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Interrelationships Among Environmental and Physiological Factors at Insemination with Conception Rate of Water Buffalo (*Bubalus bubalis*)

M. Pagthinathan, E.R.K. Perera[1], M.P.B. Wijayagunawardana[1], A.N.F. Perera[1], S.C. Kaduwela[2] and K.A. Perera[1]

Postgraduate Institute of Agriculture
University of Peradeniya
Peradeniya, Sri Lanka

ABSTRACT. *A study was carried out from January 2001 to March 2002, to find out the effect of environmental parameters, physiological parameters and management factors at the time of insemination on conception rate of water buffalo. A total of 224 buffalo cows at 75-300 days post partum (DPP) at the time of insemination were used. Measurements on environmental temperature (ET), relative humidity (RH), vaginal temperature (VT), rectal temperature (RT), respiratory rate (RR), pulse rate (PR), body condition score (BCS) and heat signs of each cow were recorded at the time of insemination. Conception was confirmed by per rectal palpation at 90 days and 120 days following insemination.*

The mean values of ET and RH during the experimental period were 28.14±2.33°C and 75.69±12.6%, respectively (n=224). The changes in ET and RR were negatively ($p<0.05$) correlated with those of RH. Vaginal temperature changes were significantly ($p<0.05$) correlated with those of RT, while VT remained 0.4°C higher than RT. Changes in VT and DPP were inversely related with ($p<0.05$) conception rate. Technician and time period from first appearance of heat signs to the time of insemination also affected ($p<0.05$) conception rate. These results indicate that higher conception rates can be achieved by inseminating buffalo cows at <150 DPP, within 6-12 h of detection of heat when VT is <38°C, by a skillful technician.

INTRODUCTION

In Sri Lanka water buffalo plays an important role in livestock farming sector as a multipurpose animal. The country has about 0.72 million buffalo population consisting of over 95% indigenous buffaloes and their crosses with exotic river breeds, and less than 5% pure exotic dairy breeds such as Murrah, Surti and Nili Ravi (Perera, 2001). Increasing reproductive efficiency is an important goal in buffalo farming in Sri Lanka because of the long time taken to attain puberty, high incidence of "silent estrus", low conception rate, long postpartum anoestrous period and sluggishness in breeding activity of this animal. Despite being a polyestrous animal, buffalo exhibits a considerable seasonality in reproduction (Abeygunawardena *et al.*, 1994; Perera and Perera, 2000) which is associated with changes in ambient conditions.

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[1] Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.

[2] Department of Animal Production and Health, Getambe, Peradeniya, Sri Lanka.

Experience with cattle suggests that reproductive efficiency depends on multitude of factors related to cow, environment and management. For example, body condition score influences the efficiency of reproduction in cattle (Domecq *et al.*, 1997). Cows having fatter body condition (>4) may be prone to difficulties at calving and delayed uterine involution, which then may lead to the development of postpartum uterine infections and infertility (Abeygunawardena *et al.*, 1998).

Thermal stress around the time of insemination affects the physiology of the cow and alters hormonal concentration (Seath and Miller, 1964), leading to lowered conception rates (Gwazdauskas *et al.*, 1973). In addition, there is evidence to indicate that management factors such as timing of insemination also affects conception rate in cattle. For example, superior conception rates have been reported when cows were inseminated at 13-18 h before ovulation. This translates into, usually from about 12 h after the onset estrous until about six hours after the end of estrous (McDonald and Pineda, 1989).

Although such information is available on the factors affecting conception rate in cattle, information is lacking on these aspects of reproduction in buffalo. Thus, this study was designed with an overall objective of identifying the interrelationships among the environmental and physiological parameters at insemination with conception rate of buffalo and to determine the critical factors and periods that affect conception rate.

MATERIALS AND METHODS

Location and animals

The study was conducted from January 2001 to March 2002 at Melsiripura and Nikaweratiya National Livestock Development Board (NLDB) farms in the Kurunegala district, located in the North Western Province of Sri Lanka.

In both farms all breedable females were used for this study. This included a total of 224 cows comprising of Nili-Ravi, Surti and their crosses maintained in the two farms. For all the cows, information was collected on age, stage of lactation and body condition score. Semen from only one buffalo bull was used to inseminate all the cows used in this study.

Insemination technician

Two artificial insemination (AI) technicians inseminated all the buffalo cows, included in this study. Information on the level of education, duration of formal training in AI and experience in AI of the two technicians were obtained.

