Effect of Heat Stress on Pregnancy Rate in Crossbred Temperate Dairy Cattle under Tropical conditions

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Abstract*-The decline of reproductive efficiency under heat stress is a drawback for the dairy industry. The objective of this study is to evaluate whether there is any relationship between the reproductive performance in cows and the Temperature Humidity Index (THI) and to improve the reproductive indices in the imported cows by using a synchronization protocol followed by Artificial Insemination (AI). Eight medium scale farms in Matale, Kandy and Kurunegala districts were selected. A group of first parity, healthy cows (n=205) were synchronized using Ov-synch synchronization protocol using intramuscular hormonal injections (Day 0: 2ml GnRH, Day 07: 2ml Cloprostinol sodium, Day 09: 2ml GnRH). Sixteen to eighteen hours after the third injection, AI was performed. After 35- 45 days, pregnancy diagnosis was performed using per-rectal ultrasonic scanning method. On each farm visit the THIs of the farms were calculated. Pregnancy rate was below 6% in 3 farms in which most of the days THI was beyond 78 causing moderate heat stress and the body temperature of the cows in those farms were between 102.9 - 104.5^{0}F. Average THI of the farms with a pregnancy rate beyond 20%, was below78 and none of them were exceeding the cut off THI for moderate heat stress zone and the body temperature of the cows was below 102.5^{0}F.There is a negative effect of high THI and high body temperature on pregnancy rate among the imported temperate dairy herds to tropical environments. Although metabolic heat generation is sufficient to maintain the body temperature, further absorption can be continue due to the high environmental temperature leading to heat stress. Thus it is essential to implement appropriate measures to reduce heat stress in order to enhance their reproductive performances.*

Key words**- heat stress, synchronization, Temperature Humidity Index**

I. INTRODUCTION

Global warming accompanied with extreme weather has aggravated environmental stresses in all living beings including dairy cattle due to the difficulty of dissipating heat from the body (Soumya *et al.*, 2016).Combinations of parameters including ambient temperature and humidity, which produce higher temperature ranges than the thermo neutral zone, can induce heat stress in animals(Soumya *et al.*, 2016). Higher producing cows are more susceptible for complications associated with heat stress (Armstrong, 1994).

Several responses to heat stress can be seen in dairy cows, but the decline of reproductive efficiency under heat stress would be the utmost concern of the dairy farmers (Hansen, 2009). Immediate effects of heat stress include delayed regression of subordinate follicles, impaired growth of medium sized follicles, reduction of follicular selection and reduction of degree of dominance of the dominant follicle which will eventually reduce the conception rate (Roth, 2008; Soumya *et al.*, 2016). Even though the oocytes exhibit normal morphology, the quality, viability and the capability of in-vitro development would be disrupted in cows under heat stress(Rocha *et al.*, 1998; Sakatani, 2017) Imbalances of hormone levels including progesterone, estradiol, luteinizing hormone (LH) and prolactin is another common cause for reproductive failures such as early embryonic deaths, abnormal oocyte maturation, implantation failures and silent heat in animals under heat stress (Roth, 2008; Soumya *et al.*, 2016). Furthermore it is said that there would be a disruption of LH receptor function upon heat stress (Roth, 2008). Compromised uterine environment due to decline of blood flow in to the uterus and increment of uterine temperature is another common outcome of heat stress in cows (Soumya *et al.*, 2016). The sensitivity of the early embryos to the elevated temperature in the uterus lead to suppression of embryonic development and embryonic losses under

heat stress (Ryan *et al.*, 1992; Roth, 2008; Sakatani, 2017). It is believed that the sperms are relatively less sensitive to heat -induced damages than oocytes (Sakatani, 2017)

Many thermal indices have been established to get a better reflection of the thermal stress among the animals out of which Temperature Humidity Index (THI) is a common measure of heat stress and if it rises above 74 it will negatively impact on reproductive traits of cattle (Soumya*et al.*, 2016). By following a hormonal protocol followed by timed artificial insemination has been used to improve the pregnancy rate during the summer all over the world (Wolfenson*et al.,* 2000). Even under that circumstances, tropical countries are tend to import temperate dairy breeds to upgrade their cattle population and to improve the milk production in a short period. But, lack of the certified breeding performance is one of the main complaint raise by the importer with few year experiences of raring them under tropical environment.

