

Physiological and Performance Parameters of Changthangi Sheep in Response to Cold and Nutritional Stress

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Abstract

Physiological and performance parameters of 33 pregnant Changthangi sheep divided into three groups (G_1 , G_2 and G_3) of 11 each on the basis of body weight, age and parity was undertaken during winter months. Ewes of G_1 and G_2 were kept inside the closed shed all the time whereas the ewes of G_3 were kept in an open area which was chain-link fenced from four sides and was provided with a roof shelter to protect from direct rain or snow. G_1 and G_3 were fed 400g concentrate and 600g fodder per head per day as per ICAR feeding standard. Ewes of G_2 were given concentrate @ 500g and fodder @ 1000g per head per day. Environmental parameters (temperature, relative humidity and wind velocity) were recorded on a daily basis in animal houses and wind chill index was calculated using these parameters. Physiological parameters (rectal temperature, pulse rate and respiration rate) were recorded weekly in the morning. Fortnightly weight of ewes and monthly weight of lambs was recorded upto weaning. Extreme Wind Chill Index was observed throughout the study period in open house. Pulse rate of supplemented ewes with closed housing was significantly ($p < 0.05$) higher than G_1 and G_3 ewes while respiration rate and rectal temperature were significantly ($p < 0.05$) higher in group reared in open house. Significantly ($p < 0.05$) higher body weight of ewes, birth weight and weaning weight of lambs was obtained in the supplemented group G_2 than G_1 and G_3 ewes. Economic appraisal revealed a net gain of Rs. 3672.15 in the group reared in a closed shed and supplemented with extra feed and a loss of Rs. 593 in the group reared in open housing system than ewes reared in a closed shed without supplementation.

Introduction

Sheep farming forms an integral component for socio-economic upliftment of resource poor farmers in Jammu and Kashmir region of India. Many sheep breeds exist in this temperate region which provide for nutritional and livelihood security of more than 20% of the population which depend on this sector as a fulltime enterprise or as a subsidiary occupation. Tribals of this region undertake transhumance production system or semi-migratory production system of sheep rearing for securing their nutritional and economic demands. Winter in this part of the world is severe where temperature dips below minus and there is shortage of feeds and fodders during this period. This period coincides with the late gestation of the ewes wherein nutrition demand is more but the resource poor farmers rely on poor or meagre nutritional resources which adversely affects the performance of sheep and results in less economic gains. Many sheep breeds were introduced in this region for breed improvement programmes which resulted in better economic returns to the stakeholders. As a prelude to that Changthangi sheep breed known for its hardiness and thriving ability under harsh climatic conditions was introduced in temperate Himalayan Region of Kashmir valley for performance evaluation and breed improvement programme. Changthangi sheep is a breed of Changthang region, a cold arid region of Ladakh, reared by local Changpa tribe. This sheep and Changthangi goats are the sole source of income for the tribals who rear these animals under trans-humance production system. Marked differences exist in geo-climatic conditions of these two regions in terms of climate and availability of nutrition. Distinguishable wool follicles, staple length and other wool characteristics (Malik et al., 2021) of this breed makes it breed of

choice for R & D and reviving the sick woolen sector of this region and hence the socio-economic status of the stakeholders. No work has been conducted so far in temperate region of Kashmir valley (non-traditional belt) necessitated its evaluation for productive and reproductive performance under different housing and feeding interventions during winter months.

Material And Methods

The experiment was conducted at Mountain Research Centre for Sheep and Goat (MRCSG), Shuhama, Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir during the year 2019 for the winter months of January to March. The animals were reared under intensive system of housing during the experimental period.

Thirty three pregnant Changthangi ewes were selected for the experimental trial and divided into three groups of 11 each on the basis of body weight, age and parity. Ewes of G₁ and G₂ were kept inside the closed shed all the time whereas the ewes of G₃ were kept in an open area which was chain-link fenced from four sides and was provided with a roof shelter to protect from direct rain or snow. G₁ and G₃ were fed 400g concentrate and 600g fodder per head per day as per ICAR feeding standard. Ewes of G₂ were given concentrate @ 500g and fodder @ 1000g per head per day. Concentrate was provided in the form of commercial pelleted feed (89% DM, 20% CP, and 72% TDN) which was offered daily at 4:00 pm on the group basis. The trial was conducted for a period of 90 days. The following parameters were recorded during the experimental period.

