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The future of reproductive management in dairy cows

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Abstract: *Reproductive management in dairy cows is undergoing a substantial shift driven by precision technologies, data integration, and advances in reproductive biology. As fertility remains a key determinant of productivity and profitability in dairy systems, future management strategies are increasingly focused on improving the accuracy and timeliness of reproductive decisions. This article reviews the main developments expected to shape reproductive management in dairy cattle, with particular emphasis on automated estrus detection, timed artificial insemination protocols, genetic selection for fertility, and the use of biological and performance data to support targeted decision-making. The review also considers emerging regenerative approaches, including platelet-rich plasma, as potential adjunctive therapies for selected cases of reproductive dysfunction. Overall, the future of reproductive management in dairy cows will likely be defined by a transition from standardized protocols toward integrated, data-driven, and cow-specific strategies that improve reproductive efficiency, animal health, and herd sustainability.*

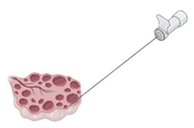
• Introduction

Reproductive efficiency remains one of the most economically significant parameters in dairy cattle production. Prolonged calving intervals, low conception rates, and increased involuntary culling due to reproductive failure translate directly into reduced profitability and compromised herd sustainability. High-producing dairy cows face a well-recognized antagonism between milk production and fertility. More recently, automated activity monitoring (AAM) systems and wearable sensor technologies have introduced a new dimension to estrus detection, enabling continuous, objective, and individual-level monitoring of behavioral changes associated with the periovulatory period .

• Automated estrus detection

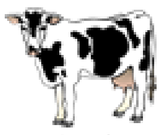
Automated activity monitoring (AAM) systems operate by detecting the characteristic increase in locomotor activity associated with the periovulatory period. The data generated by these systems — particularly estrus intensity and duration — have been shown to correlate closely with ovarian and uterine function and with subsequent fertility.
A major focus of recent research has been the use of estrous expression within the voluntary waiting period (VWP) as an early marker of subsequent reproductive performance. Looking ahead, the integration of AAM data with individual cow health records, parity, lactation stage, and performance metrics is expected to enable more sophisticated, targeted reproductive decision-making.
Machine learning and artificial intelligence tools are increasingly being explored to extract predictive patterns from the large volumes of sensor data generated in commercial herds, with the goal of automating reproductive management decisions with minimal human input.

• Timed artificial insemination protocols



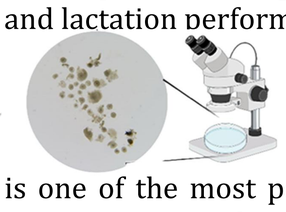
Timed artificial insemination (TAI) protocols represent one of the most significant practical advances in dairy cattle reproductive management over the past three decades. By synchronizing follicular development, luteal regression, and ovulation through sequential hormonal treatments, these programs allow insemination at a predetermined time, independent of estrus detection, thereby improving insemination rates and enabling more structured herd management.
The foundational Ovsynch protocol revolutionized reproductive management by reducing reliance on estrus detection for AI submission. Adding a second PGF2α treatment on day 8 of the Ovsynch protocol significantly increased the likelihood of complete luteal regression and improved pregnancy outcomes 32 days after TAI.
Building on this evidence, the Double Ovsynch protocol — which adds an initial Ovsynch cycle before the breeding Ovsynch — was developed to further optimize ovarian follicular status at the start of the breeding protocol and to increase the proportion of cows entering the breeding Ovsynch at a favorable stage of the estrous cycle.

• Combined sensor-assisted strategies and targeted reproductive management



The parallel development of AAM systems and refined synchronization protocols has raised an important practical consideration for the dairy industry, specifically whether these approaches should be applied independently or integrated to achieve synergistic benefits. Emerging evidence increasingly supports the latter view, and the concept of targeted reproductive management — in which individual cows receive tailored reproductive interventions based on their specific biological and performance characteristics — is gaining substantial research attention.
This vision of real-time, automated, individualized reproductive decision-making represents the logical convergence of AAM technology, synchronization protocols, and data science. Lucy (2019) similarly argues that the intersection of biology and advanced technologies will fundamentally redefine how reproductive decisions are made on dairy farms — moving from standardized population-level programs toward cow-specific strategies that account for each animal's health history, sensor data, genetic merit, and lactation performance.

• Genetic selection for fertility



Genetic improvement for fertility is one of the most powerful long-term tools available in dairy cattle management. Unlike synchronization protocols or automated monitoring systems — which improve reproductive outcomes in the short term — genetic selection works across generations, gradually shifting the biological capacity of cows to conceive, maintain pregnancy, and resume cyclicity after calving.
Beyond genetic selection through conventional AI programs, embryo technologies represent an increasingly important avenue for accelerating genetic improvement in dairy cattle.
However, the full potential of this technology is currently limited by several biological hurdles: in vitro produced embryos differ from their in vivo counterparts in lipid content, gene expression, epigenetic profile, and chromosomal stability, which translates into lower pregnancy rates after transfer compared with embryos produced by superovulation. The researchers identified three key research priorities to address this gap: optimizing in vitro oocyte maturation and fertilization, improving embryo competence to establish and maintain pregnancy, and increasing recipient cow fertility through selection and management.

• Emerging regenerative therapies: Platelet-Rich Plasma

Platelet-Rich Plasma (PRP) is a blood-derived product obtained by concentrating platelets in a small volume of plasma. When activated, platelets release a range of growth factors and signaling molecules that can stimulate tissue repair, cell proliferation, and local biological activity. From a broader perspective, the emergence of regenerative approaches in bovine reproduction reflects a wider shift in veterinary medicine toward biological, individualized, and minimally invasive interventions — a direction consistent with the sustainability-oriented trajectory described for the next two decades of cattle reproductive research.

• Conclusions

Reproductive management in dairy cows is undergoing a major shift toward more flexible, individualized, and data driven approaches that consider the specific context of each animal.