

*Original Research***Growth Performance of Sirohi Goats under Farm and Field Conditions in Southern Rajasthan****Hina Ashraf Waiz*, Lokesh Gautam, Rajendra Kumar Nagda and Mukesh Chand Sharma**

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Abstract

The body weight in a goat is an important parameter related to selection, feeding and health care. Thus present study was undertaken to assess the growth performance of Sirohi goats based on their morphometric measurements viz., heart girth, height at withers and body length at birth, three, six, nine and twelve months of age. Analysis of growth data of Sirohi goats reared under farm and field conditions for a period of 5 years revealed that the least square means of body weights at birth, three, six, nine and twelve months of age were 2.50 ± 0.39 , 11.21 ± 0.36 , 15.29 ± 0.41 , 18.00 ± 0.57 and 21.86 ± 0.77 kg respectively. The present results revealed that effect of sex, type of kidding, cluster and dam's weight at kidding significantly ($p < 0.01$) affected body weight and body measurements viz, heart girth, height at withers and body length at birth, three, six, nine and twelve months of age. Influence of season was highly significant ($p < 0.01$) on body weight and body measurements at 6 months of age. Significant ($p < 0.01$) effect of field cluster on body weight and body measurements was observed at birth, 3, 6, 9 and 12 months of age.

Key words: Body Measurement, Growth Performance, Morphological Traits, Semi-Arid Region, Sirohi Goat

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Introduction

Goat is an important species in the small ruminants and second largest species in livestock category which contributes in milk production after cattle and buffaloes. As per 19th livestock census (2012), goat forms about 26.40% of the total livestock population. Out of 135.04 million of indigenous goats, 26.97% are pure breed, 11.77% are graded breeds and remaining 61.26% are non-descript breeds. Goat is a household animal of Rajasthan. It plays an important role in livelihood of small and marginal farmers of Rajasthan

as a source of cash, meat and milk because it can affectively survive on available shrubs and trees in harsh environmental conditions all over the world (Khan *et al.*, 2006).

Rajasthan with its 57.7 million livestock population ranks second in the country and shares more than 11% of India's total livestock population (Animal Husbandry Department Rajasthan, 2016). The state ranks first with 16% share in total goat population of the country. Livestock contributes about 8% to the state GDP and Sirohi is the predominant goat breed of Rajasthan which accounts for 60% of Rajasthan's total goat population (Animal Husbandry Department Rajasthan, 2016). It is commonly found in arid and semi-arid region along the most parts of Aravalli hills of Rajasthan. The breed has predominantly brown coat, with light or dark brown patches and occasionally white in colour. Most Sirohi goats are wattled and have medium size flat leaf like dropping ears. The breed is also known by other names such as Parbatsari, Devgarhi and Ajmeri, reared mainly for meat and milk production. The breed weighs about 1.5-3kg at birth and reaches about 12kg when weaned at 3months. Average body weight of adult bucks and does are 50kg and 23kg respectively.

Body weight is an indicator of its physique and economic viability for marginal as well as landless farmers (Alemayehu *et al.*, 2010). However, this fundamental knowledge is often unavailable to those working with goats in the small scale farming sector, due to non availability of scales. The chief method of weighing animals without scales is to regress body weight on a certain number of body characteristics, which can be measured readily. Morphological measurements are used to assess several characteristics of animals. These measurements provide important evidences for the growth of the breed and the properties that change with environmental effects and feeding factors (Mule *et al.*, 2014). In addition, body measurements are important data sources in terms of reflecting the breed standards and are also important in giving information about the morphological structure and developmental ability of the animals. Morphological measurements differ according to the factors such as breed, gender, yield type and age. Live weight plays an important role in determining several characteristics of the farm animals especially the ones having economic importance. Morphological traits are also used for classifying goat breeds and suggested for the inclusion of linear dimensions in breeding programme of goats.

