ITEMS TO TACKLE FERTILITY CONSTRAINTS AT MODERN, HIGH YIELDING DAIRY HERDS

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Abstract

Challenges in current dairy herd health and reproduction management include the significant increase in herd/farm size, quota removal (within Europe) and the increase in technologies to aid in dairy cow reproductive management. Key areas for improving fertility management lie in handling of substantial volumes of data, genetic selection (including improved phenotypes for use in breeding programmes), nutritional management (including transition cow management), control of infectious disease, reproductive management (and automated systems to improve reproductive management), ovulation / oestrous synchronisation, rapid diagnostics of reproductive status, and management of the male side of fertility. This review covers the current status and future outlook of many of these key factors that contribute to dairy cow herd health and fertility.

Introduction

Dairy herd health management is undergoing a period of radical change worldwide. Challenges include the massive increase in technologies to aid in dairy cow reproductive management, quota removal (within Europe) and the significant increase in herd / farm size. Following the removal of quotas in Europe, the EU dairy business has ambitious plans to expand dairy output significantly, this is to be achieved by a combination of increased herd size and greater milk output per cow. While this expansion has commenced, it is somewhat curtailed by the current downward pressure on world market price for milk.

Herd fertility and data management strategies

Historically, the emphasis in veterinary medicine has focused on the individual cow affected with a clinical disease. However, about 30 years ago, it was recognized that subclinical disease was the major cause of economic losses in dairy herds. The multifactorial origin of most subclinical diseases was examined during regular herd visits by veterinarians. This turned out to be effective in improving the overall health status of the herd, and hence profitability. This approach was called herd health management and has been implemented in veterinary education for at least 3 decades. Over the same time period, Internet and Communication technology has emerged and integrated in herd health management to leverage the understanding of cow records. The generation and use of cow related data has occurred for in excess of 100 years. Technologies to collect and store data have been evolving at a quicker pace compared with the speed at which new insights in dairy science have been discovered. The exponentially increased volume and speed at which data is created in the post-dotcom decade, commonly referred to as Big Data, has brought new challenges for research in dairy science.

Genetic strategies to improve reproduction

Up to the early 2000s, dairy genetic selection programmes in dairy producing countries traditionally selected predominantly for milk yield often at the expense of other dairy relevant traits, including fertility and health. Breeding programmes in the early part of this century started to include fertility (eg longevity and calving intervals) and health as part of the selection traits. Inclusion of these traits has served to reverse some of the earlier trends that gave rise to reduced fertility. Over the last 15 years it is now recognized that trends in both longevity (increased) and calving intervals (decreased) have improved. The major challenge for breeding programmes in terms of incorporation of fertility traits has been to develop phenotypes that have high heritability. For example many fertility traits have typically only low heritability estimates (eg 0.1, compared with many growth and carcass traits where the heritability is 0.25-0.5). The second major issue for many fertility traits is to have easily measured phenotypic traits or genomic markers (single-nucleotide polymorphisms; SNPs) that correlate to appropriate fertility traits. Opportunities may now be arising for selection of new traits that could be incorporated into breeding programmes.

Nutritional strategies to improve reproduction

Modern dairy cows have been predominantly selected for a high milk yield in early lactation that is associated with a very high capacity to mobilize body reserves during this period. The genetically and hormonally driven body mobilization is further aggravated by a serious mismatch between the energy need and the cow's capacity to take in energy. The latter often being even further negatively affected by an inadequate adaptation of both the gastro-intestinal tract and the overall intermediary metabolism and often an elevated incidence of diseases in the period after calving. Management strategies for transition cows are mainly focused on helping the cows to cope with the metabolic load by optimizing health, minimizing stress (e.g., by minimizing the changes in group or ration), stimulating dry matter intake and immune function. There are great opportunities for the veterinary practitioner to regularly monitor and adapt the herd management in order to do so. Practitioners have to indicate key issues to optimize their clients' transition-cow management.

Furthermore, application of diets specifically designed to improve fertility by counteracting mechanisms related to the negative energy balance (NEB) or by supporting a specific pathway that is necessary for successful fertility, has always been a very attractive way to circumvent the impairment of reproduction during early lactation. Adaptations of the diet composition have been very attractive in the pursuit of reducing the fertility decline. Although the reproductive system is known to be influenced by multiple hormones that are also involved in the adaptation towards high milk production (e.g., growth hormone; GH, insulin-like growth factor I; IGF-1 and leptin), only insulin is known to be relatively responsive to changes in the composition of the ration.

