common in dairy cows in the transition period and can have implications on the quality of colostrum produced.
- The health of calves in the early rearing period is dependent on adequate intake of quality colostrum as soon as possible after calving.
- Adequate calf growth is essential during the early rearing period to ensure that first calving is as close to two years as possible and subsequent profitability from the animal is increased.

Management of the transition period for dairy cows is known to be a crucial time to ensure appropriate performance of the dam during lactation. Many high yielding animals enter a period of negative energy balance around this time and as such have an impaired immune response, leaving them susceptible to illnesses. Furthermore, it has been demonstrated that colostrum quality is reduced in dams that experience metabolic stress in the dry period. As colostrum is essential for calf immunity, these calves will be more predisposed to illnesses in the early weaning period and it has been shown that their growth rate may also be impaired. Adequate growth rate is essential to ensure that dairy heifers reach an appropriate weight to support first calving as close to two years of age as possible, subsequently increasing the profitability of the production lifespan. Therefore, it would be beneficial to be able to identify calves at an early stage that are likely to need further management input to achieve a suitable health and growth status. Biomarkers are naturally occurring biological factors (such as molecules or characteristics) which are measurable and can therefore be used as indicators of diseases or even biological states (e.g. negative energy balance). An ongoing project funded by Farming Connect in 2019 is working to establish biomarkers in either the dam or calf for precision calf rearing.

Dams during the transition period

It is well known that metabolic stresses increase in the transition period due to the final stages of foetal development and production of colostrum and milk. These stresses are also

accompanied by a decrease in feed intake, which can result in animals not consuming enough energy and protein to meet the rising demands of the period, termed negative energy balance (NEB) and negative protein balance (NPB).

In high yielding dairy cows, NEB is a particular problem during the transition period. As a result of selective breeding to increase milk yields, we have bred animals which are unable to support their own energy needs at this time. A natural genetic drive is present which supports milk production and prioritises resources to the great needs of the mammary gland over the needs of the dam. Therefore, dairy cows with high milk yields, become energy starved and often experience a loss of body condition in the first 80 days post calving. Yet NEB also leads to immune compromised animals which are more prone to contracting diseases such as mastitis and metritis. Furthermore, imbalances during this period also lead to a reduction in fertility. For more information on assessing the metabolic profile of dairy cows during this period, see the [Farming Connect technical article](#).

Calves during the neonatal and early rearing period

Calves are dependent on the dam for energy provision during the final stages of pregnancy and colostrum production in the immediate post-natal period, coinciding with the period of metabolic stress. Colostrum provision in the first 24 hours of life is essential for passive immunity through provision of antibodies, such as IgG. Ensuring a calf receives adequate provision of these antibodies is essential for the health of the calf in early life. Therefore the 3Q's of colostrum feeding should be followed – [Quantity, Quality and Quickly](#). It must be ensured that the calf is able to ingest enough good quality colostrum, usually defined as 50g of IgG per litre of colostrum and a low bacterial load, as soon as possible within the first 6 hours of life. Antibodies are not the only key factor in colostrum. Compared to milk, colostrum also contains high levels of fat, protein and lactose, growth hormones and immune components.

Colostrum quality varies between cows, with breed, parity and pre calving nutrition all affecting quality. Cows that experience weight loss in the dry period are [four times more likely](#) to produce colostrum with less than 50g/L of IgG and therefore of poor quality. Yet measuring the quality of colostrum alone does not consider if enough antibodies have been absorbed.

Therefore, a more accurate test involves taking blood samples from the calves at 24 to 48 hours of age. Furthermore, several immune and growth components are impaired in neonatal calves from cows deprived of nutritional energy. Therefore, it is clear that despite the calf

only being with the dam for a short period of time in dairy systems, the nutrition of the dam is imperative for ensuring calves receive the best start in life.

Calf growth during the rearing period is essential to ensure first calving as close to two years of age as possible. [First calving at two years of age](#) reduces the cost of early life production, increases total days in milk, milk yield, percentage of time spent in milk over 5 years and the likelihood of calving for a third time. It should be noted that first calving earlier than two years of age is associated with an increased risk of calving problems as heifers are normally too immature. Therefore, it is in the best interest of dairy systems to ensure heifers reach an appropriate weight for first service to ensure adequate heifer fertility. However, calves with a low average daily weight gain up to 180 days of age are less likely to reach an appropriate target weight. Furthermore, common health problems in calves, such as respiratory diseases, septicaemia and scours, are associated with a reduced growth rate between 1 and 6 months. Calves not destined for the dairy industry should not be forgotten, as it is of benefit to the rearer that calves are as healthy as possible with the best potential for growth, to ensure increased profits from improved growth rates. Therefore, it is clear that the immunity of the calf in the early rearing period is imperative for both health and growth development.

Can biomarkers be used to predict unhealthy calves?

An ongoing Farming Connect innovation project at Trawsgoed Farm, Aberystwyth University in 2019 is working to identify potential biomarkers that predict calves prone to poor development. Such a test would identify calves that need further management input and would therefore improve precision calf management.

As the metabolic status of the dam has an implication on the quality of colostrum, the project has blood sampled from a cohort of heifers and multiparous dairy dams at one week before calving and one and three weeks after calving. These samples will be assessed for metabolic and immune biomarkers to establish whether animals are in NEB and whether their own immune system is compromised. Furthermore, the dams will also be assessed for body condition score, weight and rumen fill scores. All dams in the herd are monitored with activity collars and so, data such as rumination and activity will also be assessed throughout the transition period.

Subsequently, all calves from the sampled dams will also be followed. Calves will be blood sampled at 48 hours and 5 weeks of age to assess the transfer of antibodies as well as other



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immune and growth parameters. The calves will also be weighed, [health scored](#) and illnesses recorded.

The measured parameters in dams and calves will be used to assess if there is a biological predictor or biomarker that can be utilised to predict unhealthy calves and therefore those at risk of reduced growth rate.

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