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RESEARCH ARTICLE

Evaluating the Performance of the Artificial Insemination Program in Kahatagasdigiliya Veterinary Service Division, Anuradhapura District, Sri Lanka: A Case Study

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ABSTRACT

Artificial insemination is an essential reproductive technology in the dairy industry, widely used to enhance genetic quality and boost productivity. The profitability of dairy herds is closely linked to reproductive efficiency; thus, poor reproductive outcomes can significantly affect overall farm performance. This study evaluated the reproductive performances of dairy cows in the Kahatagasdigiliya Veterinary Service Division, located in Anuradhapura District, Sri Lanka. Secondary data related to artificial insemination were collected from the Divisional Veterinary Office, covering the period from 2016 to 2020. Descriptive statistics and Analysis of Variance (ANOVA) were conducted to assess key performance indicators: female calf birth rate and services per conception ratio. The findings showed an average female calf birth rate of 55.63%, ranging from 48.19% in 2016 to 62.26% in 2020. The average services per conception ratio was 1.45, with annual variation between 1.34 and 1.57. No significant differences were observed in reproductive performance based on the source of semen. An economic assessment, based on data from the Department of Animal Production and Health indicated a 45% increase in the cost of artificial insemination services and a 45% decline in milk revenue, primarily due to poor reproductive outcomes. In conclusion, the artificial insemination program in the study area showed suboptimal reproductive performance, indicating room for improvement. Addressing these challenges requires a collaborative approach among veterinarians, farmers, and government agencies to enhance the effectiveness and outcomes of artificial insemination programs.

Keywords: *Artificial insemination, Economic loss, Reproductive efficiency, Reproductive indices, Services per conception*

INTRODUCTION

Dairy husbandry is a complex and dynamic agricultural practice that makes a significant contribution to global agriculture. The annual national milk consumption requirement for the year 2021 was approximately 750 million litres (Department of Animal Production and Health, 2021). Only 45% of total milk demand in Sri Lanka is met by the local cattle population (Vidanarachchi *et al*., 2019). The country relies on milk powder imports to bridge the annual gap between local milk demand and supply, resulting in a revenue outflow. As a result, the continuous development of the local dairy sector is a pressing necessity at the moment (Department of Animal Production and Health, 2017). Due to the conducive climatic conditions and resources available in the area, many smallholder dairy farmers successfully rear animals in the north-central province. Particularly, Anuradhapura district contributed to approximately 14% of the total amount of milk collected by Sri Lanka's leading dairy food manufacturers (Department of Animal Production and Health, 2017), and the majority of farmers in this area use livestock as their sole farming system. Most of them are smallholders with no more than 5 cattle in a farm. They primarily raised Sahiwal and Jersey crossbreds, which are heat tolerant and produce a significant amount of milk than pure breeds.

The animals are raised in free range in which the cows have cattle sheds where they can sleep only at night. Feeding is practised as stall feeding and grazing, with concentrates ensuring good welfare practices with disease control management. In order to get consistent milk production, it is essential to practice timely and successful breeding. In general, a healthy female cow can give birth to one calf per year. Currently in Sri Lanka, natural mating and artificial insemination (AI) are the two most common methods used for breeding dairy animals. A stud bull is simply used to mount on an oestrus cow in natural mating. However, the stud bull's feeding costs and labour wages are quite high. In contrast to natural breeding, artificial breeding entails manually collecting sperm cells from a male animal and depositing them in the reproductive tract of a female. AI has emerged as a pivotal technique for improving farm animal genetics. Once the semen is collected from the bull, it is deep-frozen, and stored in a container with liquid nitrogen at -196°C (Tesfu *et al.*, 2014). AI necessitates both technical assistance and close monitoring of the breeding herd. Therefore, when properly performed, AI is considered more effective and advantageous for cattle reproduction compared to natural mating (Lima *et al.*, 2010).

