Healthy nest: the key to avoid loss in genetic selection

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Introduction

Due to the rapid growth in global population and a significant decrease in natural resources means our farming systems will need to increase productivity and sustainability to remain profitable. Both beef and dairy production are based on reproductive performance and therefore directly correlated with fertility.

Technologies such as artificial insemination, embryo transfer in vitro fertilization and cloning have gained market globally as a way of accelerating genetic selection based on traits of interest (milk yield, marbling, heat stress). The use of these biotechnologies increases the value of the pregnancy which therefore creates a need to prevent reproductive losses in order to protect this investment.

In modern farming, the focus of reproductive losses is on prevention. Veterinarians now have to be able to analyse disease in a multifactorial nature. Epidemiology has been a critical new influence and tool to describe and quantify the interconnected risk factors that produce disease. In turn, health management or production medicine is characterized by an integrated, holistic, proactive, data based, and economically framed approach to prevention of disease and enhancement of performance.

As describe previously in order to be effective, management of reproductive disease should be based on the following 4 fundamentals. Maintain a high level of general resistance to infectious disease; keep infectious agents out of the herd; minimize spread of infectious agents within the herd and maintain a high level of specific resistance to infectious disease. This concept agrees with the global demand in recent years to move away from treatment of clinical illness towards disease prevention.

Diagnostic techniques have also advanced in order to support the smart management of infectious disease. Collection and analysis of samples have evolved to make the implementation of screening programs for disease more cost-effective. The aim of this paper is to propose smart use of diagnostic tools to improve management of reproductive disease and increase productivity in the modern breeding herd.

Main factors to consider when managing reproductive losses


Independent of breeding method, management of the ‘egg donor’ should be focussed on animal selection targeting those of higher genetic value and capable of producing higher number of embryos. Improved donor performance is focused on maintaining breeding cyclicity and shortening the period between cycles. Healthy animals will have superior cyclicity and therefore an increased chance of producing both a higher quantity and quality of oocytes. Reproductive disease should be controlled through vaccination and periodic surveillance schemes, for BVDV (Bovine Viral Diarrhoea Virus), Campylobacter, Tritrichomonas, Leptospirosis and biosecurity measures should be implemented, as recommended by FAO.

Tighter biosecurity, including the routine screening of replacement heifers for diseases including those associated with poor reproductive performance, for example, BVDV,
IBR (Infectious Bovine Rhinotracheitis), Campylobacter, and Leptospirosis, should be performed before introduction to the herd, based on disease status of the herd, to minimise risk.

Molecular testing tools for the ‘egg donor’ include, next generation sequencing (NGS) for genetic selection and PCR and serology for diagnostics, to ensure good health to maintain healthy reproductive cycling. PCR is becoming more accessible, easily automated and less laborious which greatly improves result turnaround times when compared to traditional methods including, culture and virus isolation.

2. Let’s not forget the other half. Key factor for reproductive disease control

As we know the bull in a farm is the main carrier of disease. Conditions like Trichomoniasis and Campylobacteriosis are considered venereal disease transmitted only by mating, but bulls can also be a source for BVDV, IBR and others that can be transmitted by direct and indirect contact. Bull evaluation (soundness test) focuses on clinical assessment and semen evaluation but some diseases can be asymptomatic in which case laboratory diagnostics is the only method of detection. It is important to highlight that even with the introduction of biotechnologies (AI, embryo transfer) the presence of bulls on the farms remains in order to improve pregnancy rates by the end of the breeding season. A study in northern Spain, showed that Tritrichomonas can increase the calving intervals by 79 days (P < 0.0001) and resulted in a higher percentage of cows-not-in calf (36% vs. 19%; P < 0.001). Identification of infected bulls via molecular diagnostics (qPCR) and culling resulted in a reduction in calving intervals (P < 0.0001) and increase in calving percentage (P < 0.05).

Reproductive health management should include diagnostic screening of the bulls for the main reproductive disease as part of pre-breeding season bull soundness test. During sample collection for semen evaluation, a smegma swab can be collected to test for Tritrichomonas, Campylobacter and IBR. If a new bull is being introduced to the herd the screening should also include collection of sample for BVDV, to exclude inclusion of a PI animal within the herd.

