Adoption of digital technologies for the management of repeat breeder cows in the dairy herds of Bangladesh

Abstract

A crucial component of contemporary livestock dairy production is digitalization. In order to monitor and manage repeat breeder (RB), we describe the use of dairy herd records, closed-circuit (CC) cameras, and ultrasonography findings. A cow must get through a number of physiological hurdles after calving in order to become pregnant. Herd fertility is achieved through timely artificial insemination (AI) using CC cameras and ultrasonography. Using CC cameras and ultrasonography, we surveyed 25 local farms and 25 commercial farms for this study. Within the dairy farms under survey, we discovered 10 RB. Following six months of observation, we minimized that 70% of RB cows were pregnant. AI is the term for the widespread use of reproductive tools in Bangladesh. The precise timing of ovulation and estrous is essential to the success of AI. These two AI factors are determined in part by the CC camera. During our investigation, AI was used by all farms, but ultrasonography was only occasionally used. However, very few commercial farms exclusively employed CC cameras for security. No farm that uses CC cameras for reproduction was found by us. Although recent developments in ultrasonography can aid in the diagnosis of reproductive tract pathophysiology, more research is needed to determine whether these techniques can be used clinically in veterinary practice. To exploit that research findings are applied to enhance on-farm performance and raise awareness among dairy herd owners, new tools such as on-farm CC camera surveillance must be developed.

Key Words: Dairy cows, Repeat breeder,Digital technologies, Adoption, Management.

Introduction

Compared with other livestock sectors, the dairy cattle sector has by far more digital technologies available (Stachowicz and Umstätter, 2020). In Bangladesh, there is a lack of use of reproductive digital technologies. On the other hand, reproductive diseases or disorders leading to prolonged intervals between calvings and low conception rate in Bangladesh (Shamsuddin *et al.*, 2001, 2006; Sheldon *et al.*, 2009).In the bovine practice, closed-circuit (CC) camera and ultrasonography have become an important diagnostic tool for evaluating the dairy herd and female reproductive system, where it is possible to view the entire reproductive system in a non-invasive manner (Carriere *et al.*,2005). Following studies on the technique's utility in examining the reproductive organs of the cow, interest in ultrasonography among veterinarians and animal scientists began to develop in the early 1980s (Taylor et al., 2004; Pierson et al., 1988).Ultrasonography can be used effectively to diagnose reproductive problems and track treatment response (Kumar and Purohit, 2009). The goals of reproductive illness treatment are to reverse inflammatory alterations that limit fertility while improving uterine and ovarian defense and repair.

Due to more inseminations, longer calving intervals, and higher culling rates, repeat breeding (RB) is a significant issue in cattle breeding that causes significant financial losses for dairy producers (Bartlett et al. 1986, Lafi et al. 1992). The inability to conceive after three or more regularly spaced services without obvious abnormalities is known as repeat breeding (Zemjanis, 1980).
One of two possible causes of the need for RB—a return to oestrus following a mating or artificial insemination—is either failed fertilization or embryonic death. Numerous studies have concluded that early embryonic death within 3 weeks of fertilization accounts for approximately 10% of the incidence of fertilisation failure in female cattle with normal fertility. 30%, resulting in a nearly 40% early pregnancy loss in the first 21 days following AI (Roche 1981). This indicates that following each AI or mating, 40% of females will, on average, go back into oestrus. This early embryonic loss in cattle has been attributed to a number of environmental factors, including nutrition and climate, as well as intrinsic animal factors (Ayalon 1984, Pope 1988). Additionally, it has been suggested that early embryonic loss—which results from the early elimination of unfit genotypes—should be considered "normal" (Bishop 1964). El-Khadrawy et al. (2011) list the following non-infectious causes: poor management, chromosomal aberrations, hormonal imbalance, anatomical defects of the reproductive tract, improper timing of insemination, inadequate detection of estrus, improper handling of semen, infertile bulls, poor nutrition, and heat stress. In this study, we used CC cameras to monitor the RB cows on dairy farms and concentrated on accurately detecting estrus.