The economy of a farm is mainly affected by the production and reproduction performance of its animals. Evaluating productive and reproductive performance requires considering several variables. Birth weight, average milk yield per day, calving to first service interval, and calving interval are important parameters that determine cattle reproductive and production efficiency (Lof *et al.*, 2012). Repetitive breeding, abortion, endometritis, uterine prolepses, anoestrus, retained fetal membrane, and mastitis are the major factors that contribute to reduced reproductivity efficiency. Improving farm management activities such as adequate nutritional management, accurate heat detection, and conducting AI programs appropriately helps to avoid low reproductive efficiency in farms. Hence, forecasting the factors affecting low reproductive efficiency and long-term prediction of cattle reproductive performance at both the individual level and farm level directly affects the farm’s economy, helping to avoid the risk of profit loss. Farmers on a dairy farm can benefit from a high female birth rate within an AI program because female animals can be used to continuously maintain milk production cycles. The key concern that the farmers have raised in recent years is the birth of most male animals as a result of AI. However, the highest AI success rates will be obtained through the usage of high-quality sperm, proficient insemination, performed at the most appropriate time in relation to the oestrous cycle, and the technician's skills in the procedure. Heat stress, parity, milk production, diet, and diseases are the other factors that influence the success rate of an AI program (Chebel *et al.*, 2004). Poor reproductive performance resulting from an AI program leads to economic losses on a farm and necessitates frequent veterinary intervention.

In the local scenario, there is an urgent need for an economical evaluation of AI performance and farm production, in order to identify the strategies that can be implemented to improve the production levels of cattle. At present, there are only a limited number of resources that offer such information regarding AI programs in cattle farming. Hence, this study was carried out to evaluate the efficiency of reproductive performance in cows that received AI services at the Kahatagasdigiliya Veterinary Service Division in the Anuradhapura District, Sri Lanka and to provide recommendations for improving the AI process in dairy cows.

MATERIALS AND METHODS

Data collection

The study was conducted at the Kahatagasdigiliya Veterinary Service Division located at a latitude of 8°25'59" N (8.4229542), longitude of 80°41'29" E (80.6937177), and an altitude of 130 meters, in the Anuradhapura District, North Central Province of Sri Lanka (Figure 1). The secondary data (monthly reproductive data), obtained from breeding records maintained at the Kahatagasdigiliya Divisional Veterinary Office were taken for analysis. The unit of analysis was the number of AI performances conducted for different sample sizes from the year 2016 to 2020. Recorded data of 580 performed AIs were collected for the year 2016 while the sample sizes from the year 2017 to 2020 were 710, 570, 625, and 675 respectively. The information gathered included the number of male and female calves born, the number of inseminations/services provided, the number of services required for successful conceptions of individual animals, and the source of animal semen.

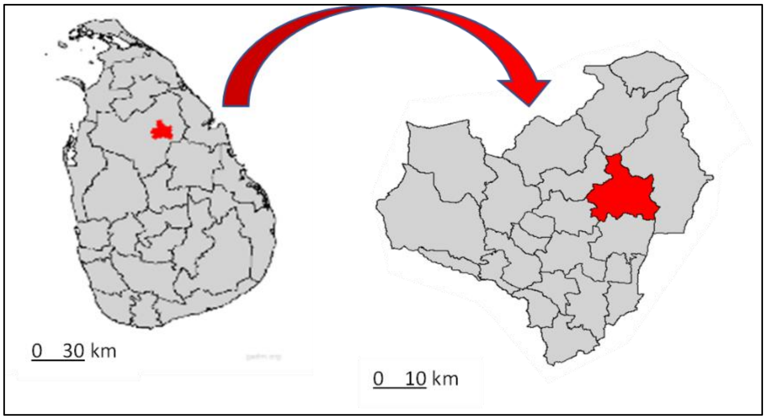

Figure 1: The study area of Kahatagasdigiliya Veterinary Service Division, North Central Province, Sri Lanka (Source: Global Administrative Areas, 2018)

Data analysis

The reproductive indices were calculated using descriptive analytical techniques such as frequencies, means, proportions, and standard deviations. The current study used two reproductive indices based on the obtained secondary data. They were the birth rate of female calves (BRFC) and the services per conception (SPC). The BRFC is defined as the ratio of total female calves to total calves born (Berry *et al.*, 2011).

BRFC = (Total number of female calves/Total number of calves born) ×100

The SPC rate was calculated by dividing the total number of services by the total number of conceptions in cows (Razi *et al.*, 2010).

SPC = (Total number of services / Total number of conceptions)

The first service conception rate (FSCR) was used to evaluate the impact of sperm source on reproductive performance. The analysis of variance (Cochran Q-test) technique was used to evaluate the effect of seven breeds on reproductive performance: Jersey, Jersey-Sahiwal cross, Sahiwal, Sahiwal (imported), Australian Frisian Sahiwal, Girolando, and Girolando cross breeds.