Temperature (°C): Minimum and maximum temperature of the housing areas of animals was recorded using an automatic digital thermometer (TempTec).

Relative humidity (%): Minimum and maximum relative humidity of the housing areas of animals was recorded using a digital hygrometer (TempTec).

Wind chill index (°C) was calculated as per the formula devised by Swarnkar et al. (2018)

$$WCI (kcal/ m^2 /h) = (10\sqrt{v} - v + 10.5) \times (33 - Ta)$$

Where “v” is the wind velocity (m/sec) and “Ta” is air temperature (°C) and wind velocity was calculated using anemometer (Make: Nielsen-Kellerman).

Physiological parameters:

Rectal temperature (°C), Pulse rate (beats/min) and Respiratory rate (breaths/min) were recorded on weekly basis in the morning. Rectal temperature (°C) was recorded with a clinical thermometer by keeping the thermometer in contact of rectal mucosa for about 2 min. Respiration rate per minute of each animal was recorded by visual observations of inward and outward abdominal movement. Pulse rate per minute was recorded with the help of stethoscope.

Performance parameters

i. Body weight of dam

Body weight of the experimental animals was recorded every 15 days upto 90 days of the study period using an electronic weighing balance and expressed in kilograms. The animals were weighed in the morning before feeding and watering so as to avoid any possible variation.

ii. Birth weight of lambs:

The birth weight of lambs was recorded immediately after birth using electronic weighing balance.

iii. Weight gain:

Body weight of the lambs was recorded after every 30 days in subsequent months till weaning (90 days). All the recordings were taken in the morning using electronic weighing balance.

iv. Mortality and Morbidity

Any mortality or morbidity, if observed during the study period was duly recorded.

Economics:

Keeping all other factors constant, the economics of additional concentrate/fodder fed during the trial period was worked out on the basis of current market rates of the feed and the market value of the additional weight achieved by the experimental ewes/lambs. The cost of extra concentrate fed to the ewes during the experimental period was equated against the additional weight gain achieved by dams and their lambs at the end of the experiment period.

Statistical Analysis: Data generated was subjected to statistical analysis by the General Linear Model procedure of Statistical Package for the Social Sciences, Base 20.0 (SPSS Software products, Marketing Department, SPSS Inc. Chicago, USA).

Results And Discussion

The average environmental parameters recorded during the experimental trial are provided in Table 1.

Table 1: Environmental condition during the experimental period

Parameter	Open house	Closed house
Minimum Temperature (°C)	0.35	8.32
Maximum Temperature (°C)	8.11	11.38
Minimum relative humidity (%)	56.53	59.63
Maximum relative humidity (%)	82.90	76.41

Wind Chill Index (WCI)

The results have been presented in Table 2 and Figure 1. The minimum value of WCI was observed during week-10 while the maximum value was observed in week-1 in both open and closed housing systems. Swarnkar et al. (2018) classified WCI (kcal/m²/h) as no chill (<300.0), low (<300.1–350.0), moderate (350.1–400.0), high (400.1–450.0) and extreme (>450.1). Throughout the study period (January to March) extreme wind chill was observed in the open house while the animals seemed to be in the comfort zone in the closed house. In this study, though extreme wind chill was observed in the open houses but no detrimental effects were reflected in dams as well as lambs. Only one death each in open and closed house was reported. Changthangi sheep are native to cold climate and thus can tolerate wide extremes as depicted in the results.