Furthermore, the non-invasive nature of ultrasonography makes it a perfect clinical and scientific tool for the study of bovine reproduction (Mwaanga et al., 2004; McDougall, 2001). It has been shown that ultrasound technology is the best way to identify an RB cow's pregnancy. To increase reproductive efficiency, we also evaluated the corpus luteum, ovarian follicles, and ovarian cyclicity in Bangladeshi zebu cows. This technique allowed us to look at changes in the uterus and cervix. (Hoque et al., 2009). As a result, the CC camera and ultra-sonograph are helpful tools for increasing herd fertility, particularly for RB cows. Farmers also profit financially from the increased production rate and decreased expenses associated with managing and treating RB cows.

Methods and Materials

Data collection

This work was performed by using comprehensive written postal survey among farmers with the aim to assess the current state of mechanisation and automation in our livestock dairy production for labour-economic evaluations. For this purpose, specific questionnaires for 25 local and 25 commercial livestock dairy farms was developed to cover the typical machinery usage and working procedures accruing in each enterprise. The questionnaires will contain different numbers of questions and answer options, which are relevant to our livestock dairy production. The field work placed in the commercial dairy farms and local farms on the basis of using CC camera and ultrasonography in the different areas of Bangladesh.

Closed-Circuit (CC) Camera

CC camera systems was installed in the selected and identified RB cows dairy farm monitoring.

a) **Heat Detection:** CC cameras was installed in areas where cows congregate or exhibit signs of heat.
b) **Calving Surveillance:** CC cameras placed in calving pens or maternity areas allow farmers to remotely monitor cows during the calving process.
c) **Fertility Monitoring:** CC camera systems was used to monitor reproductive health and fertility parameters in dairy cows. This includes observing estrusbehavior, assessing body condition score, monitoring uterine discharge, and detecting signs of reproductive disorders such as metritis or cystic ovaries.

Ultrasonography

Transrectal ultrsound was used to scan the reproductive tract of the dairy cows to visualize the presence of a developing fetus as early as 28 days after artificial insemination. Ultrasonography will be performed by using a portable ultrasound machine with a linear array dual frequency probe (3.5 MHz). Real-time B-mode ultrasound 3.5 MHz (frequency conversed from 3.5-7.0 MHz) scanner (EsaoatePiemedical, Tringa Linear) was used.

Statistical analysis

Numerical data that were recorded had been stored in MS Excel spread sheet and descriptive statistics (percentages) was computed. The results were expressed as mean ± standard error (SE) and were analyzed using nonparametric methods.

Results and Discussion

In Bangladesh, artificial insemination (AI) is the nationwide use of reproductive tool. We observed 25 commercial and 25 local farms in different locations of Bangladesh. The results are presented in Table 1 and 2. We found most of the farms using AI for the breeding purpose. On the other hand, a few commercial farms (7) using ultrasonography and rarely (3) using in the local farms. Moreover, very few commercial farms 3) using CC camera only for the security purpose other than reproductive purpose. Local farms did not use CC camera.

Table1: Reproductive and monitoring tools using in the commercial livestock dairy farms

Dairy herd	Number	Artificial insemination	Ultrasonography	CC camera
Commercial	1	+	-	+
	2	+	+	-
	3	+	-	-
	4	+	-	+
	5	+	-	-
	6	+	-	-
	7	+	+	-
	8	+	-	+
	9	+	+	-
	10	+	-	-
	11	+	-	+
	12	+	+	-
	13	+	-	-
	14	+	-	+
	15	+	-	-
	16	+	-	-
	17	+	+	-
	18	+	-	+
	19	+	-	-
	20	+	-	-
	21	+	+	-
	22	+	-	-
	23	+	-	+
	24	+	-	-
	25	+	+	-
	"+" Using the specified tools and "–" not used			

Table 2: Reproductive and monitoring tools using in the local livestock dairy farms

Dairy herd	Number	Artificial insemination	Ultrasonography	CC camera
	1	+	-	-

Local	2	+	-	-
	3	+	+	-
	4	+	-	-
	5	+	-	-
	6	+	-	-
	7	+	-	-
	8	-	-	-
	9	+	-	-
	10	+	-	-
	11	+	+	-
	12	+	-	-
	13	+	+	-
	14	+	-	-
	15	+	-	-
	16	+	-	-
	17	+	-	-
	18	+	+	-
	19	-	-	-
	20	+	-	-
	21	+	-	-
	22	+	-	-
	23	+	-	-
	24	+	-	-
	25	+	-	-
	"+" Using the specified tools and "–" not used			

Repeat breeder cows, closed-circuit cameras and ultrasonography

Ten RB cows were identified from selective commercial and local dairy farms were under close observation and records. The RB cows underwent timely artificial insemination, accurate estrus detection, and close monitoring. Seven RB cows out of ten were found to be pregnant through ultrasonography. The remaining RB cows were not expecting. We hypothesized that the failure to detect estrus was the reason behind 70% of RB cows. It was recommended to cull the non-pregnant RB cows because of the unidentified cause shown in Table 3.