The Cochran's Q test is an extension test that allows three or more variables to be tested. FSCR was the dependent variable in this study. FSCR is the proportion of female cows that conceive at their first insemination after calving or at their first insemination in life.

FSCR = (Number of cows pregnant after the first service / Number of cows inseminated for the first time) × 100

The cow was considered as the block in this study, and the sperm sources were used as the experimental treatments. The dependent variable was coded as 1 if conception occurred during the first service, and as 2 if it did not. The level of significance was set at p=0.05 to test for statistical differences between the independent variables. All statistical analyses were performed using SPSS software.

The cost of AI services, the value of reduced milk production, and the additional maintenance costs of male animals resulting from poor AI performance were considered to estimate the direct economic loss associated with poor AI performance. The economic estimates were based on secondary data extracted from published sources.

RESULTS AND DISCUSSION

Reproductive indices of cows received AI services

Birth rate of female calves (BRFC)

From 2016 to 2020, BRFC in the Kahatagasdigiliya Veterinary Service Division showed a fluctuating but generally upward trend. Going through the annual BRFC values, the lowest rate was reported in 2016 at 48.19% (Figure 2). Over the five-year period, the average BRFC was 55.63%, indicating a gradual improvement in female calf births, with a notable peak observed in 2020. This trend aligns with the general assumption of a 50% female calf rate in AI (Nor *et a*l., 2015). However, despite the positive trend, the average BRFC remains below the recommended level (70–75%) suggested by Perera *et al.* (2008). To achieve an optimal BRFC, factors such as poor heat detection, mistimed insemination, and poor management practices have to be thoroughly monitored. Training farmers in detecting more accurate estrus and precise timing of insemination are crucial to meet the expected results.

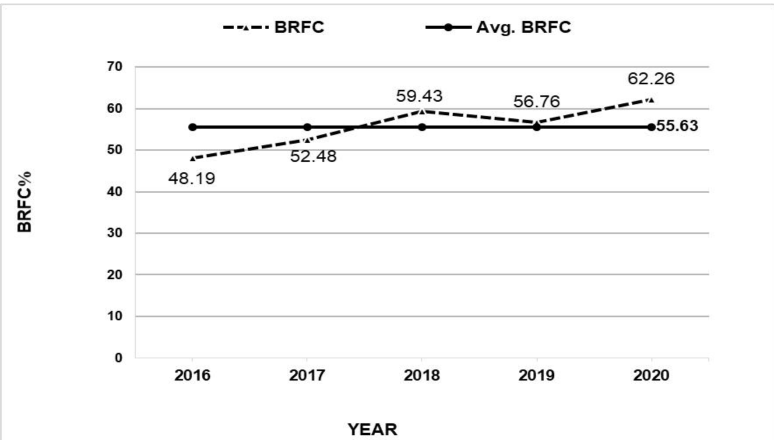

Figure 2: Birth rate of female calves (BRFC) from 2016 to 2020 in Kahatagasdigiliya Veterinary Service Division

Further, the reported average BRFC indicated that approximately 45 out of every 100 calves born were male and the higher proportion of male births contributes to increased dairy herd management costs, as male calves are generally less economically beneficial in dairy production. Therefore, a higher BRFC is desirable for an improved reproductive performance.

Services per conception (SPC)

Figure 3 shows SPC from 2016 to 2020 in Kahatagasdigiliya Veterinary Service Division. It showed slight fluctuations, with an overall average of 1.45. According to Borkowska *et al*. (2012), the typical SPC range is 1.6 to 1.8. Moreover, in the European context, SPC has been recorded as 1.76 (Cielava *et al*., 2017) while it was reported at 1.95 in North Shoa, Ethiopia (Jemal and Lemma, 2016). In comparison with the aforementioned data, the average SPC in the study area falls within an acceptable success rate. An increased SPC not only reflects reduced reproductive efficiency but also leads to higher costs for farmers due to repeated inseminations and extended calving intervals. The highest SPC (1.57) was reported in 2020 in the study area, indicating potential reproductive issues in the cow, which can have a negative impact on the farm's economy (Inchaisri *et al*., 2010). Previous studies have shown that, aside from internal factors, external factors such as the content of the feed provided, feeding frequency (Butler *et al*., 2006), housing management, season and weather, AI procedures, and timely heat detection (Nabenishi *et al*., 2011) can affect SPC.