Thus, the objective of this study is to evaluate whether there is any relationship between the reproductive performance in cows and the THI and to improve the reproductive indices in the imported temperate cows by using a synchronization protocol followed by Artificial Insemination (AI) in a tropical environment.

II.METHODOLOGY AND EXPERIMENTAL DESIGN

Eight medium scale farms, those were introduced imported temperate dairy herds (Jersey × Friesian) at a same period and reared under intensive management system, in Matale (n=04), Kandy(n=02) and Kurunegala (n=02) which are popular areas for the dairy farming in Sri Lanka were selected for the study.

Selection of Cows

A group of first parity and 3 to 4 years old cows from above herds were selected at the initial selection of each farm. The Body Conditions Score (BCS)of those animals were assessed individually, under the scale of 1-5 (1; Very emaciated, 5; Very obese). Cows with2.5-3.5BCS were selected for the program. The selected cows were clinically examined and cows with any type of disease condition (e.g. chronic mastitis, lameness etc.) were not selected for the breeding program. Per-rectal examinations of the pre-selected animals were done and the statuses of the reproductive tracts were evaluated. Cows with reproductive disorders (e.g. endometritis, pyometra, cystic ovaries etc.) and/ or acyclic ovaries were removed leaving only the non-pregnant, cyclic cows for the breeding program (n=205).

Estrus synchronization

The selected cows were synchronized using Ov-synch synchronization protocol. The protocol was started with the first injection of2ml Gonadotrophin Releasing Hormone - GnRH (GonavetVeyx®, 0.05mg/ml solution) intramuscular route (IM)on day 0. The second injection of 2ml Cloprostinol sodium (PGF Veyx®, 0.263 mg/ml solution) was given in IM route on Day 07 followed by the third injection of 2mlGnRH with same origin in IM route on day 09.

Artificial Insemination (AI)

Sixteen to eighteen hours after the third injection of the synchronization protocol, AI was performed, using mini (35 million sperms/0.25ml) Jersey semen straws. During the AI those semen straws which had been produced at Central Artificial Insemination Station (CAIS), Department of animal production and health, Kundasale were thawed at 35-37 ^{o}C for 30 seconds and inseminated to the uterine body at the level of internal os of the cervix by a qualified technician.

Pregnancy Diagnosis

In-between 35- 45 days of AI, pregnancy diagnosis was performed using per-rectal ultrasonic scanning method (LANDWIND®, 7.5MHz). The pregnancy rates of the selected herds of cows were evaluated.

Calculation of Temperature Humidity Index (THI)

On each visit (4 times per farm) for hormone injections and AI, the THIs of the farms were calculated using the "Temperature-Humidity Index Table for Dairy Producer to Estimate Heat Stress for Dairy Cows" illustrated by Dr. Frank Wiersma Department of Agricultural Engineering, The University of Arizona, Tucson (1990), separately.

III. RESULTS

The pregnancy rates of the 08 farms were ranging from 0.00% to 66.60%. Pregnancy rate was below 6% in 3 farms. Most of the days those farms were having a THI beyond 78, which cause moderate heat stress in cows while rest of the days were having 72-78 which cause a

mild stress. Average temperature humidity index of the farms which had a pregnancy rate beyond 20%,was below78 and none of them were exceeding the cutoff THI for moderate heat stress zone.

Body (rectal) temperatures of the selected cows in 3 farms which represented the lower pregnancy rates were between 102.9 - 104.50F; but the body temperatures of the cows in the rest of the farms were below 102.50F.