Table 2: Wind Chill Index

Week	WCI (kcal/m ² /h) Open house		WCI(kcal/m ² /h) Closed house	
	At T _{min}	At T _{max}	At T _{min}	At T _{max}
	1	756.57±28.85	592.41±15.51	300.90±2.42
2	719.02±56.56	556.21±32.80	283.50±3.6	257.25±1.71
3	701.34±17.29	611.34±22.98	286.35±6.12	262.65±4.60
4	713.35±22.47	559.39±40.36	291.90±3.53	259.80±1.09
5	710.74±32.58	600.75±32.82	268.20±1.88	246.45±3.21
6	749.82±41.63	595.14±21.98	278.25±5.96	248.70±4.27
7	672.07±16.13	515.72±26.89	258.00±2.19	225.15±4.12
8	718.28±17.17	468.15±9.57	261.15±5.23	229.65±3.89
9	711.80±29.11	458.11±38.09	239.10±5.79	202.65±5.16
10	629.63±19.35	431.27±24.64	220.05±3.83	184.35±5.77

Animals try to cope up with the environmental stresses by physiological adjustments. For implications following physiological parameters were recorded on weekly basis during the entire trial period.

Pulse rate: The changes in pulse rate in experimental ewes during the trial period have been presented in Table 3 (a). In general marked variations were observed in all the groups but G₂ showed higher pulse rate (beats/min) during most of the weeks than other groups. It was concluded that the animals kept inside with extra nutrient supplementation had significantly ($P<0.05$) higher pulse rate than the animals kept outside the shed although it was within the normal range. Results similar to present findings have been reported earlier (Rathwa et al., 2017) in indigenous sheep. Results contrary to present findings have also been reported earlier in Indian goats (Banerjee et al., 2015), Malpura lambs (Maurya et al., 2013) and new born Merino lambs (Slee et al., 1991) wherein they reported higher pulse rate in the animals kept outside. Decrease in pulse rate in animals kept outside could be attributed to physiological response of ewes to conserve energy.

Table 3(a) Pulse rate (beats/min) of Changthangi ewes (Mean \pm SE)

WEEK	G1	G2	G3
1	73.09 \pm 3.7	82.77 \pm 5.3	75.33 \pm 2.11
2	73.31 \pm 2.62	76.66 \pm 2.77	69.33 \pm 3.31
3	69.42 \pm 1.47 ^b	57.42 \pm 4.99 ^a	64.66 \pm 2.92 ^{ab}
4	79.33 \pm 3.39 ^b	78.00 \pm 2.33 ^b	70.00 \pm 2.39 ^a
5	66.66 \pm 1.49	68.00 \pm 2.41	73.33 \pm 3.68
6	76.66 \pm 2.04 ^b	72.66 \pm 1.63 ^{ab}	69.33 \pm 1.76 ^a
7	70.33 \pm 1.53 ^a	71.33 \pm 1.13 ^a	81.33 \pm 4.09 ^b
8	68.00 \pm 0.76 ^a	77.33 \pm 1.67 ^c	72.66 \pm 2.04 ^b
9	80.00 \pm 3.0	84.00 \pm 3.00	84.33 \pm 3.79

Means with different superscript row wise differ significantly ($P<0.05$)

Respiratory rate

The changes in respiratory rate (breaths/min) in experimental ewes during the trial period have been presented in Table 3 (b). Overall, it was found that G₃ had significantly higher ($p<0.05$) respiration rate followed by G₁ and G₂ which implies that ewes reared in open house had higher respiration rates. Results similar to present findings have also been reported earlier in Indian goats and Malpura lambs (Banerjee et al., 2015 and Maurya et al., 2013) wherein they reported that animals in open house had higher respiratory rate than those provided protection against the cold weather. Exposure to cold leads to

increase in BMR thereby leading to an increase in the respiratory rate. Increase in respiration rate may be reaction of homoeothermic animals to cold stress by enhancing the thermoregulatory mechanism to avoid undesirable increase in rectal temperature as has been reported earlier (Maurya et al., 2013).

