Stress-Reproduction Relationship in Domestic Livestock and Poultry under the Subtropical Environment

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Reproduction and Stress Axes work alternatively

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Hypothalamus-pituitary-Gonadal Axis

Environmental and endogenous signals through CNS

Hypothalamus

GnRH

Hypophysis

FSH/LH

Gonadal functions of reproductive physiology

Thermal
Nutritional
Lactation
Epigenetics
Leptin
Receptors

Anestrus
Silent estrus
Silent Ovulation
Cyst ovaries
Abortion

HPA Axis only works when the HPA Axis is inactive.

Hypothalamus-pituitary-Adrenal-Axis

Hypothalamus

CRH

Hypophysis

ACT

Adrenal cortex functions of stress physiology

Environmental and endogenous signals through CNS

(Qureshi MS, 2009)

Seasonality of breeding in Nili-Ravi dairy buffaloes - Nutritional Factors

- Buffaloes shows a seasonal pattern of breeding, autumn/winter being normal (NBS) and spring low breeding season (LBS) (Qureshi et al, 1999).
- Seasonality is caused by changing thermal stress, fodders availability and daylight.
- LBS showed lower progesterone levels associated with summer infertility and CP/ME ratio.
- Onset of breeding season was associated with higher intake of ME, Zn, and Ca and lower intake of CP, Mg, P and Cu.
- Higher milk production in the NBS calving buffaloes was associated with better reproductive performance probably due to better utilization of the excess intake of crude proteins than the low yielders.

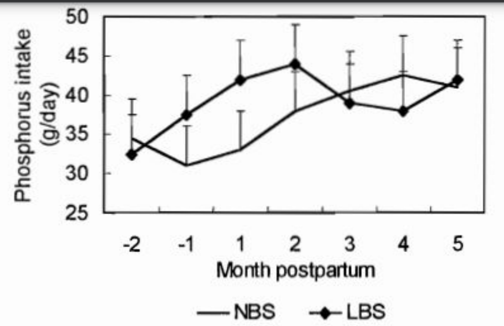


Figure 1. Phosphorus intake in normal (NBS) and low breeding season calving (LBS) buffaloes various months post-partum

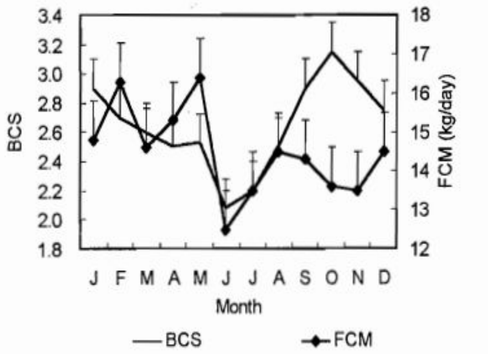


Figure 4. Annual pattern of body condition score (BCS) and 4% fat-corrected milk production (FCM) in buffaloes

Progesterone pattern and associated factors with summer infertility

- Onset of breeding season (OBS) commenced during August and went up to January.
- OBS was associated with decreasing atmospheric temperature, increasing body condition score and milk production, high serum glucose levels, lower serum urea, protein, Ca and Mg.
- Low postpartum reproductive performance in dairy buffaloes during LBS was primarily due to inadequate functioning of the corpus luteum in secreting optimum concentrations of progesterone (Qureshi et al, 2000).
- The higher incidence of silent estrus during LBS indicated improved management for the detection of estrus.

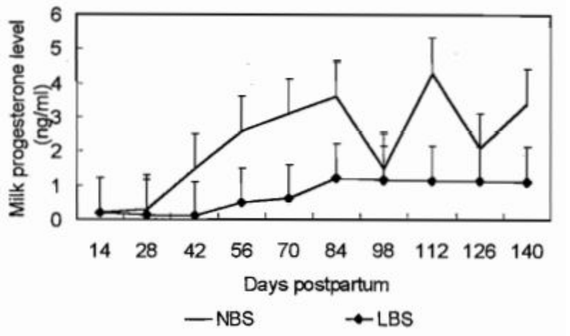


Figure 1. Milk progesterone levels at various postpartum intervals in normal (NBS) and low breeding season calvers (LBS) ($p<0.01$)