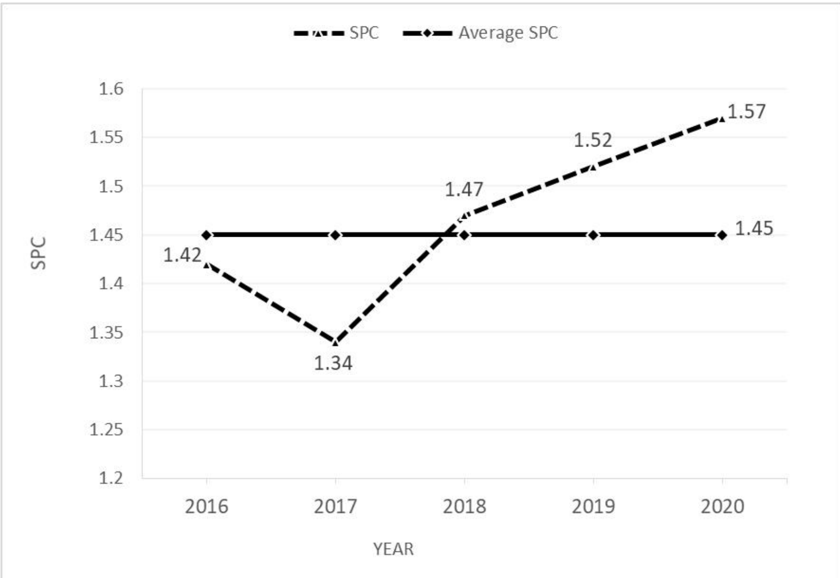

Figure 3: Services per conception from 2016 to 2020 in Kahatagasdigiliya Veterinary Service Division

Effect of semen source on reproductive indices

A Cochran's Q test revealed no significant difference ($p>0.05$) in FSCR among semen sources from Jersey, Sahiwal, Sahiwal-import, Jersey-Sahiwal Cross, Girolando, Australian Frisian-Sahiwal, and Girolando Cross bulls, indicating that the semen source did not significantly impact FSCR. This finding aligned partially with Washburn *et al.* (2002), who reported minimal variation in fertility outcomes across sires, although other studies suggested breed-specific differences. For instance, Potdar *et al.* (2020) and Bhagat and Gokhale (2016) documented higher conception rates in indigenous breeds compared to crossbreds, likely due to superior semen quality and cryotolerance. Factors such as bull age, frequency of semen collection, environmental stressors and insemination practices also influence FSCR (Perumal *et al.*, 2018). The absence of significant variation in this study may reflect uniformity in semen processing or effective herd management practices. However, further studies incorporating additional reproductive indices and broader environmental and management variables are needed to fully understand the complex factors influencing conception rates.

Direct economic loss due to poor AI performances

Poor AI performance in dairy cattle leads to significant direct economic losses, primarily due to the costs of repeated inseminations, reduced milk yield from extended calving intervals, and additional maintenance costs associated with rearing male animals. In the current study, only these direct costs were considered in the economic estimation for the study area. Reviewing the world context, in Ethiopia, poor reproductive performance was associated with a loss of 957,531 tons of milk, valued at approximately USD 331.7 million (Tesema *et al.*, 2020). Similarly, in the United Kingdom, suboptimal fertility management is estimated to cost the dairy sector over £50 million annually (Esslemont and Kossaibati, 2002). Moreover, maintaining bulls for natural mating due to AI failure contributes substantially to economic losses, with annual costs ranging from €1,440 to €1,670 per bull in Greece (Valergakis *et al.*, 2007). These losses are intensified by factors such as poor semen quality, inadequate technician training, delayed or inaccurate estrus detection, and suboptimal herd nutrition and management (Nilani *et al.*, 2013). Addressing these factors is essential to improving AI efficiency and minimizing direct economic losses in dairy production systems.

Repeated insemination cost

The cost of semen doses, veterinary or technician service fees, labour and handling, hormonal treatments or diagnostic procedures determines the service charge in AI. In this study, the SPC rate was 1.45. Using an assumed herd size of 100 cows, the total number of services needed for the entire herd would be 145. This implies that 45 additional services are required to successfully impregnate the entire herd. Assuming a service charge of LKR 250 per AI, these additional services would result in an extra cost of LKR 11,250 beyond the initial service. Consequently, this represents a 45% increase in AI-related costs compared to the baseline cost of a single service per cow.

