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Impact of space allowance on growth performance and physiological responses of Sirohi kids under intensive management system

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Abstract
The current study was conducted to investigate the impact of space allowance on growth performance and physiological parameter of Sirohi kids under different space allowance in intensive management system. Twenty four kids of Sirohi breed of either sex between the age group of 3 to 4 months were selected from the goat unit of LRS, Boujunda, Chittorgarh district of Rajasthan. These kids were randomly divided into four treatment groups comprising of six kids in each and kept under different space allowances.T1 group served as control ($0.8m^2$), T2 ($0.9m^2$), T3 of ($0.7m^2$) and T4 had a floor space of $0.6m^2$ / kid in covered area respectively. The feed and management practices for the kids in the all four treatment groups were the same. There was significant ($P<0.05$) effect of space allowance on body weight and average daily gain of sirohi kids. There was no statistical difference ($P>0.05$) in physiological parameters (rectal temperature, pulse rate and respiration rate) between treatment groups under varying space allowances.

Keywords: growth performance, space allowance physiological parameter, Sirohi kid

Introduction
After cattle and buffalo, the goat is the most important small ruminant species and the second largest species in the livestock category (148.88 million), contributing to milk production. It is a multipurpose animal that produces meat (chevon), milk, fibre, skin, hair (mohair and pashmina) and manure. The major sources of income from this breed are meat and milk production. Goat the most popular domestic species among India's small and marginal farmers for their livelihood as they are well adapted to all types of environmental severities and exhibit superior performance among the other domesticated ruminants. According to the 20thLivestock Census (2019) [1], goats are 27.80% of the total livestock population, showing an increase of 10.1% than the last census. Present goat population of India is 148.88 million. Rajasthan has a goat population of 20.84 million, accounting for 16 percent of India's total goat population. As a result of the gradual shift in goat rearing strategies from extensive to intense, housing has become one of the most important products. The main goal of animal housing is to create an environment that encourages high efficiency, health, production, comfort, and management ease. Space allowance is defined as the average area given per animal (Petherick, 2007 [17]; Petherick and Philips, 2009) [16]. Because of its economic importance, it is regarded as a distinguishing characteristic of all animal production systems. A goat kid (3-6 months) requires a minimum of $0.8m^2$ of floor space (BIS 2008) [4]. Only a small percentage of our farm animals are maintained scientifically at the time. The space allowance shows significant variation in social behavior of small ruminates which influence the performance of animals. (centoducati *et al*. 2015) [5]. Space impediment can have negative results on welfare and performance of animals. It has been observed that space restrictions are related with increased behavioral problems, aggression and reduction of the performance in animals (Averos *et al*. 2010 and Wechsler, 2011) [3, 23]. With an increase in space allowance, the most of the performance parameters such as body weight gain (BWG), average daily gain (ADG), feed conversion ratio (FCR) increase and the performance parameters are better in large space allowance (Thakur *et al*. 2016 and Mohammed 2014) [21, 11]. The floor space shows significant effect on performance parameter of kids and positively correlated with the growth performance of kids (Panda *et al*. 2016) [12]. The welfare of animal is highly influenced by stocking density and increasing physiological stress responses with closely associated with high stocking

density. The floor space had no significant effect on physiological parameter (rectal temperature, pulse rate and respiration rate) of Osmanabadi kids, kids are comfortable in spite of reducing floor space than the BIS requirement (Panda *et al.* 2015) [13].

Materials and methods

The experiment was carried out in goat unit of Livestock research station, Bojunda, Chittorgarh of Rajasthan University of Veterinary and Animal sciences, Bikaner. A total twenty-four kids of three month old of both sexes were chosen for research. The kids were separated into four groups [T1 (control), T2, T3, and T4], each including six kids, and the study lasted three months under intensive management system. The feed and management practices for the kids in all four treatment groups were the same, but the floor space in each group was varied. The space allowance for T1, T2, T3 and T4 of 0.8 m^2,0.9 m^2,0.7 m^2 and 0.6 m^2 /kid in covered area and 1.6m^2,1.8 m^2,1.4 m^2 and 1.2 m^2 /kid in open area respectively. Data on body weight, average daily gain and physiological parameters (rectal temperature, pulse rate and respiration rate) of kids were recorded at fortnightly intervals. The body weight of kids was recorded early in the morning, before offering feed, at fortnightly intervals by the help of digital weighing balance. Rectal temperature of each kid was recorded by inserting digital thermometer in rectum. Pulse rate of each kid was measured using the femoral artery on the inside of the rear leg roughly one-third of the way down the thigh with minimum disturbance to animal and respiration rate of each kids was measured by counting flank movement with the help of a stop watch at fortnightly intervals.