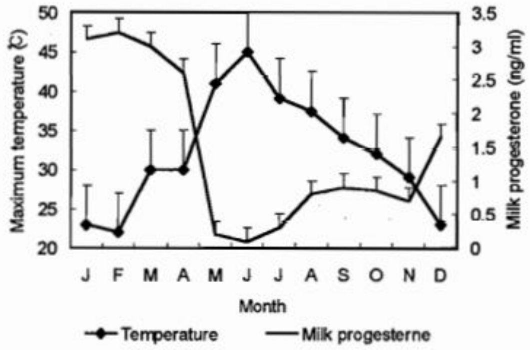


Figure 2. Annual maximum ambient temperature and milk progesterone concentration in buffaloes

Protein toxicity in perurban dairies

- Excess intake of crude protein, associated with increasing serum urea levels, may lead to delayed postpartum ovarian activity in Nili-Ravi buffaloes under field conditions (Qureshi et al, 2002).
- Low energy intake associated with poor body condition of buffaloes (BCS<2.75), may be a key factor for low reproductive efficiency in the animals.
- A very narrow ratio of CP/ME support estrous activities.
- Increasing milk production removes the toxic effects of excess intake of crude protein, resulting in higher levels of serum urea, an energy consuming process. Peri-urban uneducated farmers feed higher quantities of oil cakes with an intention to enhance milk yield.
- Improving the pre- and postpartum nutrition of such animals is likely to overcome the problem.

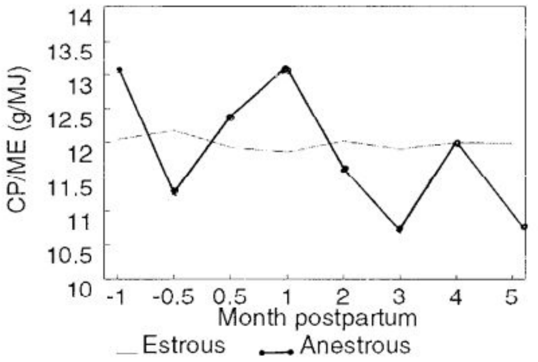


Figure 3. Ratio of crude protein/metabolizable energy intake (CP/ME) in estrous and anestrous buffaloes during various postpartum months (PMO)

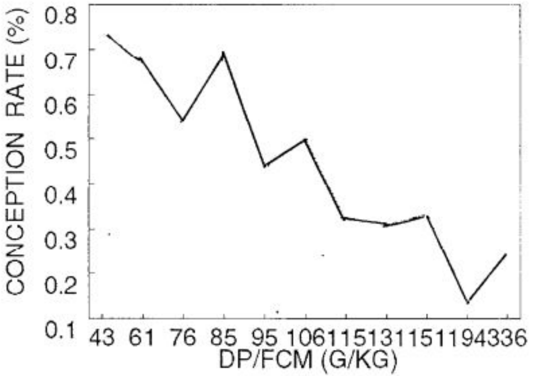
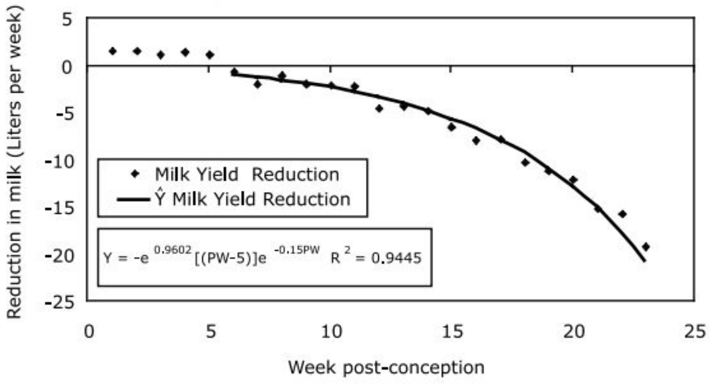


Figure 4. Relationship of degradable protein intake/4% fat-corrected milk production ratio (DP/FCM) with conception rate (CR%) in buffaloes