Material and Methods

The data pertaining to growth records at 3,6,9 and 12 months of age of Sirohikids born during 2013-2017 were collected from the farm and farmer's field maintained under All India Coordinated Research Project on Sirohi goats, Livestock Research Station (LRS), Vallabhnagar, Udaipur, Rajasthan. The study area is located in western part of India and situated at 582m above mean sea level (24°35' N and 73°43' E) characterized by semi-arid climatic conditions with undulated topography having an average rainfall of 660 mm annually. Similarly the temperature ranges from 2.3°C to 42.3°C. Breeding bucks properly

tagged were reared and maintained at LRS under AICRP, Vallabh Nagar during off breeding season and distributed amongst identified farmers during breeding seasons. The kids born out of such mating were tagged and their pedigree records were maintained at LRS, Vallabh Nagar. Animals were allowed to graze freely during day time and during night confined to sheds. Sorghum straw, tree leaves, straw of different pulses and grasses were fed to goats under farm conditions. Green and dry fodder was fed to goats by some goat keepers as per availability under field conditions. Goats were vaccinated against enterotoxaemia and Peste des petites ruminants. The data were recorded on the same day for body weight and body measurements viz. heart girth (HG), height at withers (HAW) and body length (BL). The records were taken from birth up to 12 months at the interval of 3 months of age. The collected data were classified according to sex, season of birth viz. monsoon, winter and summer. The type of kidding, cluster and dam's weight at kidding were also considered as source of variation.

Statistical Analysis

The data on growth traits was analyzed through mixed model least-squares and maximum likelihood method designed by Harvey (1990). To study the effect of sex, season and types of birth on body weights and morphological traits the following statistical model was as under-

$$Y_{ijkp} = \mu + A_i + B_j + C_k + b(DW_{ijk} - \overline{DW}) + e_{ijkp}$$

Where,

Y_{ijkp} = Performance record of the k^{th} sex of j^{th} types of birth belonging to i^{th} season of an individual

μ = Overall population mean

A_i = effect of i^{th} season of birth ($i = 1, 2, 3$)

B_j = Effect of j^{th} types of birth ($j = 1, 2$)

C_k = The effect of k^{th} sex of animal ($k = 1, 2$)

$b(DW_{ijk} - \overline{DW})$ = The regression of the traits on dam's weight at kidding

e_{ijkp} = Random error NID (0, σ^2)

Duncan's Multiple Range Test as modified by Kramer (1957) was used to make pair wise comparison among the least squares means.

Result and Discussion

The least-squares means and Analysis of variance for body weight and morphometric traits at birth, 3, 6, 9 and 12 months of ages of Sirohi goats are given in Table 1 to 5, respectively.

At Birth

The overall least-squares means for the birth weight and body measurements viz. heart girth (HG), height at withers (HAW) and body length (BL) were 2.50 ± 0.39 , 30.12 ± 0.33 , 30.65 ± 0.31 and 28.88 ± 0.48 , respectively (Table 1). The present means were comparable with the similar values for birth weight were

reported by Meel *et al.* (2010) in Sirohi goats, Mandal *et al.* (2010) and Bhusanet *et al.* (2012) in Jakhrana goats.

Table 1: Least square means for body weight and body measurements of Sirohi goats at birth

Effects	N	Body Weight (kg)	Body Measurements (cm)		
			Heart Girth	Height at Withers	Body Length
Overall	2683	2.50 ± 0.39	30.12±0.33	30.65±0.31	28.88±0.48
Sex			*** ** *		
Male	1359	2.67 ±0.04	30.49±0.33	31.11±0.31	29.28±0.48
Female	1324	2.33±0.04	29.75±0.33	30.19±0.31	28.48±0.48
Season			NS ** ** *		
Rainy	899	2.53±0.04	30.10±0.33 ^b	30.59±0.31	28.92±0.48
Winter	1371	2.49±0.04	29.95±0.33 ^c	30.45±0.31	29.0±0.48
Summer	413	2.49±0.04	30.31±0.34 ^a	30.90±0.32	28.72±0.48
Type of Kidding			*** ** *		
Single	1817	2.95±0.03	31.24±0.33	31.86±0.31	30.01±0.48
Multiple	866	2.06±0.03	29.0±0.33	29.44±0.32	27.75±0.48
Cluster			*** ** *		
Field	2276	2.38±0.04	31.27±0.33	31.86±0.32	28.02±0.48
Farm	407	2.62±0.04	28.97±0.34	29.44±0.33	29.74±0.49
Regression on dam's weight at kidding Regression coefficient (b) (kg/kg)		0.04±0.002**	0.20±0.01**	0.12±0.01**	0.16±0.01**

*Significant ($P<0.05$), ** Significant ($P<0.01$), NS-Non –significant, Means with different superscript within the columns differ significantly with each other.