Table 1: Pregnancy Rates and THI of the farms

Farm NO	*Total AIs*	*No of Preg.*	*Preg.%*	*Average*	
01	5	0	0.00	76.75	MI
02	39	1	2.50	80.50	MO
03	18	1	5.50	78.25	MO
04	29	7	24.10	74.75	MI
05	64	22	34.30	77.00	MI
06	21	11	52.00	<72	NO
07	20	12	60.00	76.25	MI
08	9	6	66.60	77.00	MI

(AI: Artificial Insemination, Preg.: Pregnancy, MO: Moderate stress, MI: Mild stress, NO: No stress)

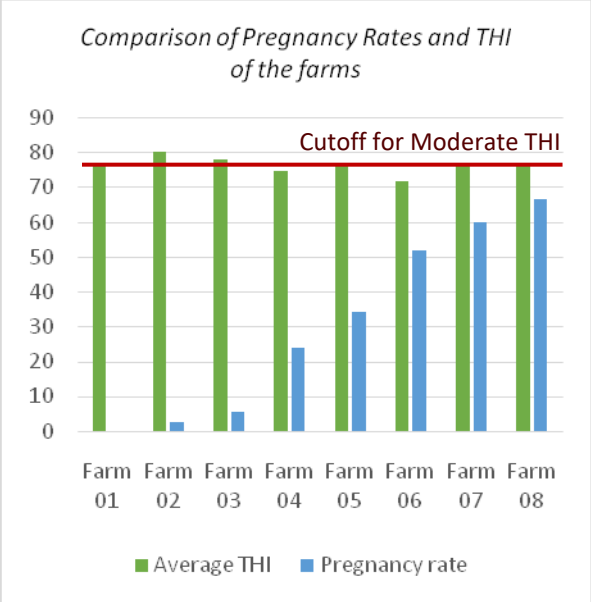

Figure 1. Comparison of the Pregnancy rates and THI of the farms

IV. DISCUSSION

Temperate (exotic) breeds have evolutionarily adapted to their original environment. Hence, those animals are not baring prominent dewlaps and naval sheaths; those facilitate efficient heat dissipation mechanism, compared to the tropical breeds. Thus, temperate breeds which have imported to a tropical country are highly vulnerable for the heat stress and associated secondary complications.

Reduction of the reproductive efficiency is one of the drawbacks associated with heat stress in dairy industry. Results revealed the farms where THI exceeds the cutoff point for moderate heat stress, the pregnancy rate is less; but, in the farms where pregnancy rate is high, THI did not exceed the cutoff point of the samein any of the above days revealing that the high THI has a negative effect on the reproductive performances of the imported cows. Furthermore, the body temperature of the cows which were not conceived, exceed the upper margin of the normal body temperature of the cattle (102.5^0F). Both high THI and high body temperature were observed in the farms where the pregnancy rate was law. Although they are warm blooded animals high body temperature (than the upper margin of the normal value) could be due to the failure of efficient thermoregulatory mechanism secondary to presence of higher THI for longer period and it might lead to the low pregnancy rate too. Farms which were having mild or zero heat stress throughout the study period were shown 24.1- 66.6% pregnancy rates. Reason for this variation could be due to the other factors that affects the pregnancy rate. Such as feeding and nutrition, insemination procedure, semen quality and post AI caring etc. Same reasons with low AI number (n=5) could be the other supportive factors to get zero pregnancy rate in one farm with average mild heat stress. Other possible reason to get the above result of the particular farm could be due to the presence of moderate heat stress in 50% of the study period.

Heat stress among dairy cattle can be reduced by several means including, administration of antioxidants in heat stress conditions in order to decrease thermal-oxidative stress, development of genetically heat tolerant dairy breeds and environment modifications including artificial cooling systems(Armstrong, 1994;

Soumya *et al.*, 2016; Sakatani, 2017). Using timed artificial insemination protocols and embryo transfer can also enhance the reproductive performances in the dairy cows under heat stress (Hansen, 2009). Therefore, it is essential to implement appropriate measures to reduce the effect of the heat stress on reproductive indices among the imported dairy herd.

V. CONCLUSION

There is a negative effect of high THI and high body temperature on pregnancy rate among the imported temperate dairy herds to tropical environments, thus it is essential to implement appropriate measures to reduce heat stress in order to enhance their reproductive performances.

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