

Milk protein percentage and dairy cow fertility

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The InCalf Project coordinated by Dr. John Morton and funded by Dairy Research and Development Corporation (DRDC) reported that:

- * interval from calving to mating start date,
- * heat detection
- * AI practices
- * body condition
- * heifer liveweight
- * milk protein percentage

were the six most important factors affecting reproductive performance in seasonal-calving Australian dairy herds. These six factors explained more than 70% of the variation in reproductive performance between herds. To most observers these factors would be considered obvious determinants (known as causal relationships) of fertility, with the possible exception of milk protein percentage.

Cows with a milk protein percentage of 2.75 or less had 6-week in-calf rates of 52 % compared with 67 % for cows with milk protein percentage of greater than 3.50 %. Similar trends were found for 3-week submission rate, first insemination conception rate and 21-week not in-calf rate. Ninety five percent of herds (118 / 124) had some cows with low milk protein concentration (less than 3%). Dr. David Nation and Dr. John Morton using a subset of the InCalf data also found that low milk protein percentage in the first 120 days of lactation was a significant risk factor for Phantom cow syndrome. A Phantom cow is a cow that has been inseminated, does not return to oestrus within 24 days of insemination and is retrospectively diagnosed not pregnant to that insemination.

Has this association been reported in other studies?

A recent Irish study by Dr. Frank Buckley and his co-authors (Moorepark Farm Fertility Study) which was similar in design to the InCalf Project found cows with low milk protein concentration (305-day and at AI) had lower submission rates and lower 6-week incalf rates.

A Belgian study by Dr. Gert Opsomer and his co-authors reported that low mean protein percentage during the first 100 days of lactation was associated with an increased risk of anovulatory anoestrus.

A Dutch study by Dr. Cord Heuer and his co-authors found that cows with a fat to protein ratio of >1.5 had a higher risk of ketosis, displaced abomasum, ovarian cyst, lameness and mastitis.

Those cows produced more milk but had lower first service conception rates, longer calving to conception intervals and increased services per conception. The recommended threshold values for fat to protein ratio beyond which individual cows are regarded as at higher risk of metabolic and other diseases range from 1.35 to 1.50. However, it should be remembered that fat to protein ratio can be driven by both low milk protein percentage and by high milk fat percentage.

What is the biological interpretation of this relationship?

It is important to consider that low milk protein percentage does not cause poor fertility. The results are telling us that there is simply an association between the two i.e. cows with low milk protein percentage are more likely to have poor fertility. It is possible that there are two types of low protein cow. One is inherently a low protein cow which cannot be altered by nutrition or management to any great extent while the second type may be a cow's way of telling us that she is unable to adapt to her environment particularly in a low concentrate pasture based production system. It has been suggested that milk protein content is a reflection of energy balance and prolonged negative energy balance in early lactation is known to result in poor fertility. Cows in negative energy balance will show an increase in percentage milk fat (mobilisation of body fat reserves) and a decrease in milk protein (shortage of glucose for milk protein production from the udder).

Milk urea nitrogen (MUN) together with milk protein percentage are increasingly used as indicators of the protein-energy balance and for monitoring nutrition and diagnosing feeding disorders. Metabolism and

utilization of dietary protein depends on energy availability. Therefore, cows in negative energy balance postpartum with excess protein intake receive a double whammy as it were, where energy an already scarce commodity must also be used to excrete the excess protein.

Although high milk and blood urea nitrogen is associated with poor fertility in many American studies a similar relationship has not been found in most studies carried out in grass-based production systems. Given that cows graze spring pasture containing up to 30% crude protein following nitrogen fertiliser application and maintain adequate fertility the differences between studies are somewhat perplexing. The obvious differences between production systems are cow genetics and nutrition. The fact that concentrations of urea increase with the level of milk production complicates the interpretation of the significance of urea in relation to protein / energy nutrition and fertility. However, bulk milk urea samples taken in isolation are unlikely to yield meaningful results where only a proportion of the herd or individual cows may be affected.

Genetics

As the association between milk protein percentage and reproductive performance has been found on a within-herd basis this suggests that herd management or environmental effects are less likely to driving the relationship. This assumes of course that all cows in a herd are managed similarly and are subjected the same environmental influences. The question could then be asked is there a genetic component to this relationship and is this really a proxy variable for high milk production genetics? Its worth remembering that InCalf found that milk yield and ABV (Australian Breeding Value) generally had small effects on reproductive performance.

Traditionally breeding indexes have been heavily weighted towards increased milk protein production but not milk protein percentage and this has favoured the use of high production genetics. However, new breeding indexes recently introduced in many countries, including Australia, with survival components and negative weightings for milk volume should reduce any negative effects on fertility. It is also worth remembering that simply selecting bulls with high milk protein percentage to improve fertility is not the answer. A breeding index which includes a survival or fertility component will achieve this goal far more efficiently.

At this stage the association between milk protein percentage and fertility appears to underline the importance of selecting genetics that are proven in a given environment. The relationship between milk protein percentage and fertility including the genetic and metabolic components to the relationship are areas of continuing research at the University of Melbourne in collaboration with industry partners.