Similar values for heart girth and height at withers were reported by Patil *et al.* (2008) in Osmanabadi goats and Fahim *et al.* 2013 in Rohilkhand local goats. For body length similar values were reported by Kharkar *et al.* (2014) in Berari goats, Sharma *et al.* (2008) and Dudhe *et al.* (2015) in Sirohi goats. Comparatively higher values for birth weight and body measurements were reported by Patil *et al.* (2013) in Sangamneri goats.

At 3 months of Age

The overall least-squares mean for body weight at 3 months was 11.21±0.36kg and for body measurements viz., heart girth (HG), height at withers (HAW) and body length (BL) were 49.40±0.56, 49.27±0.47 and 44.11±0.47 cm, respectively (Table 2). Similar values for body weight were reported by Tyagi *et al.* (2013) in Surti goats and Panda *et al.* (2016) in Osmanabadi goats. Higher body weight was reported by Dudhe *et al.* (2015) in Sirohi goats. However, comparatively lower body weight was observed by Bhusan *et al.* (2012) in Jakhrana kids and Bhagat *et al.* (2015) in Konkan kanyal goats. Similar values for heart girth and height at withers were reported in Sangamneri by Jagdale *et al.* (2012). However, values for HG and HAW were also reported by Dudhe *et al.* (2015) in Sirohi goat. For body length, similar values were reported by Pathodiya *et al.* (2004) in Sirohi goat. However, higher values were also reported by Dudhe *et al.* (2015) in Sirohi goats.

Table 2: Least square means for body weight and body measurements of Sirohi goats at 3 months of age

Effects	N	Body Weight (kg)	Body Measurements (cm)		
			Heart Girth	Height at Withers	Body Length
Overall	2273	11.21 ± 0.36	49.40±0.56	49.27±0.27	44.11±0.47
Sex		** ** *			
Male	1161	11.83±0.36	50.30±0.56	50.24±0.67	44.97±0.48
Female	1112	10.58±0.36	48.50±0.56	48.29±0.67	43.25±0.48
Season		** NS ** NS			
Rainy	822	10.91±0.37	49.31±0.57	49.14±0.67	44.1±0.49
Winter	1123	10.96±0.36	49.27±0.56	48.94±0.67	43.89±0.48
Summer	328	11.75±0.38	49.62±0.59	49.73±0.69	44.33±0.51
Type of kidding		** ** *			
Single	1551	11.89±0.36	50.36±0.56	50.30±0.66	44.96±0.47
Multiple	722	10.52±0.37	48.44±0.57	48.23±0.68	43.26±0.49
Cluster		** ** *			
Field	1940	13.03±0.37	51.80±0.57	52.09±0.68	45.64±0.49
Farm	333	9.39±0.38	46.99±0.60	46.45±0.71	42.58±0.53
Regression on dam's weight at kidding Regression coefficient (b) (kg/kg)		0.26±0.01**	0.29±0.02**	0.31±0.02**	0.30±0.25**

* Significant ($P < 0.05$), ** Significant ($P < 0.01$), NS-Non –significant, Means with different superscript within the columns differ significantly with each other

At 6 months of Age

The overall least-squares means for body weight and body measurements viz. heart girth (HG), height at withers (HAW), body length (BL) were 15.29±0.41 kg, 55.07±0.63, 54.21±0.86 and 48.70± 0.85cm, respectively (Table 3).