Table 3 (b) Respiratory rate (breaths/min) of Changthangi ewes (Mean ± SE)

WEEK	G1	G2	G3
1	24.7±1.27 ^a	23.33±0.60 ^a	29.66±1.15 ^b
2	27.33±0.99 ^b	23.21±0.63 ^a	26.66±1.03 ^b
3	23.28±1.77	27.14±1.39	24.16±1.06
4	26.33±0.68 ^b	22.66±0.94 ^a	25.33±1.39 ^{ab}
5	26.66±0.99 ^{ab}	29.0±0.88 ^b	25.83±0.85 ^a
6	35.0±3.94	28.0±0.93	35.33±3.25
7	32.66±0.99 ^b	30.66±1.58 ^{ab}	28.33±0.87 ^a
8	29.33±1.39	33.33±2.26	34.0±0.71
9	32.66±1.74	32.66±1.46	34.66±0.44

Means with different superscript row wise differ significantly (P<0.05)

Rectal temperature

The changes in rectal temperature (°F) in experimental ewes during the trial period have been presented in Table 4.6 (c). In general it was found that G₃ had higher values followed by G₁ and G₂. The rectal temperature (°F) varied throughout the study period but overall higher values were observed for the group kept outside or exposed to cold. Results similar to present findings have been reported earlier by Maurya et al. (2013) and Doubek et al.

(2003) in Malpura and Merino and Romney sheep wherein they reported that animals in open house had higher rectal temperature than those provided protection against the cold weather. Ekpe and Christopherson, (2000) concluded that both cold exposure lowered rectal temperature which is in contrast with present findings wherein animals housed outside with no supplementation had higher rectal temperature. Increase in rectal temperature might be as a result of activation of the thyrotropic axis together with shivering thermogenesis (Doubek et al., 2003). The hypothalamic-pituitary-thyroid (HPT) axis plays an essential role in the maintenance of metabolic homeostasis in response to alterations in metabolism and external environment. From the present study it can be concluded that Changthangi sheep are well adapted to climatic extremes and maintain homeostasis even under cold conditions.

Table 3(c) Rectal temperature (°F) of Changthangi ewes (Mean ± SE)

WEEK	G1	G2	G3
1	100.03±0.37 ^a	100.61±0.39 ^{ab}	101.61±0.15 ^b
2	98.73±0.54 ^a	100.23±0.75 ^b	100.91±0.29 ^b
3	98.31±0.35 ^a	98.71±0.3 ^a	100.93±0.27 ^b
4	101.69±0.24	101.61±0.25	101.86±0.25
5	102.30±0.12 ^b	102.43±0.16 ^b	101.33±0.18 ^a
6	102.23±0.24 ^b	101.20±0.15 ^a	102.56±0.22 ^b
7	103.13±0.13 ^b	102.10±0.21 ^b	101.73±0.12 ^a
8	102.76±0.09	102.80±0.10	103.0±0.08
9	102.33±0.21 ^b	100.13±0.55 ^a	101.80±0.19 ^b

Means with different superscript row wise differ significantly (P<0.05)

Performance parameters

Managerial interventions reflect in the overall performance of the animals. Since different managerial interventions were adopted in the present study, a regular assessment of performance parameters was made in order to evaluate their effects which are discussed under following headings.

Effect of managerial interventions on fortnightly dam weight

Results obtained have been presented in Table 4. Overall, higher body weight (Kg) was obtained in G₂ followed by G₁ and G₃. Results similar to present findings have been reported earlier (Maurya et al., 2004; Chaturvedi et al., 2003; Mohamed and Abdelatif, 2010) wherein ewes raised on supplementary feeding showed better performance in terms of weight gain. The experimental period coincided with the gestation period which is associated with foetal growth and hence increase in dam weight. Higher dam weight in supplemented group could be attributed to better nutrition and hence better dam and lamb performance.