Value of reduced milk yield

Based on the results of service per conception, FSCR was calculated to be 0.55. As a result, the number of cows conceived during the first service was 55, while 45 cows were not conceived during the first service. If the average time between two services is one month and the average milk production of a typical cow is 300 L per month, the total reduction in milk yield due to delayed conception is estimated at 13,500 L. At an average milk price of 75 LKR per litre, the value of the reduced milk production is 1,012,500 LKR, implying that 45% of the potential value of milk production has been lost due to the low first-service conception rate.

Additional maintenance cost

In the context of this study, a BRFC of 55.63% is moderately favourable and aligns with typical expectations in dairy cattle operations. In contrast, the birth rate of male calves was 44.37%. Hence, female calves are generally preferred due to their future potential as milk producers, male calves are considered less economical. When the proportion of male births increases, farms have to spend higher maintenance costs for animals that provide a limited return in dairy systems. Male calves require the same basic inputs such as colostrum, milk replacer, and housing as female calves. This adds labour and feeding costs without enhancing the genetic or productive potential of the dairy herd. Therefore, maintaining a high BRFC value helps reduce the additional resource burden associated with male calf maintenance, contributing to improved cost-efficiency.

CONCLUSION

The reproductive ability of dairy herds is essential for the long-term sustainability of livestock production in Sri Lanka. The average birth rate of female calves (BRFC) in Kahatagasdigiliya located in the Anuradhapura district, Sri Lanka showed an improved reproductive management over the study period. However, a higher percentage of male calves increased overall farm maintenance costs, proving that a lower BRFC has substantial economic ramifications. The reported services per conception (SPC) rates were in acceptable ranges while the study found no significant differences in the first service conception rate (FSCR) among different semen sources. Maintaining optimal BRFC, SPC, and FSCR requires strategies such as improved herd nutrition, accurate artificial insemination timing, and accurate estrus detection. Furthermore, extending the current national AI coverage of 15% (Abeygunawardena *et al.*, 2001) could increase farm profitability and herd replacement efficiency while reducing the financial strain associated with raising male calves.

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REFERENCES

Abeygunawardena, H., Alexander, P.A.B.D. and Abeygunawardena, I.S. (2001). Artificial insemination of cattle in Sri Lanka: Status, performance and problems (online). (Accessed on 04.04.2024) Available at: https://inis.iaea.org/records/yd4sy-av857

Berry, D.P., Kearney, J.F. and Roche, J.R. (2011). Evidence of genetic and maternal effects on secondary sex ratio in cattle. Theriogenology. 75(6), 1039–1044.

Bhagat, R.L. and Gokhale, S.B. (2016). Studies on factors influencing conception rate in rural cattle. The Indian Journal of Animal Sciences. 86(5), 550–552.

Borkowska, D., Piatek, D., Janus, E. and Mucha, J. (2012). Fertility indices of cows in a high-yielding herd. Scientific Annals of the Polish Society of Animal Production. 8(3), 21–29.

Butler, S.T., Pelton, S.H. and Butler, W.R. (2006). Energy balance, metabolic status, and the first postpartum ovarian follicle wave in cows administered propylene glycol. Journal of Dairy Science. 89(8), 2938–2951.

Chebel, R.C., Santos, J.E., Reynolds, J.P., Cerri, R.L., Juchem, S.O. and Overton, M. (2004). Factors affecting conception rate after artificial insemination and pregnancy loss in lactating dairy cow. Animal Reproductive Science. 84(3-4), 239–255.

Cielava, L., Jonkus, D. and Paura, L. (2017). Number of services per conception and its relationship with dairy cow productive and reproductive traits. International Conference on Research for Rural Development. 67–73.

Department of Animal Production and Health. (2017). The National Livestock Breeding Policy: Guidelines and strategies for Sri Lanka. Department of Animal Production and Health, Gatambe, Sri Lanka.