Statistical Analysis

Data pertaining to growth performance and physiological parameters (rectal temperature, pulse rate and respiration rate) were recorded in M.S. Excel and for analysis using SPSS software (IBM Corp. IBM SPSS Statistics for Windows, Version 17.0. Armonk, NY, USA). Comparison between means was analyzed through one-way ANOVA for growth performance and physiological parameters. Differences were considered to be statistically significant if probability value was less than 0.05. Significant (P<0.05) differences among variables were separated using Duncan's Multiple Range Test (Steel *et al*.1997) [20].

Results and Discussions

Body Weight (kg)

The overall body weight mean were 12.01± 0.68, 12.59±0.86, 11.30±0.60 and 11.12±0.57 kg for treatment group T1 (control), T2, T3 and T4 respectively (Table 1). Treatment group T2 had the highest overall body weight mean at fortnightly, followed by T1 (control), T3, and T4 treatment groups.

Table 1: Means ± SEM of fortnightly body weight (kg) of kids under four space allowances

Groups / Days	T1	T2	T3	T4
	6	6	6	6
0	9.44±0.02	9.53±0.02	9.49±0.02	9.49±0.02
15	10.11±0.03^{c}	10.45±0.05^{d}	9.69±0.04^{b}	9.53±0.07^{a}
30	10.83±0.5 ^{a}	11.35±0.05 ^{c}	10.40±0.08 ^{a}	10.21±0.01 ^{a}
45	11.80±0.06 ^{b}	12.56±0.07 ^{c}	11.07±0.06 ^{a}	10.90±0.09 ^{a}
60	12.81±0.04 ^{b}	13.76±0.07 ^{c}	11.91±0.07 ^{a}	11.74±0.08 ^{a}
75	13.53±0.04 ^{c}	14.74±0.04 ^{d}	12.79±0.05 ^{b}	12.50±0.11 ^{a}
90	14.58±0.07 ^{b}	15.75±0.10 ^{c}	13.76±0.06 ^{a}	13.50±0.12 ^{a}
Overall	12.01±0.68 ^{b}	12.59±0.86 ^{c}	11.30±0.60 ^{a}	11.12±0.57 ^{a}

* -Significant (P<0.05), ** - Significant (P<0.01), a, b, c, Means with different superscript within the columns differ significantly with each other

Highly Significant (P≤0.01) influence of space allowance in the present study on fortnightly body weight was similar to the findings reported by many researchers like (Fisher *et al.* 1997 in heifers, Jang *et al*. 2017 in pigs and Panda *et al.* 2016 in Osmanabadi kids) [6, 12, 8].

The results showed that kids reared on 0.6m^2 (T4) floor space had lowest body weight than kids reared on 0.9m^2 (T2), indicating that body weight is altered as space is reduced. It could possibly be because the T2 group (larger space) has a higher maintenance demand than the other groups.

Mohammed (2014) [11] in Egyptian balady goats and Thakur *et al*. (2016) [21] in Beetal kids also reported that body weight and body weight gain in larger space allowance was higher compared to small space allowance. These findings are also agreement with the results of present study.

Average daily gain (g/d)

The overall mean for average daily gain weight were observed as 57.02 ± 4.76, 68.51 ± 3.94, 51.36 ±4.72 and 47.39 ± 6.28 g for treatment group T1 (control), T2, T3 and T4 respectively (Table 2). The highest overall mean for average daily gain weight was observed in T2 followed by T1 (control), T3, and T4 treatment groups.