Molecular testing tools for the bull include, next generation sequencing (NGS) for genetic selection and PCR for diagnostics, to monitor both individual and herd health via systematic seasonal screening.

Internal study: Use of diagnostics improvement in reproductive performance
The prevalence of trichomoniasis in bulls in the Mexican state of Chihuahua in the sampled breeding population was in 22% based on PCR analysis of culture enriched SMEGMA samples. Age was found to be the highest risks factor for T. foetus-positive bulls, with 73.5% of the -positive bulls between 5 and 12 years of age. Herd management practices after diagnostics showed that the producer was able to increase calving rate from 57% to 80%.

3. Finally let’s make sure that the nest for the next 9 months is healthy and safe for the embryo.

The ‘host’ / ‘carrier’ of the pregnancy will have a major impact on pregnancy outcome. In certain cases where artificial breeding technologies are employed (embryo transfer, IVF) the host can be of lower genetic value (recipient cow), however, sanitary management is even more important that the donor as ‘host’ health will have the largest impact on the pregnancy and embryo development. Thus, the management of recipients can be the key to success in breeding programs and reproductive disease control should be a priority to this group. Smart vaccination and biosecurity practice is essential to maintain
high calving rates. Whilst it may be desirable to induce twinning and increased milk yield/quality for host based herd improvements.

When pregnancy loss occurs, early identification of the cause is crucial. For the veterinarian, the collection of samples from empty cows (reproductive disease screening) can be a potential tool to identify possible causes, as co-infection can also occur in cases of abortion. Screening for multiple diseases can also identify uncommon causes which would not arise if test selection was based solely on clinical signs.

A Salmonella outbreak on dairy farms in Wales was studied and concluded that the financial loss associated with the outbreak was far greater than the potential cost of controlling the disease through ongoing preventative measures. Salmonella is an interesting example because it will impact on reproduction both clinically and sub clinically. Sub clinical disease can lead to decrease of milk and infertility and clinical disease can result in abortion and diarrhoea that can have up to 11% of loss between death and cull.

The ability to collect a cervical swab and screen for multiple diseases can be beneficial in determining the underlying pathogens associated with abortion more rapidly, facilitating accelerated implementation of effective management strategies, including herd vaccination. Whilst typing/strain identification of pathogens can assists with understanding of treatment resistance and pathogenicity (toxin production) whilst concurrently providing traceability of the infection and facilitating systematically removal of infected animals from the herd.

The utility of these applications makes PCR the key molecular tool, for the ‘host/carrier’, which is focused on pre pregnancy/implantation diagnostics and/or determining the cause of failed pregnancy.

**Future of reproductive disease management**

There is an ongoing challenge for prevention of diseases. Information already exists to substantially reduce or prevent the disease altogether—the challenge is in effectively and consistently implementing the required management practices.

The value of the veterinarian in modern farming is to add value to prevention of disease and implement biosecurity when doing reproductive management. The use of fast, specific, sensitive diagnostics to monitor disease supports the veterinarian in dynamic and efficient herd health management.

Diagnostic tools have evolved and are more dynamic and flexible. The technology of PCR allows the study of multiple pathogens from a single sample simultaneously or identification of different strains of the same pathogens (important to study mutations or possible outbreaks in the herd) for epidemiological analysis. Whilst the use of serology can be implemented at a herd level to provide information on prevalence, immune competency status and vaccine efficiency.

NGS can be employed for trait selection in genetics driven livestock, herd improvement programs through Genotyping-By-Sequencing (GBS) applications. Ion Ampliseq™ is a highly multiplexed, PCR-based resequencing technology that enables the targeting of hundreds to thousands of markers across hundreds of samples in a single sequencing run using the Ion Torrent™ Sequencing. Early attempts in trait based herd improvement resulted in reductions in fertility and immuno-competence which created of focus for systematic improvement of the key criteria for effective herd development. Building reports of reproductive disease management will give phenotypic information to improve animal selection that can be now not only in high production, but also to introduce traits which focus on reproductive performance and disease resistance.

As elucidated in previous study in order to effectively select animals for disease
resistance it is important to have confidence in phenotypic measurements along with an understanding of the environmental impact on genetic selection.\(^{10}\).

In conclusion, the management of reproductive disease is fundamental for the success of breeding programs and frequent monitoring and screening for reproductive disease should be implemented to improve efficiency of herd management.

References