Department of Animal Production and Health. (2021). Annual Report (online). (Accessed on 09.06.2025) Available at https://daph.gov.lk/files/uploads/pdf_document/0-1715852975.pdf

Esslemont, R.J. and Kossaibati, M.A. (2002). Standards of recording management, health and fertility information pp. 171–183. In: Crettenand, J., Moll, J., Mosconi, C., and Wegmann, S. (Ed.), Performance recording of animals; State of the art. Wageningen Academic Publishers, Netherlands.

Inchaisri, C., Jorritsma, R., Vos, P.L., Van der Weijden, G.C. and Hogeveen, H. (2010). Economic consequences of reproductive performance in dairy cattle. Theriogenology. 74(5), 835–846.

Jemal, H. and Lemma, A. (2016). Review on major factors affecting the successful conception rates on biotechnological application (AI) in cattle. Global Journal of Medical Research. 15(3), 19–27.

Lima, F.S., De Vries, A., Risco, C.A., Santos, J.E.P. and Thatcher, W.W. (2010). Economic comparison of natural service and timed artificial insemination breeding programs in dairy cattle. Journal of Dairy Science. 93(9), 4404–4413.

Lof, E., Gustafsson, H. and Emanuelson, U. (2012). Evaluation of two dairy herd reproductive performance indicators that are adjusted for voluntary waiting period.

Acta Veterinaria Scandinavica. 54(1), 1–11.
Nabenishi, H., Ohta, H., Nishimoto, T., Morita, T., Ashizawa, K. and Tsuzuki, Y., (2011). Effect of the temperature-humidity index on body temperature and conception rate of lactating dairy cows in southwestern Japan. International Journal of Reproduction. 57(4), 450–456.
Nilani, K., Eswaramohan, T. and Mahadhevan, P. (2013). Status of AI performance and problems related to low conception rate in cow breeding in Jaffna Peninsula, Sri Lanka. International Journal of Current Science. 3(3), 97–105.
Nor, N.M., Steeneveld, W., Mourits, M.C.M. and Hogeveen, H. (2015). The optimal number of heifer calves to be reared as dairy replacements. Journal of Dairy Science. 98(2), 861–871.
Perera, B.M.A.O. and Jayasuriya, M.C.N. (2008). The dairy industry in Sri Lanka: Current status and future directions for a greater role in national development. Journal of the National Science Foundation of Sri Lanka. 36, 115–126.
Perumal, P., De, A.K., Bhattacharya, D., Kundu, A., Sunder, J., Ravi, S.K., Bala, P.A., Alyethodi, R.R. and Ahmed, S.K. (2019). Birth rate and birth weight of crossbred calves in Andaman and Nicobar islands. International Journal of Bio-resource and Stress Management. 10(3), 323–328.
Potdar, V.V., Joshi, S. and Swaminathan, M. (2020). Factors affecting conception rate in AI bred cattle under field conditions of Maharashtra. Indian Journal of Veterinary Sciences and Biotechnology. 16, 49–53.
Razi, K.M.A., Asgar, M.A., Kabir, M.H., Bag, M.A.S. and Parvez, M.M. (2010). A study on estimation of conception rate and services per conception in cattle after artificial insemination. International Journal of Biological Research. 2(7), 25–29.
Tesema, Z., Taye, M. and Kebede, D. (2020). Current status of livestock crossbreeding in Ethiopia: Implications for research and extension. Journal of Applied Animal Science. 13(2), 9-26.
Tesfu, F., Gebrekidan, B. and Afera, B. (2014). Assessment and comparison of sex ratio following artificial insemination and natural mating in small scale and modern dairy cattle farm in Mekelle. Journal of Risk and Insurance. 5(2), 58–64.
Valergakis, G.E., Arsenos, G. and Banos, G. (2007). Comparison of artificial insemination and natural service cost effectiveness in dairy cattle. Animal. 1(2), 293–300.
Vidanarachchi, J.K., Chathurika, H.M.M., Dias, H.M., Gedara, P.K., Silva, G.L.L.P., Perera, E.R.K. and Perera, A.N.F. (2019). Dairy industry in Sri Lanka: Current status and way forward for a sustainable industry. Association of Animal Production, University of Peradeniya: Peradeniya, Sri Lanka. 1–38.
Washburn, S.P., Silvia, W.J., Brown, C.H., McDaniel, B.T. and McAllister, A.J. (2002). Trends in reproductive performance in southeastern Holstein and Jersey DHI herds. Journal of Dairy Science. 85(1), 244–251.