Synchronization of estrus

All breedable cows in the farms were subjected to rectal palpation to identify their reproductive stage. The cows that were found to be having active ovaries, non-pregnant and in normal physiological condition, were subjected to estrus synchronization. For this purpose, progesterone releasing intra-vaginal device (PRID) was administered on day 0 (day of administration), and removed on day 8, followed by 500 μg $PGF_{2\alpha}$ injected on day 9. Synchronized cows were artificially inseminated using frozen semen, on day 11 or 12. Based on date of PRID administration and removal, the date of insemination was determined.

Measurements

Rectal temperature (RT), vaginal temperature (VT), pulse rate (PR), respiratory rate (RR) and body condition score (BCS) of each buffalo cow at insemination were recorded. Visible heat symptoms of each cow, and ambient temperature (AT) and relative humidity (RH) of the environment were also recorded at the time of insemination.

Rectal and vaginal temperatures were obtained by using a digital thermometer placed in the rectum and vagina, respectively. Pulse rate was assessed by palpation of coccigial artery. Respiratory rate was estimated by visual observation of chest and abdominal movements. To assess BCS, palpation and visual observation of the area on either side of the tail-head and rectum, tuber coxae, thoracic vertebrae and transverse processes of lumbur vertebrae were used. The scoring was made based on a scale ranging from 1 (emaciated animal) to 5 (obese animal). Heat signs of each cow at the time of insemination were assessed based on the appearance of vulva, mucus discharge and urination. The scoring system used in this regard is given in Table 1. Ambient temperature and relative humidity were recorded using a dry and wet bulb thermometer.

Table 1. Scoring system used to assess heat symptoms.

Heat signs		Score
Colour of vulva	Red	4
	Light red	3
	Pinkish red	2
	Light pink	1
	Normal colour	0
Mucus discharge	Thick	3
	Moderate	2
	Thin	1
	Less or None	0
Urination	Frequent	1
	No urination	0

AI was mainly done during day time, and over 80% were conducted during morning hours (Table 2). All the animals were closely monitored for re-exhibition of heat symptoms between 18-21 days after insemination. In addition, they were subjected to per-rectal diagnosis of pregnancy at 90 days after insemination. Conception was confirmed again at 120 days following insemination.

Table 2. **Distribution of inseminations during day time.**

Time of day (h)	0800-1000	1000-1200	1200-1400	1400-1600	1600-1800
No of inseminations	94	85	27	1	14
Percentage	42.5%	38.5%	12.2%	0.5%	6.3%

Statistical analysis

Data were tabulated and analysed by using the correlation and regression analytical procedures, analysis of variance and chi-square procedure of Statistical Analysis System (SAS).

RESULTS AND DISCUSSION

Environmental parameters (ET and RH)

The mean (± SD) environmental temperature (ET) at the time of insemination of 224 cows was 28.14°C±2.33 (range 22.48 - 33.00°C) in the two farms. The mean relative humidity (RH) at the time of insemination was 75.69±12.60% (range 50-96%). The values of mean ET and RH reflect the ambient conditions that prevailed at the times of insemination, specially during morning hours in the two locations.

Physiological parameters

The mean and range of physiological parameters recorded from each animal at the time of insemination are given in Table 3. These values are within the range of physiological norms of rectal temperature (37.5 - 38.5°C), respiration rate (15 - 20 breaths min^{-1}) and pulse rate (40 - 45 min^{-1}) reported for buffalo (Perera, 2001). Slightly higher pulse rate could be the result of excitement caused during obtaining measurements.

Relationship among environmental parameters and animal physiological parameters

The correlation coefficients among environmental parameters and animal physiological parameters are given in Table 4. Environmental temperature changes were negatively correlated to those of relative humidity ($p<0.01$, $r = -0.71$). Such negative correlation, reflecting the opposite directional changes in ambient temperature and relative humidity were expected.

Table 3. Mean±SD, minimum and maximum values of physiological parameters at the time of insemination.

Source	Minimum	Mean±SD	Maximum
Vaginal temperature (VT) °C	36.82	38.59±0.39	40.58
Rectal temperature (RT) °C	35.82	38.22±0.54	40.17
Pulse rate (PR) min^{-1}	48.00	58.44±3.72	70.00
Respiration rate (RR) min^{-1}	15.00	21.01±2.93	30.00

Table 4. Correlation coefficients among physiological parameters and environmental parameters.

	RT	PR	RR	ET	RH
VT	0.59*	0.07	0.09	-0.05	0.06
RT		0.06	0.07	0.07	-0.02
PR			0.25**	0.09	0.01
RR				0.11	-0.14**
ET					-0.71*

* $p<0.01$ ** $p<0.05$

None of the animal physiological parameters had significant correlation with ambient temperature within the range. Such absence of significance in correlation could be due to the use of a large number of cows (n=224) which had high individual animal variation resulted from obtaining measurements at different times of the day, on different days, over a period of 13 months, with no repeated measurement from any cow.