Table 4: Body weight (kg) of Changthangi ewes (Mean± SE)

Means with different superscript row wise differ significantly (P<0.05)

Effect of managerial interventions on lamb weight

Results obtained have been presented in Table 5 (a). It was found that birth weight (Kg) of lambs born in G₂ (3.32 ±0.15) and G₃ (3.03±0.093) was significantly (p<0.05) higher than those of G₁ (2.48±0.08). At 90

Days	G1 (n=11)	G2 (n=11)	G3 (n=11)
0	27.58±1.03	27.66±1.09	27.68±0.97
15	28.29±0.75	30.30±0.71	28.11±0.82
30	29.54±0.82	30.63±1.06	28.44±0.92
45	30.83±0.87	32.56±1.18	30.02±1.16
60	32.56±1.17 ^{ab}	34.70±1.05 ^b	30.93±0.64 ^a
75	29.76±0.73 ^a	32.08±0.70 ^b	28.07±0.92 ^a

days of age, significantly ($P < 0.05$) higher body weight (Kg) was observed in G_2 (12.27 ± 0.45) than G_1 (10.15 ± 0.52) and G_3 (9.6 ± 0.54) lambs. It was concluded that the animals kept inside with extra nutrient supplementation had significantly ($P < 0.05$) higher birth and weaning weight. Chaturvedi et al. (2003) and Shah et al. (2012) reported that supplementation of extra concentrate in ewes during peri-partum period results in improvement in growth performance of their lambs in terms of body weight which is in agreement with the present findings. Higher

birth weight could be attributed to higher plan of nutrition in the dams resulting in enhanced foetal growth during prenatal period while better weaning weight could be because of higher milk production in supplemented ewes.

Table 5 (a) Body weight (kg) of Changthangi lambs (Mean ± SE)

DAYS	G1	G2	G3
0	N=11 2.48±0.08 ^a	N=11 3.32 ±0.15 ^b	N=11 3.03±0.093 ^b
30	N=10 6.54±0.38 ^a	N=11 8.28±0.34 ^b	N=10 6.36±0.30 ^a
60	N=10 7.90±0.50 ^a	N=11 9.8±0.49 ^b	N=10 7.53±0.25 ^a
90	N=10 10.15±0.52 ^a	N=11 12.27±0.45 ^b	N=10 9.6±0.54 ^a

Means with different superscript row wise differ significantly ($P < 0.05$)
Effect of managerial interventions on average daily gain

(ADG)

Results obtained have been presented in Table 5 (b). ADG was found to be significantly ($P < 0.05$) higher in G_2 (160g/day) than G_3 (110g/day) during the first month. Overall significantly ($P < 0.05$) higher average daily gain was attained in G_2 (90g/day) followed by G_1 (80g/day) and G_3 (70g/day) at the end of three months. Results similar to present findings have been reported earlier (Chaturvedi et al., 2003 and Shah et al., 2012). Due to faster growing rates, ADG was higher during the first month as compared to the following two months. Also, higher average daily gain (first month) in G_2 could be due to higher plan of nutrition in the dams resulting in better foetal growth during prenatal period whereas as better ADG during third month could be attributed to better pastures which in turn lead to higher milk production.

Table 5 (b): Average daily weight gain (kg/day) of Changthangi lambs (Mean ± SE)

DAYS	G1	G2	G3
0-30	0.13±0.01 ^{ab}	0.16±0.01 ^b	0.11±0.009 ^a
30-60	0.04±0.005	0.05±0.007	0.03±0.007
60-90	0.07±0.003	0.08±0.006	0.06±0.007
0-90	0.08±0.005 ^b	0.09±0.004 ^c	0.07±0.001 ^a

Means with different superscript row wise differ significantly (P<0.05)

Lamb morbidity and mortality

Results obtained have been presented in Table 5 (c). In the experimental groups all dams gave birth to apparently healthy lambs without any assistance. No case of stillbirth or dystocia was recorded. One mortality each in G₁ and G₃ was recorded during the first month wherein cause of the death was hypothermia. There was no mortality in G₂ wherein the animals were kept in closed shed and given extra supplementation.

