Popular Article

Harnessing Multiple Approaches for Accurate Calving Prediction in Dairy Animals

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Introduction

Reproduction is an important consideration in the economics of dairy production. The birth of a healthy calf is a primary goal of reproduction management. It is an important event for farmers in effectively producing replacement heifers and achieving the profitable dairy farm aim of "one calf per year". Calving is a complex physiological event of delivery of the foetus and foetal membranes characterized by distinct physical and hormonal changes, observed within 72 hours before parturition. Cattle and buffalo are more prone to calving-associated complications like dystocia, and stillbirth. 73% of calf deaths that occur in the perinatal period have no pathological signs (Szenci, 2022). Death mainly occurs due to dystocia (20-45 %) and asphyxia (58.3%), which have a significant impact on the farm leading to mortality of dam, loss of neonatal calves, RFM (Retention of fetal membrane), slower re-breeding performance, metritis, uterine torsion and reduced fertility. Therefore, accurate calving prediction is a determining factor to support animal welfare and herd profitability and calving management is crucial to minimise the adverse effect of dystocia for both dam and calf. Various methods of calving prediction can reduce the risk of dystocia, and stillbirth and overall increase in animal welfare.

Prediction on the basis of breeding record

It is the earliest method of prediction of calving based on breeding and insemination records kept by dairy farms. This method is not accurate for calving prediction as this gives only a tentative date of calving.

Prediction based on behavioural changes

Behavioural changes in animals occur when they approach calving. Cows showed less lying time, increased tail-raising activity, more lying bouts, and more activity on the day before calving compared to 2–4 days before calving (Jensen, 2012). During the last 6 h before calving the number of lying bouts and the activity level increased. During the last 2 h before calving the duration of the contractions and the number of times the cow turned her head toward the abdomen was increased, while the duration of feeding, drinking and rumination was reduced. These changes can be used for the prediction of calving in animals.

Prediction based on clinical signs

When calving approaches, animals show certain outwardly evident changes. Approaching parturition is characterized by visible changes in the udder, vulva, and pelvic ligaments. The symptoms differ across individual animals and sequential parturitions. The symptoms cannot accurately predict the exact time of parturition in an animal but can indicate the approximate timing (Safdar *et al.*, 2014). Monitoring the peripartum cattle by conventional method is a time-consuming challenge for breeders and may have similar limitations.

Prediction based on hormonal change

The endocrine control of pregnancy and parturition varies amongst cattle. Following luteolysis, progesterone levels in cattle drop sharply, and a corresponding rise in estrone sulphate concentration signals calving within 24 h. Calving within 12 h is predicted by a drop in progesterone concentration of less than 1.2 ng/mL. In the early antepartum period, there is a favourable correlation between the concentration of steroid hormones in blood and pre-colostrum, yet tests for blood or milk on farms are not yet accessible. Characteristic changes in plasma and salivary cortisol concentration occur in cattle. Salivary cortisol concentration in cattle increases only during the last hour before the birth of the calf. Because of individual variations, the determination of rising salivary cortisol concentrations so far is, however, not feasible for the prediction of parturition (Nagel *et al*., 2020)

Digital Video Recording System (DVRS) to predict calving

Computer-based vision for calving prediction uses image processing and machine learning tools to monitor cows for signs of impending birth. It is a relatively inexpensive and non-invasive technique to predict calving. In this camera continuously captures the activity of the animal, and algorithms assess behavioural changes like restlessness, frequent lying down, and tail movements, as well as physical signs such as udder swelling and visible contractions. When the system detects that calving is near, it alerts farmers for timely intervention (Higaki *et al*., 2021).

Using digital video recordings and accelerometers attached to the cow's legs, behavioural changes in thirty-two multiparous Holstein Frisian cows housed in individual calving pens were studied from 96 h before to 96 h after calving to describe behavioural signs of impending calving and recovery after calving (Jensen, 2012). They noted observable alterations in their behaviour, especially the increased activity and frequency of laying sessions in the final 6 h before calving. He concluded that computer-based vision for predicting calving is a valuable tool that enhances both animal welfare and farm productivity by providing real-time insights and reducing the need for manual monitoring (Schoenig *et al*., 2004).