Pregnancy depresses milk yield in Dairy Buffaloes

- The buffaloes of India and Pakistan are dairy type; named River buffaloes by Macgregor (1939) but our group has used the word Dairy buffaloes (Qureshi, et al., 1999).
- China has introduced dairy characteristics in their swamp buffaloes through crossbreeding with dairy buffaloes form India and Pakistan (Borghese, 2006).
- Production of average fat corrected milk has been reported to be 15.31 and 13.55 kg/day in the normal and low breeding seasons (P<0.01; Qureshi, et al., 1999), ranging from 2 to 35 kg/day.
- This study (Qureshi et al, 2007) concluded that an earlier pregnancy in in drastic decline in milk yield at an earlier stage.
- The dairy buffaloes do not produce on their own cost and manifests an decline in milk yield with the onset of pregnancy.
- The buffaloes conceiving at an earlier stage of lactation were also good milk producer.

Figure 2. Change in milk yield with the advancement of pregnancy in dairy buffaloes at small-sized private farms.



Effect of suckling and use of exytoxin

- Suckling is commonly used as a stimulus for milk let down under conventional farming in the northwest frontier province (NWFP of Pakistan, while oxytocin is used for milk let down when a calf dies at a young age (Qureshi, 1995).
- A study (Qureshi et al, 2008) concluded that a lower reproductive efficiency of dairy buffaloes under the peri-urban farming system was reflected by ovarian cyclicity in 68.63% buffaloes within 150 days postpartum and silent estrus in 51.5% of the cases.
- Buffaloes needed a stronger premilking stimulation through suckling and use of oxytocin injections.
- Increasing suckling duration and use of oxytocin delays postpartum ovulation, however, POI is shortest in buffaloes suckled for one month.
- The high yielding buffaloes also manifested better reproductive cyclicity; while moderate yielder showed shorter ovulation intervals and higher conception rate

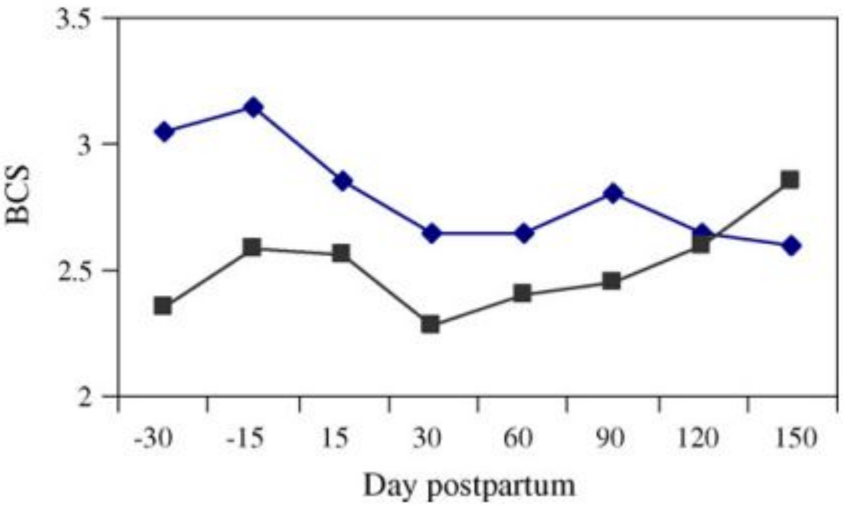


Fig. 1. Postpartum body condition score of estrous and anestrous buffaloes (not assuming estrus up to 15 days postpartum.)

Zinc as antioxidant in semen extenders

- There is a strong relationship between essential elements and spermatogenesis. Zinc (Zn) is found in high amount in male reproductive tract and semen (Chia et al. 2000).
- Our results (Hafez xxx) indicated that semen volume and sperm motility increased significantly ($p < 0.05$) in treated groups compared with control.
- In group 3, SOD and GPx concentration increased significantly ($p < 0.05$), without affecting AST and ALT concentration (Table 2)
- Based on the findings present results, it is suggested that zinc sulphate at the rate of 100 mg/buck/day was an optimum dose to improve semen volume, motility and seminal plasma antioxidants (SOD, GPx) in Beetal bucks.