Controlling infectious diseases

Veterinarians managing fertility in dairy herds should regularly evaluate the herd health status for pathogens known to compromise reproductive efficiency. Infections with pathogens like *Leptospira hardjo*, Bovine Virus Diarrhoea or Herpes viruses are known to reduce conception rates, while infections with *Neospora caninum* and emerging viruses like the Bluetongue virus may cause foetal losses and abortions. Bovine Herpes Virus 4 is reported to have a tropism for endometrial cells which is therefore suggested to be especially monitored and controlled in herds suffering from uterine diseases. Besides continuing careful monitoring, appropriate biosecurity plans eventually including vaccination protocols should be implemented to prevent the introduction of new agents into the herd and to prevent eventual spread within the herd.

Of special interest among infectious diseases, is the minimization of uterine diseases. In cattle, bacterial contamination of the uterus is ubiquitous at parturition. However, the latter does not automatically imply the establishment of uterine disease and subsequent fertility problems. Despite the fact that several papers have been published aiming to come to a general agreement about the definitions of postpartum uterine diseases based on mainly clinical symptoms, there is still a lot of confusion about these definitions among practitioners. The latter gives rise to a wide variety of preventative and curative treatment protocols being applied in the field, many of which are not scientifically proven to be efficacious. Recent literature underlines the high incidence of especially subclinical endometritis in high yielding herds. Diagnosis of this impairment is based on intra-uterine sampling for cytology, which is not routinely done at the moment. Therefore, recently we reported the use of the cytotape that allows sampling during insemination and facilitates for example profiling in repeat breeder cows. The generally accepted necessity to minimize the use of antibiotics in cows should be extended to treatment of uterine infections. It is important to determine the risk factors for the different uterine diseases, and design prevention and control programmes to reduce the incidence of disease.

Use of precision livestock farming

Oestrous detection

Successful reproductive performance based on detection of oestrous behaviour implies the need to accurately detect oestrous onset in the majority of cows, and then inseminate 4 to 16 hours later. This led to the common practice of breeding cows according to the am-pm rule. This requires that cows are observed for oestrus 5 times per day, and those commencing oestrus in the morning get inseminated that evening and those commencing oestrus after 12.00 noon are inseminated the next morning (onset of oestrus defined as the first observation period where the cow is observed to stand to be mounted by other herd mates or a teaser bull). This approach has served well for herds prepared to invest the time and effort into good and accurate oestrous detection. However, it requires a significant commitment of labour, good cow identification and personnel trained in detection of oestrus in cows.

To achieve high submission rates to artificial insemination (AI), which are critical to achieve a 365-d calving interval in seasonal calving herds, requires an effective, practical means of identifying each cow in oestrus. Standing to be mounted is considered the main behavioral sign identifying an estrous period and is used to determine the correct time to inseminate. Attempts have been made to monitor changes in physical activity to predict oestrus. The pedometer, either attached to a leg (S.A.E. Afikim, Kibbutz Afikim, Israel; or neck collar (ALPRO; DeLaval International AB, Tumba, Sweden), identifies increased physical activity as an activity cluster. Several aids exist to improve the efficiency of detection of oestrus.

Oestrous synchronization and ovulation synchronization
Traditional oestrous synchronisation methods were designed to synchronise oestrus, but at best still require observation of oestrus to optimize timing of mating and pregnancy rates. At best use of 2 injection of prostaglandin 11 days apart in heifers can work will with FTAI at 72 and 96h or alternatively at 72h, and then intensively observe for oestrus for a further 3-4 days and inseminate those late coming into oestrus, in response to standing oestrus (using the am-pm rule).

Ovulation synchronisation programmes were designed to facilitate use of AI in herds without significant investment of time and labour into oestrous detection. These were developed from the early 1990s onwards. They are more appropriate to large non-seasonal herds where calving to calving intervals are somewhat less relevant to economic performance of the herd and often calving intervals are allowed to extend beyond 400-420 days. The major issues for a basic ovulation synchronisation (OVSYNCH) programme is that conception rates to a single round of OVSYNCH are approximately only 30%; and in a European context are relatively expensive. Strategies to improve pregnancy rates have been developed (e.g., Double OVSYNCH and presynchronisation-ovulation synchronisation (PRESYNCH-OVSNCH) that are acceptable in many US herds, but incur substantial costs in terms or time and drug costs that leave their use questionable in European dairy herds.

Pregnancy detection
Various methods are available to determine pregnancy status, these include return to oestrus, rectal palpation of the reproductive tract and ultrasound scanning to observe the reproductive tract. In practice return to oestrus is fraught by the vagaries of oestrous observation, so currently most pregnancy detection in cows is carried out by ultrasound scanning of the reproductive tract to detect the presence or absence of the early embryo and foetal fluid. Using this method pregnancy status is generally determined from day 28 onward of pregnancy.

Indirect methods for early pregnancy diagnosis use qualitative or quantitative measures of hormones or conceptus-specific substances in maternal body fluids as indirect indicators of the presence of a viable pregnancy. Commercially available indirect methods for pregnancy diagnosis in dairy cows include milk progesterone tests and tests for pregnancy-associated glycoproteins (PAGs) in blood or milk.