Table 5(c): Lamb morbidity and mortality

Parameter		G1	G2	G3
Sample size		11	11	11
Birth type	Assisted	-	-	-
	Twin	-	-	-
Lamb mortality	Stillbirth/Dystocia	-	-	-
	Post-natal death	1	-	1
Overall mortality		9.0%	-	9.0%

Economics of feed supplementation during experimental period

The results obtained have been presented in Table 6. Present study revealed that the supplementation of ewes which were kept inside the sheds during the trial period resulted in enhanced performance which was also

reflected in the performance of their lambs. A net gain of Rs. 3672.15 was achieved in the group reared in a closed shed and supplemented with extra concentrate while a loss of Rs. 593 occurred in the group reared in open housing system with no supplementation. It can be concluded that the Changthangi ewes should be supplemented with better nutrition during prepartum period for better economic returns.

Table 6: Economics of feed supplementation

Groups	Expenditure				Income		
	Extra conc. fed (kg)	Cost of extra conc. (Rs.)	Extra fodder fed (kg)	Cost of extra fodder (Rs.)	Additional wt. achieved (lambs+ewes+extra lamb)	Gross income (Rs)	Net income (Rs)
G1	-	-	-	-	0	0	0
G2	9	180	36	576	16.71	4428.15	3672.15
G3	-	-	-	-	-2.24	-593	-593

Declarations

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

The authors confirm contribution to the paper as follows: conceptualization: Hilal Musadiq Khan; formal analysis: Anees Ahmad Shah, Asma Altaf Malik; Investigation: Asma Altaf Malik; Resources: Hilal Musadiq Khan, Zahoor Ahmad Pampori, Gowher Gull Sheikh; Supervision: Hilal Musadiq Khan; Writing-original manuscript preparation: Asma Altaf Malik; Writing - review and editing: Hilal Musadiq Khan, Anees Ahmad Shah. All authors reviewed the results and approved the final version of the manuscript. Niha Ayman helped in the experimental trial.

Data availability

All data generated or analysed during this study are included in these published articles.

<https://doi.org/10.1080/09291016.2014.984999> Taylor and Francis online

<https://doi.org/10.5713/ajas.2003.983> Animal bioscience

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<https://doi.org/10.1016/j.smallrumres.2021.106364> Elsevier

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Ethics approval

All applicable international, national and/or institutional guidelines for the care and use of animals were followed.

Consent to participate not applicable

Consent to publish not applicable

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Figures

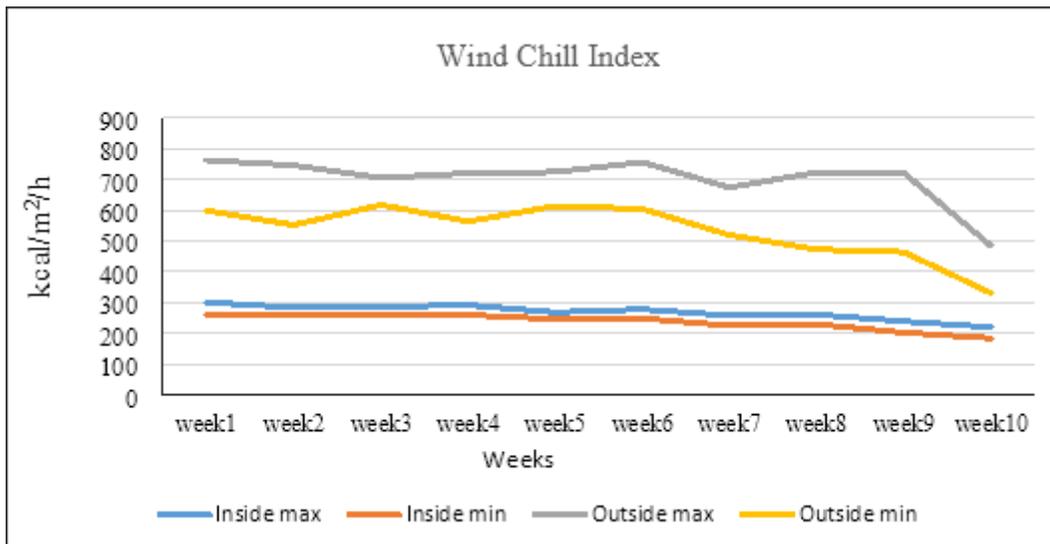


Figure 1

Wind Chill Index of animal houses