Table 3: Least square means for body weight and body measurements of Sirohi goats at 6 months of age

Effects	N	Body Weight (kg)	Body Measurements (cm)		
			Heart Girth	Height at Withers	Body Length
Overall	1444	15.29 ± 0.41	55.07±0.63	54.21±0.86	48.70±0.85
Sex		** ** *			
Male	712	16.28±0.64	56.34±0.64	55.49±0.87	49.92±0.85
Female	732	14.30±0.42	53.80±0.64	52.97±0.87	47.49±0.85
Season		** ** *			
Rainy	590	14.82±0.42	54.63±0.64	53.67±0.87	48.36±0.86
Winter	589	15.42±0.42	55.34±0.64	54.51±0.87	48.72±0.86
Summer	265	15.62±0.44	55.23±0.66	54.43±0.89	49.03±0.87
Type of kidding		** ** *			
Single	956	16.11±0.41	55.89±0.63	55.03±0.86	49.61±0.85
Multiple	488	14.46±0.43	54.25±0.65	53.39±0.88	47.80±0.86
Cluster		** ** *			
Field	1250	18.19±0.44	58.68±0.66	58.93±0.89	45.61±0.90
Farm	194	12.39±0.46	51.46±0.70	49.49±0.91	51.79±0.87
Regression on dam's weight at kidding Regression coefficient (b) (kg/kg)		0.18±0.02**	0.20±0.03**	0.15±0.03**	0.21±0.03**

*Significant ($P < 0.05$), ** Significant ($P < 0.01$), NS-Non –significant, Means with different superscript within the columns differ significantly with each other.

Similar values for body weight were reported by Swami *et al.*, (2006), Jagdale *et al.* (2012) and Bhakar *et al.* (2015) in Marwari, Sangamneri and Sirohi goats, respectively. Similarly, same results were reported by Alex *et al.* (2010) for heart girth and height at withers in Malabari goats, while Sharma *et al.* (2008) and Reotheia *et al.* (2013) in all the three morphometric traits in Sirohi and Bakerwali goats. However, Dudhe *et al.* (2015) reported higher values in Sirohi goats for body weight and all three morphometric traits.

At 9 months of Age

The overall least-squares means for body weight and body measurements viz. heart girth(HG), height at withers(HAW), body length (BL) were 18.0 ± 0.57 kg and 58.86 ± 0.88 , 57.89 ± 1.01 and 53 ± 1.07 cm, respectively (Table 4).

Table 4: Least square means for body weight and body measurements of Sirohi goats at 9 months of age

Effects	N	Body weight (kg)	Body Measurements (cm)		
			Heart Girth	Height at Withers	Body length
Overall	1034	18.00 ± 0.57	58.86 ± 0.88	57.89 ± 1.01	53.00 ± 1.07
Sex			*** **		
Male	468	19.13 ± 0.58	59.95 ± 0.88	58.88 ± 1.01	54.00 ± 1.07
Female	566	16.87 ± 0.58	57.76 ± 0.88	56.89 ± 1.01	52.01 ± 1.07
Season			** NS NS **		
Rainy	356	17.77 ± 0.58	58.93 ± 0.89	57.82 ± 1.02	52.96 ± 1.08
Winter	520	17.71 ± 0.58	58.91 ± 0.88	57.89 ± 1.02	52.65 ± 1.07
Summer	158	18.52 ± 0.60	58.73 ± 0.90	57.95 ± 1.03	53.39 ± 1.09
Type of kidding			*** **		
Single	729	18.94 ± 0.57	59.69 ± 0.88	58.77 ± 1.01	53.73 ± 1.07
Multiple	305	17.06 ± 0.59	58.03 ± 0.89	57.01 ± 1.02	52.28 ± 1.08
Cluster			** ** *		
Field	862	22.53 ± 0.60	63.02 ± 0.90	63.38 ± 1.03	56.21 ± 1.09
Farm	172	13.47 ± 0.63	54.69 ± 0.92	52.40 ± 1.05	49.79 ± 1.11
Regression on dam's weight at kidding Regression coefficient (b) (kg/kg)		$0.14 \pm 0.03^{**}$	$0.08 \pm 0.03^{**}$	$0.12 \pm 0.03^{**}$	$0.16 \pm 0.03^{**}$

* Significant ($P < 0.05$), ** Significant ($P < 0.01$), NS-Non –significant, Means with different superscript within the columns differ significantly with each other.