Vaginal temperature, rectal temperature and pulse rate were not significantly correlated to relative humidity. However, respiratory rate was negatively correlated ($p<0.05$) to relative humidity. This reflects the negative impact of relative humidity on respiratory evaporation (Bearden and Fuguay, 1997).

The changes in vaginal temperature were significantly correlated with ($p<0.01$, $r = 0.59$) those of rectal temperature. Relationship between VT and RT is shown in Fig. 1.

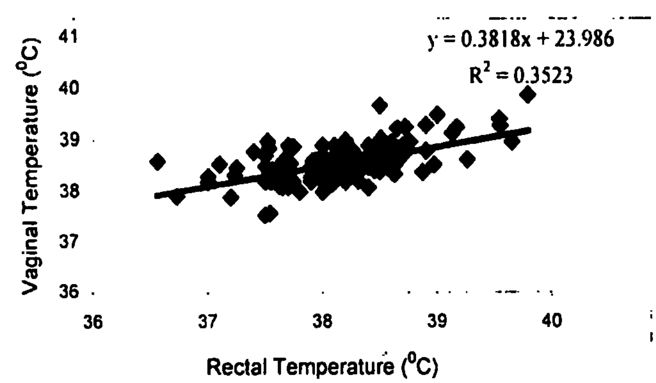

Fig. 1. Relationship between rectal temperature and vaginal temperature.

Vaginal temperature was one degree higher than the rectal temperature of the cows (Table 3). This finding is in agreement with reported results for cattle (Perera *et al.*, 2000). However, pulse rate and respiration rate changes were not significantly related to those of rectal temperature ($p>0.05$). This could be due to greater individual animal variation in these parameters resulted from excitement during obtaining measurements.

Conception rate (CR)

Overall conception rate was 55.4%. A previous study has recorded less than 30% of conception rate in buffalo (Perera *et al.*, 1977). The higher conception rate achieved in this study could be due to many factors such as the use of PRID, better timing of insemination and greater skill of technicians.

Relationship between environmental parameters and conception rate

Environmental temperature within the range of 22.5–33.33°C was not significantly associated with conception rate. High environmental temperature is reported to cause conception problem in dairy cows (Gwazdauskas *et al.*, 1973; Gordon, 1996). Heat stress causes a depression in progesterone secretion by the corpus luteum and reduces the thyroid activity, leading to loss of body condition and lower conception rate (Bearden and Fuguay, 1997). However, the findings of this study did not reveal any significant ($P>0.05$) adverse effect of ET on CR in buffalo. However, conception rate reduced from 79–48% as the RH increased from 50–96% (Fig. 2), suggesting adverse effects of RH on conception rate.

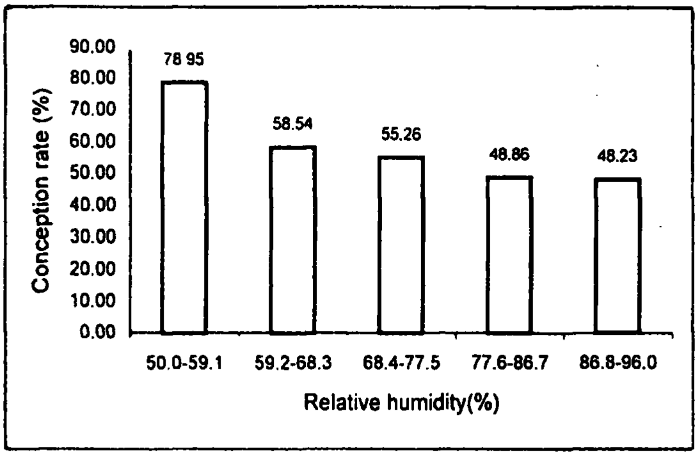

Fig. 2. Relationship between relative humidity and conception rate.

Relationship between vaginal temperature and conception rate

Changes in vaginal temperature were inversely associated with conception rate ($p< 0.05$, Fig. 3). When vaginal temperature increased from 36.5–41.0°C, conception rate decreased from 75–22.22%. Variation in uterine temperature at the time of insemination is associated with certain physiological and hormonal changes occurring in the animal (Gwazdauskas *et al.*, 1973). Elevation of uterine temperature can affect sperm capacitation in the female tract, resulting in lower embryonic survival (Bearden and Fuguay, 1997). The findings of this experiment suggests that VT of 36–38°C at insemination in buffalo cows to be favourable for conception.