Prediction based on temperature change

Many species have a documented relationship between steroid hormone concentrations and body temperature, which is particularly helpful for predicting whelping in the case of bitch. Cattle's body temperature dropped when parturition was induced, which is most likely related to the sharp drop in progesterone levels. However, there is only a weak correlation between progesterone levels and body temperature in cattle. The idea of predicting cattle parturition with moderate to good accuracy based on body temperature has been discussed by several authors in cow (Nagel *et al*., 2020; Wrenn *et al*., 1958; Lammoglia *et al*., 1997); moose (Graesli *et al*., 2023); buffalo (Teja *et al*., 2023) sow (Gulliksen *et al*., 2023); mare (Muller *et al*., 2023); ewes (Nabenishi and Yamazaki, 2017) and drop in temperature suggested for the prediction of calving.

As the calving approaches, there are distinguished behavioural changes and temperature variations in dairy animals. These changes can be used to predict the approximate time of calving. Therefore, to enhance the prediction of the calving process and also to improve postpartum health management of both the dam and neonate in cattle, Infrared Thermography (IRT) would be a potential non-invasive technique for monitoring temperature-associated changes with a calving process in cattle.

Automated monitoring system for calving prediction

Precision dairy farming technology offers a unique opportunity to address individual animal needs and challenges by combining advanced tools like sensors and real-time wireless technologies (Halachmi *et al*., 2019). Traditional methods of direct visual observation are not only time-consuming, but they can also disrupt the natural process, especially during critical stages (particularly the second stage of calving), potentially leading to an increase in the occurrence of calving problems in cattle. In the global market, a wide range of sensors and electronic devices are available to improve dairy cattle monitoring and management. Pedometers, rumination monitoring devices, electronic data loggers, pressure sensors, activity monitors, and ear tag sensors are all available on the global market.There are various sensors in the market to detect these changes and help in the prediction of calving (Table. 1) (Adapted from Dizier and Maillard, 2015))

Conclusion

Accurate calving prediction significantly enhances the ability of farmers and veterinarians to improve herd management and animal welfare. By integrating advanced technologies such as machine learning, sensor-based monitoring, and physiological indicators, alongside traditional methods, it is possible to more precisely predict calving events. These approaches help reduce the risks associated with calving, such as dystocia and allow for timely intervention, leading to improved outcomes for both the animals and the farm. Furthermore, accurate calving prediction increases operational efficiency, reduces labour costs, and supports the overall health and productivity of dairy animals.

Calving sign(s) detected (stage of parturition)	Type of sensor or technologies	Tool name (producer)	Place on/ in the cow
Tail raising and behavioural changes (stage 1)	Accelerometer or inclinometer	Alert'Vel (ALB Innovation)	Tail
		Calving Alert Set (Patura)	Tail
		SmartVel (Evolution XY)	Tail
		Moocall Sensor (Moocall)	Tail
Uterine and abdominal contractions (stages 1 and 2)	Pressure sensors	Agrimonitor (Databel Technics)	Abdominal harness
Fall in vaginal Temperature and allantochorion expulsion (stage 1 and onset of stage 2)	Temperature sensor	Radco(Verdor NV)	Vagina (caudal part)
		Vel'Phone (Medria)	Vagina (cranial part)
		Vel'Box (Gènes Diffusion)	Vagina (cranial part)
		Gyuonkei(NTT Docomo)	Vagina (cranial part)
Expulsion of the calf (stage 2)	Temperature and light sensors	iVET (IVET)	Vagina (caudal part)
	Light sensor	Cow Call (Farmofy)	Vagina (caudal part)
	Mechanical signal	C6 Birth Control b (Sisteck)	Vulvar lips (ligatures)
	Mechanical signal + GPS antenna	GPS-CAL c	Vulval lips and collar
	Magnets	New Deal (Happy Foaling)	Vulvar lips (implant)

Table. 1: Sensors and devices globally available for calving prediction.

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