High milk production with high reproductive efficiency is possible

At the recent Biomin World Nutrition Forum that was held in Munich, Germany, Qendrim Zebeli from the University of Veterinary Medicine in Vienna Austria, considered whether high performance and fertility in dairy cows was an illusion or reality.

Over the last decade the steady increase in milk production has been associated with an alarming decline in fertility with animals showing heat reducing from 80 to 50% and a marked increase in the number of inseminations needed. Needless to say, this adversely affects dairy farm profitability. In many countries now the number one reason for premature culling of cows is poor reproductive performance.

Qendrim highlighted how nutrition is the key link between high production and good fertility as good nutrition is required for both. Conversely, nutrition can indirectly impact on fertility and milk yield by influencing metabolic status with a consequential profound influence on the hormonal regulation of reproduction.

Meeting the nutritional needs of maintenance, production and reproduction is a challenge in early lactation when feed intake potential is limited at a time when the requirements for energy and nutrients are highest. Shifting diet composition towards energy-rich ingredients at the expense of forages induces major nutritional imbalances which impacts on rumen health.

Although similar factors affect both fertility and milk production there is no mechanism that directly associated high milk production to low fertility. So, in theory, it should be possible with good nutrition and management of the cows to achieve high production with high fertility.

Austrian observations

An Austrian example was cited in which a herd of 85 cows had an increase in milk production from 7,070kg in 2010 to >9,000kg in 2014 and lifespan production almost doubled to 26,219kg in 2014 (see Figs. 1 and 2).

At the same time reproduction improved from a 435 day calving interval in 2010 to one of 384 days in 2014 and the proportion of open cows reduced from 45.6 to 15.5% over the same period. The key factors were improved management, feed quality and nutrition. Depending on body weight and genetics, a cow producing 45kg of milk per day with 4.0% fat and 3.3% protein requires at peak production (typically in week eight) 180 MJ NEL and 4.3kg of utilisable protein in the duodenum per day. To satisfy these needs requires large quantities of energy rich grains, by-products and commercially produced fat products.

At this time forage quality is critical as this stimulates feed intake, chewing and enhanced energy intake, while keeping an acceptable level of grain in the diet.

In addition, because of the high protein requirements of the cow and limitations of microbial synthesis of protein in the rumen, the diet should contain sufficient protein ingredients which are high in ruminally undegradable protein. Rather than quantity, it is the quality of protein fed in early lactation which is critical for production and reproduction. In fact, high quantities of ruminally degradable protein is undesirable as it leads to a high level of ruminal ammonia and urea in the blood. This can damage hepatic metabolic activity which seems to

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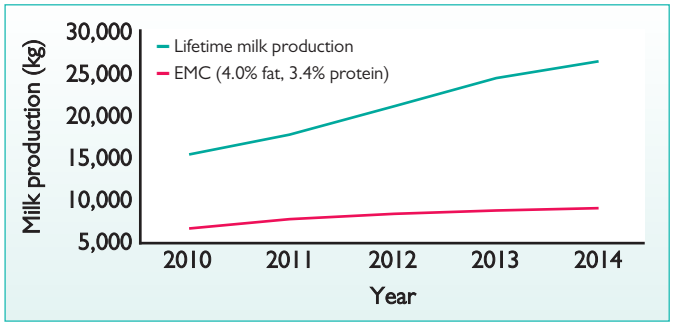

Fig. 1. Production data from the Austrian farm.

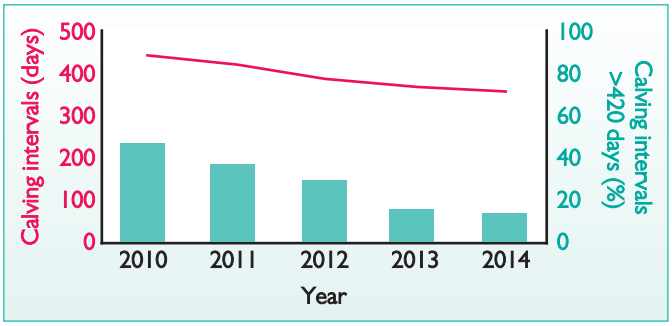

Fig. 2. Reproductive data from the Austrian farm.

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impair fertility. So at this time soybean meal and other commercially produced protein sources with high undegradable protein contents are indispensable.

By mobilising 1.0kg of body fat reserve a cow can produce 5-6kg per day of milk. However, the greater the amount of milk produced the greater the negative energy balance. Strong mobilisation of fat reserves results in increased concentrations of non-esterified fatty acids (NEFAs) and β-hydroxybutyrate in the blood and a pathological accumulation of fat in the liver and ketosis.

Increased NEFAs in the blood have been associated with infertility and NEFAs and β-hydroxybutyrate in the blood have been associated with poor immune response and an increased probability of the development of other metabolic disorders.

Currently there is much debate on the role of foetal programming on subsequent progeny performance. An Irish study in 2008 revealed that greater milk yield of the dam during preconception and gestation was associated with reduced survival and milk yield and greater somatic cell counts in the progeny. This suggests that offspring survival and performance are affected by prepartum conditions that they experience as an oocyte, embryo or foetus.

On the reproductive side successful implantation depends on the quality of the embryo, a receptive endometrium and synchronisation between the developmental stages of the embryo. In dairy cows there is a huge loss of early embryos (in 1980 this was 28% but in 2006 it was 43%). This is reflected in high fertility rates but significantly lower calving rates. Changes in metabolic profile are compromising the cow's ability to support early embryonic development.

Rumen health and function are essential for the adequate supply of energy, microbial protein and various vitamins, including magnesium and calcium, to the cow. Generation of propionate and valerate (short chain fatty acids), important for gluconeogenesis, is important in early lactation. This is because the dietary supply of glucose is not enough to meet the cow's energy needs at this time.

Low ruminal degradability

One approach to stimulate glucose pools in early lactation is to feed grains with low ruminal degradability, for example corn rather than barley. This relieves the pressure on rumen metabolism as part of the grain starch will not be degraded in the rumen but in the duodenum or upper small intestine. Here the undegraded starch that escaped from the rumen is digested and this results in a greater net glucose absorption for the cow. During the time of ovulation in peak lactation it is essential to support energy supply by enhancing the ruminal precursors of these glucogenic precursors.

When the symbiotic relationship in the rumen is disturbed it becomes a systemic concern to the cow's homeostatic mechanisms.

The rumen's luminal environment and the integrity of its epithelium are important factors in cow health. To maintain this and rumen health, the feeding of cows in the transition period is important, as are smooth change overs.

An excess of energy intake must be avoided in the drying off period and this can be achieved by feeding forage diets low in energy. During the last 2-3 weeks of gestation the grain level is gradually increased and the diet is upgraded in terms of amino acids, vitamins, minerals and trace elements. Excess energy should be avoided to control body condition score around parturition. The gradual introduction of grain in this period allows a smooth adaptation of the rumen's epithelium and microbiota to grain rich diets after parturition. Feeding at this time determines the success of the initiation of lactation.

Abrupt changes in diet, sorting of the diet by cows and damage to the ruminal epithelium make it easier for microbial toxins produced in the rumen to enter the cow's body and some of these toxins are associated with disease. Rumen disorders and ruminitis are associated with lowered dry matter intake which further aggravates negative energy balance in early lactation.

In conclusion, the reasons for infertility are varied and many. An important way to enhance fertility is to enhance early embryonic survival. In addition, cows that adapt successfully to lactation remain free of metabolic disorders and are able to reach high levels of production coupled with good reproductive efficiency. ■