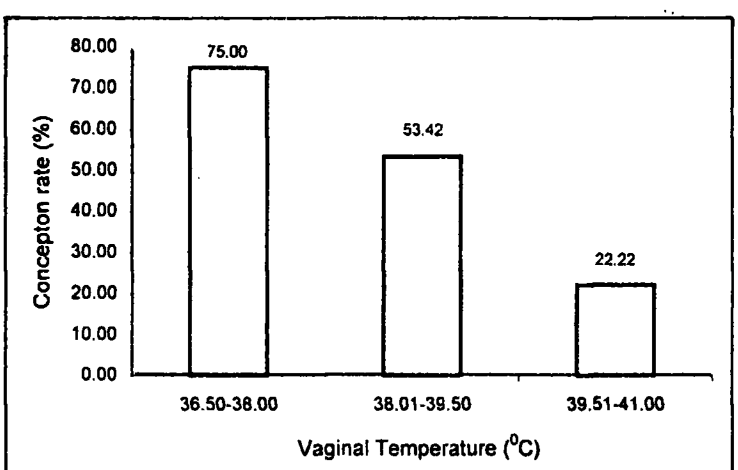

Fig. 3. Relationship between vaginal temperature and conception rate.

Relationship between rectal temperature and conception rate

Increase in RT was associated with decline in conception rate (Fig. 4). Lower conception had been recorded in cows having above normal body temperatures at insemination than in cows having normal body temperature (Fallon, 1962). Although the relationship between RT and conception rate was not significant (P>0.05) in this experiment, the results suggest RT less than 38°C at insemination to be more favourable for conception in buffalo.

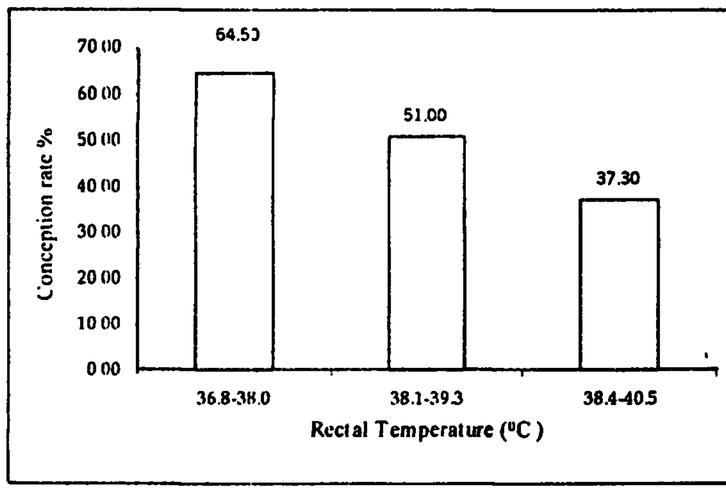

Fig. 4. Relationship between rectal temperature and conception rate.

Relationship between days post partum and conception rate

At the time of insemination the cows were within 75–300 days post partum. Conception rate was negatively correlated to days post partum ($p<0.05$). The CR reduced from 73.3% in early post partum cows (<150 DPP) to 28.6% in late post partum (>226 DPP) cows. This suggests that buffalo cows should be inseminated between 75–150 DPP to achieve better CR.

Relationship between body condition score (BCS) and conception rate

The mean BCS score of cows at the time of insemination was 3.2±1.9 (range 2–4). Most of cows (59.4%) had a BCS of three. In the present study, BCS at insemination was not related to conception rate, although the loss of BCS at insemination is reported to have negative influence on conception (Domecq *et al.*, 1997) in cattle.

Technician and conception rate

Two inseminating technicians were included in this study. Technician identity was statistically significant ($p<0.05$) on conception rate. Technician 2 had superior CR (63.6%) compared to technician 1 (41.7%). Since both technicians had similar duration of experience in AI, and both locations had similar environmental conditions, greater success achieved by technician 2 may be due to his greater skill in performing AI.

Timing of insemination related to first detection of heat and conception rate

In the present study, time lapse from first detection of heat to artificial insemination ranged from 1–24 h. When grouped into 0–6 h (n=51), 6–12 h (n=30) and 12–24 h (n=9) hours time lapse, the respective conception rates were 47.6, 70.0 and 44.4%. These values indicate significant differences in conception rate ($p<0.05$), in relation to timing of insemination. These results suggest that higher conception rate can be achieved, if buffalo cows are inseminated between 6–12 h after first detection of heat.

CONCLUSIONS

The finding of study indicate that the overall success rate of artificial insemination following PRID administration was 55.4%. Many factors including VT, DPP, technician and timing of insemination significantly affected the conception rate. Superior conception rate can be achieved when inseminations are conducted for buffalo cows less than 150 DPP, within 6–12 h of first detection heat, when VT is less than 38°C, by skillful technicians.

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