Table 3: Management of repeat breeder cows

Repeat breeder Cows	**CC camera monitoring Estrus time**	**Natural/AI Time**	**Pregnant/Non-Pregnant (Estrus /Ultrasonography**
1	11.45 PM	8.00 AM	Pregnant

2	4.45 PM	9.00 PM	Pregnant
3	2.00 AM	8.00 AM	Pregnant
4	9.23 PM	8.00 PM	Non-pregnant
5	7.43 AM	2.00 PM	Pregnant
6	3.00 AM	9.00 AM	Non-pregnant
7	2.00 AM	8.00 AM	Pregnant
8	9.23 PM	8.00 PM	Non-pregnant
9	7.43 AM	2.00 PM	Pregnant
10	3.00 AM	9.00 AM	Pregnant
Success rate-70%			

To enhance farming management and boost profits, a number of influential figures in the smart farming sector in America and Europe implemented smart dairy farming (SDF) techniques into small- or large-scale farms. To identify estrus and keep track of the herd's condition, researchers created "afimilk," "Fullwood," and "ConnectedCow" (DeLaval, 2020). However, the Asia-Pacific region has very few farms using SDF practices. There are currently no startups or businesses in Bangladesh providing high-tech goods and services. This indicates that Bangladesh's dairy cattle industry lags behind that of other nations worldwide.However, because of their advantages, CC cameras are now an essential component of dairy farms' daily operations. The advantages of CC cameras for security and safety include monitoring herds, dairy operations, and even biosecurity.According to our observations, the dairy herds only had

CC cameras installed for security reasons. The goal of this paper is to improve the detection efficiency of cows' standing-heat behaviors by proposing a non-invasive, non-contact estrus detection system that integrates internet of things (IoT) technology.