Table 2: Means ± SEM of fortnightly Average daily gain weight (g/d) of kids under four space allowances

Groups / Days	T1	T2	T3	T4
	6	6	6	6
0-15	43.77± 3.50^{c}	57.77±1.96^{d}	32.10±2.98^{b}	20.21±2.91^{a}
15-30	47.99±2.41^{a}	60.22± 1.54 ^{b}	51.99±6.25 ^{ab}	44.99±2.96 ^{a}
30-45	65.22±3.46 ^{b}	80.66±4.61 ^{c}	44.77±3.18 ^{a}	46.10±2.15^{a}
45-60	67.32±5.76 ^{ab}	79.66±7.22 ^{b}	55.99±2.12 ^{a}	55.88±3.46 ^{a}
60-75	47.88±5.67 ^{a}	65.33±5.13 ^{b}	58.43 ± 3.83 ^{ab}	50.99±3.34 ^{a}

75-90	69.99±2.25	67.46±6.11	64.88±5.53	66.21± 4.42
Overall	57.02± 4.76 [b]	68.51± 3.94 [c]	51.36± 4.72 [b]	47.39± 6.28 [a]

* -Significant (P<0.05), ** - Significant (P< 0.01), a, b, c, Means with different superscript within the columns differ significantly with each other

In the present findings space allowance showed significant ($P \leq 0.05$) effect on average daily gain weight at fortnightly intervals. Similar results were reported by many scientists like (Horten *et al.* 1991 in sheep, Fisher *et al*. 1997, Mellado *et al*. 2003 in goats, Panda *et al.* 2016 in goats) [7, 6, 10, 12] However, (Arehart *et al*.1969 in lambs, Zhang *et al*. 2009 in sheep, Vas *et al.* 2013 in goats) [2, 22, 24] reported that space allowance had no significant impact on average daily gain weight.

The current result is in line with the findings of Panda *et al*. (2016) [12] who revealed that large space allowance increased body weight gain of Osmanabadi goats at weekly intervals. Increased feed conversion efficiency could have resulted in a higher average daily gain weight in large space allowances.

Physiological parameters

Rectal temperature (°F)

The overall mean for rectal temperature were 102.66±0.14, 102.80±0.25, 103.26±0.17and 103.91±0.26 (°F) for treatment group T1 (control), T2, T3 and T4 respectively (Table 3). The numerically higher overall mean for rectal temperature was recorded for T4 followed by T3, T2 and control group T1.

Table 3: Means ± SEM of fortnightly rectal temperature (°F) of kids under four space allowances

Groups / Days	T1	T2	T3	T4
0	102.80± 0.13	103.00±0.15	102.95±0.10	103.00±0.08
15	102.48±0.17	102.61±0.21	102.55±0.31	103.01±0.01
30	101.88±0.30	102.35±0.24	102.95±0.12	103.85±0.03
45	103.01±0.25	103.00±0.29	103.66±0.07	103.93±0.03
60	102.76±0.23	102.91±0.29	103.70±0.10	104.18±0.04
75	102.70±0.21	102.66±0.25	103.38±0.25	104.56±0.04
90	103.00±0.10	103.10±0.34	103.68±0.04	104.85±0.02
Overall	102.66±0.14	102.80± 0.25	103.26±0.17	103.91±0.26

The data of table 3, clearly indicated that the rectal temperature was numerically higher but insignificant in T4 treatment group with smaller space allowance (0.6m^2) than in T3, T2 and T1 (control) groups. It clearly revealed that the experimental kids were not under stress in allotted space allowance.

The present finding were comparable with similar value for normal rectal temperature of goats were reported by Patil *et al.* (2008) [15], Kumari *et al*. (2013) [9] and panda *et al*. (2015) [13].

Panda *et al*. (2015) [13] reported that the floor space had no significant effect on rectal temperature of osmanabadi kids and kids was comfortable in spite of reducing floor space than the BIS requirement. This finding is in agreement with the results of present study.