Table 2. Mean ± SE seminal plasma enzyme concentration of control and treated male Beetal bucks

Parameters	Group 1	Group 2	Group 3	Group 4
SOD (per cent inhibition)	6.40 ± 0.24^{c}	7.40 ± 0.25^{b}	10.22 ± 0.11^{a}	7.65 ± 0.13^{b}
GPx (mU/ml)	10.22 ± 0.16^{d}	13.39 ± 0.90^{c}	22.15 ± 0.11^{a}	19.96 ± 1.13^{b}
AST (U/l)	70.14 ± 0.11	68.13 ± 0.06	65.68 ± 0.28	68.12 ± 0.01
ALT (U/l)	62.68 ± 0.08	69.63 ± 0.08	69.44 ± 0.09	68.96 ± 0.03

ALT, Alanine aminotransferase; AST, Aspartate aminotransferase; GPx, Glutathione peroxidase; SOD, Superoxide dismutase.
Group 1–4: Dietary supplementation of zinc at the rate of 0, 50, 100 and 200 mg/buck/day, respectively.
Mean value having different superscript within the same row differ significantly ($p < 0.05$).

Overcoming stress in crossbred cattle

- Heat stress occurs when heat production (the energy necessary for maintenance, production and reproduction) exceeds heat loss to the surrounding environment (Bernabucci et al., 2010).
- Holstein Frisian and crossbred cows showed favorable response (Khan et al, 2016) to vitamin E supplementation suggesting regular feeding of vitamin E to high producing dairy cows.
- Effect of heat stress on reproduction may be minimized through vitamin E supplementation as modulated by progesterone concentration and follicular dynamics in the present experiment.

Table II.- **Different stress and reproductive parameters (Mean±SE) from different dairy cattle breeds as affected by vitamin E supplementation (n=108).**

Breed	Treatment	Cortisol (ng/ml)	HSP-70 (ng/ml)	P_4 (ng/ml)	Follicle No
Sahiwal	Control	86.49±8.39 ^{cdef}	4.16±0.28 ^{ab}	3.89±0.42 ^{bcde}	1.55±0.24 ^{bc}
	E-20	75.51±8.17 ^{cdef}	2.98±0.40 ^{de}	3.95±0.55 ^{abcd}	1.22±0.14 ^{c}
	E-40	66.56±6.69 ^{f}	2.38±0.31 ^{e}	4.76±0.54 ^{a}	1.22±0.14 ^{c}
Achai	Control	98.52±13.45 ^{abcd}	4.08±0.54 ^{abc}	3.08±0.39 ^{cde}	1.44±0.17 ^{c}
	E-20	92.93±9.94 ^{bcdef}	2.97±0.48 ^{de}	4.28±0.42 ^{abc}	1.44±0.17 ^{c}
	E-40	68.91±8.30 ^{ef}	2.09±0.24 ^{e}	5.12±0.71 ^{a}	1.22±0.14 ^{c}
Cross-bred	Control	116.62±10.73 ^{ab}	4.48±0.30 ^{ab}	2.69±0.28 ^{e}	2.11±0.26 ^{ab}
	E-20	95.72±12.65 ^{abcd}	3.07±0.03 ^{cde}	3.18±0.83 ^{cde}	1.66±0.23 ^{abc}
	E-40	73.62±8.05 ^{def}	2.43±0.32 ^{e}	4.48±0.42 ^{ab}	1.33±0.16 ^{c}
Holstein-Friesian	Control	120.01±8.53 ^{a}	5.04±0.47 ^{a}	2.51±0.30 ^{e}	2.22±0.32 ^{a}
	E-20	100.79±8.83 ^{abc}	3.86±0.60 ^{bcd}	3.02±0.28 ^{de}	1.55±0.24 ^{bc}
	E-40	82.67±8.42 ^{cdef}	2.95±0.27 ^{de}	4.17±0.45 ^{abcd}	1.44±0.17 ^{c}
P- Value	Breed	0.011	0.025	0.034	< 0.05
	Vit-E	< 0.001	< 0.001	< 0.001	< 0.01
	Interaction	0.902	0.998	0.973	0.671

$^{a, b, c, d}$ means with different superscript with in the column are different significantly at p= 0.05
HSP-70, Heat Shock Protein-70; P_4 , Progesterone

Overcoming stress in sheep

- Heat stress is one of the major concerns of the livestock industry, which adversely affects their health and productivity.
- From the results of our study (Khan et al, 2017), it was concluded that vitamin E and Se at the present doses improved the physiological, hormonal and antioxidant status in Damani and Balkhi sheep. In addition, Damani sheep were more tolerant to heat stress than Balkhi sheep.