The use of ultrasonography has added another dimension to determination of the physiological state of the reproductive tract and clinical diagnosis of pathological conditions. Besides, using of surveillance CC camera play a vital role in animal reproduction and others, especially, the detection of accurate estrous time. The timing of estrous is very important for the successful AI of a dairy herd. The As such, ultrasonography determination of the proportion of animals exhibiting normal postpartum uterine involution and return to cyclicity (Crowe, 2008; Sheldon et al., 2009) as an assessment of adequacy of peri-parturient management. The use in clinical practice of information obtained from research may be limited by the frequency of reproductive examination, the skill of the operator and the time/cost the farmer is prepared to allocate to the procedure. A cost/benefit assessment has not been undertaken for the more detailed examinations now possible with the advent of Doppler and high definition ultrasound equipment. Smith, Oultram and Dobson 194 Ultrasonography allows more reliable differentiation of ovarian structures than palpation (Ribadu et al., 1994) although a level of skill and care is needed to differentiate follicles from blood vessels and the lymphatic system. Blood vessels enter the ovary at the ovarian pedicle and these may be mis-identified as a new emerging wave of small follicles. The corpus luteum (CL) is visible with care from the point of formation (76% on day of ovulation; Ginther, 1998). However, this is much easier to accomplish if the previous location of the ovulatory follicle was known, requiring frequent examination and recording of structures. For a diagnosis of anoestrous, careful scanning of the ovaries is required but conversely identification of a small amount of luteal tissue does not guarantee normal cyclicity. The first CL postpartum is often smaller and generates lower plasma/milk concentration of progesterone than normal. Usually, CL diameter is highly correlated with concentration of progesterone (Ginther, 1998), however, at the end of the cycle concentration of progesterone falls 2 to 3 days before reduction in CL size (Ribadu et al., 1994). The echogenicity of luteal tissue is higher at formation, decreases on Day 2 then remains consistent during the luteal phase. It falls again a day or two before the fall in concentration of progesterone. As the CL diameter reduces after luteolysis, the echogenicity increases again. Structurally the CL is usually detectable until the day of ovulation but is under 20 mm in diameter. Changes in CL echogenicity have been detected using computer image analysis but would require consistent set up of the ultrasound equipment and monitor if they were to be used as an indicator of age of CL clinically by eye. Echotexture or heterogeneity (variation) of the echogenicity of the structure measured by the standard deviation of the mean pixel value has been studied and is possibly a more useful indicator than echogencity itself (Siqueira et al., 2009). During spontaneous luteolysis, pulses of prostaglandin (PG) appear to be associated with temporary increases in CL blood flow, then CL blood flow declines in parallel with concentration of progesterone. Thus, Doppler ultrasonography may not give more clinically useful information than CL diameter alone (Bollwein et al., 2012). A fluid filled cavity (lacuna) is common in the centre of CL's varying in size and duration. Most reach a maximum diameter at 6 to 10 days after formation of the CL and the majority fill in by Day 18 regardless of whether luteolysis occurs or the CL is maintained due to pregnancy. Usually the radius of the cavity is not greater than the thickness of the luteal tissue wall. However, large thinwalled CL's can form during normal cycles (Ginther, 1998). Ultrasonography has played a large part in confirming that waves of follicular development occur in vivo. Cows have 2 or 3 waves per oestrous cycle emerging (over 4 mm diameter) on approximately Day 0, 9 and 16 of the cycle (see diagrams in Crowe, 2008). As a rule of thumb, if a CL is over 20 mm diameter it has acquired PG receptors to be fully responsive to exogenous PG. After luteolysis, time to oestrus is inversely related to the size of the smallest follicle with a diameter more than 5 mm (i.e. emerged). This information can be used to predict the timing of oestrus after PG injection (Siquiera et al., 2009). The echogenicity of the follicle lumen contents (antrum) is quite consistent throughout its life span. It has been suggested it gets more heterogeneous during atresia due to accumulation of cell debris (Ginther, 1998). However, this is subtle and difficult to determine in an on-farm situation. The echogenicity of the follicle wall of anovulatory follicles decline once they reach maximum size. It increases again when the follicle starts to shrink during atresia. The echogenicity of ovulatory follicle walls falls to a greater extent but then increases before ovulation (Ginther, 1998). Echogenicity has also been shown to be lower around ovaries that did not produce high-quality embryos compared with those that do when collected after slaughter and put into an in vitro maturation system. The possibility of making these differentiations by eye to predict outcome in clinical situations has not been tested. There is no difference in blood flow between the follicle that will become dominant and others before deviation. After this, blood flow is increased to the dominant follicle and reduced to others (Acosta et al., 2005). At ovulation the blood flow increases further in response to the LH surge. Differences in blood flow between follicles that do or do not ovulate after luteolysis has not yet been studied so whether it would predict fertility is not known. The uterine wall thickness, contractility, its echogenicity and amount of fluid in the lumen all increase before ovulation while the amount of folding decreases (Ginther, 1998). The presence of fluid in the uterine lumen before, but not after, ovulation is useful to differentiate stage of the oestrous cycle when a small less distinct CL is present that could have just formed (Day 3 to 4 of cycle) or be undergoing luteolysis (Day 19 to 20 of cycle). This is a better indicator than vaginal fluid that may be present at both time points, although it may contain blood after ovulation. Our experience is that many veterinary surgeons do not appreciate the above detail when examining cattle using B-mode ultrasonography. If all the above information is taken into account, and a two-wave cycle assumed in lactating cows, an estimate of the point within the oestrous cycle and time to spontaneous or PG-induced luteolysis and ovulation can be given with 2 to 3 days. Recent work has suggested that the ovarian location of the CL relative to a follicle influences the number of follicular waves and oestrous cycle length (Ginther et al., 2013). CC camera and ultrasonography tools plays a great role in the management of repeat breeder cows in the dairy herds.

Conclusions

RB in cows is a multifactorial problem involving management factors and environmental factors as well as factors coupled to the individual cow. Prevalence of repeat breeding was higher in commercial dairy farms, most likely due to intensive management system, lack of herd health approach and disease identification and eradication policy. The adoption of digital technologies in Bangladesh livestock dairy production varies strongly between different agricultural enterprises. Ultrasonography and CC camera need to be developed not only to minimize the RB cows but also to allow farmers and veterinarians to monitor the dairy herds, so that the dairy herds are cost effective and benefited to the farmers.

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