Pulse rate (Beats per minute)

The overall mean for pulse rate were 84.04±0.25, 83.80±0.27, 84.02±0.39 and 83.90±0.30 (BMP) for treatment group T1 (control), T2, T3 and T4 respectively (Table 4). The numerically higher overall mean for pulse rate was recorded for T1 (control) followed by T3, T4 and T2 treatment groups.

Table 4: Means ± SEM of fortnightly pulse rate (BPM) of kids under four space allowances

Groups / Days	T1	T2	T3	T4
0	83.33±0.66	83.66±0.71	82.83±0.60	83.16±0.54
15	83.66±0.49	85.33±0.66	85.16±0.60	85.00±0.85
30	84.00±0.44	83.33±0.55	85.33±0.66	83.50±0.84
45	83.50±0.34	84.00±0.89	83.00±0.44	83.00±0.63
60	85.33±0.84	84.16±0.74	84.16±0.79	84.83±0.83
75	84.16±0.87	82.66±0.49	83.16±0.54	83.50±0.50
90	84.33±0.55	83.66±0.80	84.50±0.71	84.33±0.80
Overall	84.04±0.25	83.80±0.27	84.02±0.39	83.90±0.30

The data of table 4, indicated that the pulse rate was statistically insignificant but numerically higher in T1 control group with space allowance of 0.8m^2 and lowest in T2 treatment groups (0.9 m^2). It indicates that the experimental kids were under comfort zone.

Shastri and Thomas (2011) [18] investigated that normal pulse rate of goats ranged from 70-90/minute. The pulse rate recorded in kids reared on different floor space also reported to be in normal range.

Panda *et al*. (2015) [13] reported the floor space had no significant effect on rectal temperature of Osmanabadi kids and kids was comfortable in spite of reducing floor space than the BIS requirement. This finding is in agreement with the results of present study.

Respiration rate (Breath per minute)

The overall mean for respiration rate were 33.18±1.25, 33.23±1.00, 32.99±0.91 and 33.61±1.00 (BMP) for treatment group T1 (control), T2, T3 and T4 respectively (Table 5). The numerically higher respiration rate mean was recorded for T4 followed by T2, control group T1 and T3 treatment group.

Table 5: Means ± SEM of fortnightly respiration rate (BPM) of kids under four space allowances

Groups / Days	T1	T2	T3	T4
0	26±0.93	27.5±0.92	28±0.93	27.66±0.76
15	33.33±0.33	33±0.36	32.66±0.33	32.83±0.30
30	34.33±0.76	33.33±0.80	35±0.96	34.66±0.76
45	34.5±1.1	34.33±0.84	33±1.09	33.83±1.01
60	33.16±1.13	35.16±1.16	33.5±0.76	34.5±1.14
75	36.16±0.74	35±1.06	33.5±0.84	35.83±0.94
90	34.83±0.94	34.33±0.88	35.33±0.55	36.±0.81
Overall	33.18±1.25	33.23±1.00	32.99±0.91	33.61±1.00

The data of table 5, indicated that the respiration rate was statistically insignificant but numerically higher in T4 treatment group with space allowance of 0.6m^2 and lowest in T3 treatment groups (0.7 m^2). It indicates that the experimental kids were not under stress with varying space allowances.

In present study, similar results of normal range of goat respiration rate were reported by many scientists like Patil *et al.* (2008) [15] in Osmanabadi, Smith and David, (2009) [19], Sastry and Thomas (2011) [18] in goats, and Panda *et al.* (2015) [13] in Osmanabadi kids.

Conclusion

There was significant effect of space allowance on growth performance of Sirohi kids. The performance parameters viz, body weight and average daily gain was better in larger space allowance T2 (0.9m^2/kid) and control group T1(0.8m^2/kid) as compared to smaller space allowance T3(0.7 m^2 /kid) and T4 (0.6 m^2 /kid) treatment groups. There was no significant effect of space allowance observed on physiological parameters (rectal temperature, pulse rate and respiration rate) under different treatment groups. Thus, from the above results it can be concluded that there was direct effect of space allowance on growth performance of Sirohi kids. Hence, the floor space provided per kid was 0.9m^2 determined to be ideal. However, kids who are kept in a reduced space allowance of 0.6m^2 have a negative impact on their growth.

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