	Progesterone (ng/ml)	FSH (IU/l)	T3 (nmol/l)	T4 (nmol/l)
Breed				
Balkhi	2.38 ± 0.31	0.37 ± 0.02	1.46 ± 0.05	60.66 ± 1.38
Damani	3.18 ± 0.41	0.34 ± 0.02	1.75 ± 0.03	69.84 ± 0.91
P value	<0.11	<0.11	<0.01	<0.01
Group				
Treated	4.62 ± 0.19	0.36 ± 0.03	1.84 ± 0.02^{a}	70.83 ± 0.80^{a}
Control	3.95 ± 0.07	0.35 ± 9.53	1.38 ± 0.03^{b}	59.67 ± 1.19^{b}
P value	<0.01	0.45	<0.01	<0.01
Day				
Day 1	3.03 ± 0.37	0.48 ± 0.03	$1.55^{c} \pm 0.05$	$63.50^{b} \pm 1.77$
Day 14	3.02 ± 0.43	0.32 ± 0.01	$1.60^{b} \pm 0.06$	$66.02^{a} \pm 1.70$
Day 28	3.30 ± 0.51	0.27 ± 0.01	$1.67^{a} \pm 0.07$	$66.24^{a} \pm 1.82$
P value	<0.11	<0.31	<0.01	<0.01
Breed × group	<0.23	<0.64	<0.01	<0.01
Group × day	<0.34	<0.92	<0.01	<0.90
Breed × group × day	0.25	0.53	0.05	0.32

Mean values bearing different superscripts in a column differ significantly ($P < 0.05$)

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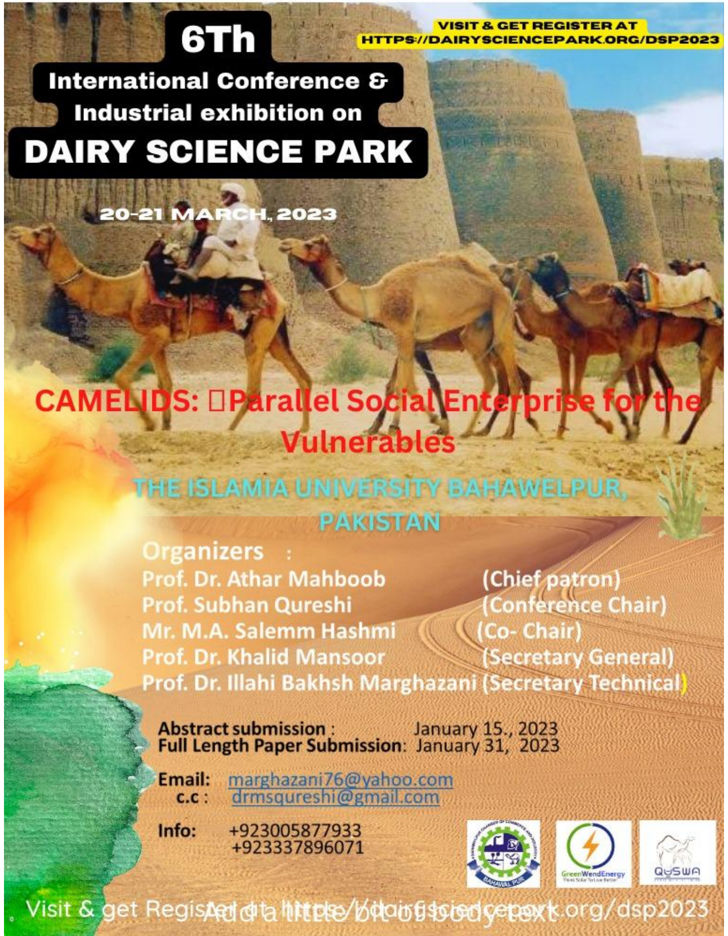

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