Similar values for body weight were reported by Roy *et al.* (1997) in Jamunapari goats and Jagdale *et al.* (2012) in Sangamneri goats. Comparatively higher values for body weight were reported in Sirohi by Bhakar *et al.* (2015). Jagdale *et al.* (2012) observed similar values for heart girth in Sangamneri goats and height at withers in Osmanabadi goats by Panda *et al.* (2016). However, comparatively higher values for all three body measurements were observed in Malabari and Sirohi goats (Alex *et al.*, 2010; Dude *et al.*, 2015).

At 12 months of Age

The overall least-squares means for body weight and body measurements viz. heart girth(HG), height at withers(HAW), body length (BL) were 21.86kg and 63.95± 0.99, 63.47 ±1.10 and 57.71 ±1.21cm, respectively (Table 5).

Table 5: Least square means for body weight and body measurements of Sirohi goats at 12 months of age

Effects	N	Body weight (kg)	Body measurements (cm)		
			Heart girth	Height at withers	Body length
Overall	722	21.86± 0.77	63.95±0.99	63.47±1.10	57.71±1.21
Sex			** ** *		
Male	247	23.46±0.79	65.22±1.0	64.65±1.10	58.96±1.22
Female	475	20.26±0.78	62.67±0.99	62.30±1.10	56.45±1.21
Season			** ** NS **		
Rainy	277	21.04±0.79	63.51±1.00	63.16±1.11	56.45±1.21
Winter	356	21.24±0.78	63.63±1.00	63.37±1.11	57.12±1.22
Summer	89	23.30±0.83	64.70±1.03	63.89±1.14	58.86±1.26
Type of kidding			** ** *		
Single	524	22.74±0.77	64.95±0.99	64.36±1.10	58.77±1.21
Multiple	198	20.98±0.80	62.94±1.01	62.59±1.12	56.65±1.23
Cluster			** ** *		
Field	605	26.81±0.81	67.35±1.02	67.21±1.13	60.01±1.24
Farm	117	16.90±0.85	60.54±1.05	59.73±1.16	55.41±1.27
Regression on dam's weight at kidding Regression coefficient (b) (kg/kg)		0.13±0.04**	0.09±0.04 ^{NS}	0.65±0.04 ^{NS}	0.15±0.04**

* Significant ($P < 0.05$), ** Significant ($P < 0.01$), NS-Non –significant, Means with different superscript within columns differ significantly with each other.

Similar values for body weight were reported by Bhusan *et al.* (2012) in Jakhrana kids and Patil *et al.* (2013) in Sangamneri goats. However, comparatively higher values for body weight were reported in Malabari goats and Surti kids (Alex *et al.*, 2010; Tyagi *et al.*, 2013) and Bhakar *et al.* (2015) in Sirohi goats. Comparatively higher values for all three body measurements were observed in Sirohi goats by Dudhe *et al.* (2015).

Effect of Sex

Sex of kid had highly significant effect ($P \leq 0.01$) on birth weight and all three morphometric traits at birth, 3, 6, 9 and 12 months of ages. However, male kids were heavier and larger as compared to their female contemporaries with regards to their body weight HG, HAW and BL at all the ages. These results was agreement with the finding of Dudhe *et al.* (2015), Pathodiya *et al.* (2004) reported highly significant ($P \leq 0.01$) effect on birth weight and all three morphometric traits in Sirohi kids. However, the non-significant effect of sex of kids on HG, HAW and BL on all ages was observed by Kharker *et al.* (2014), whereas Kharker *et al.* (2014) significant effect on height at wither at 12 months of age in Berari goats. Gohain *et al.* (2014) observed highly significant ($P \leq 0.01$) effect of sex of kid on all three

morphometric traits in Assam local goats. This was mainly due to anabolic effect of androgen which enhances the growth in male during pre- and post-weaning periods.

Effect of Season

Season had significant effect ($P \leq 0.01$) on body weight at 3, 6, 9 and 12 months of ages except birth weight. Similar results were close in agreement with the reports of Bhakar *et al.* (2015) in Sirohi goat. Influence of season birth was highly significant ($P \leq 0.01$) on all three morphometric traits at birth, 3 and 6 months of ages. However, highly significant ($P \leq 0.01$) effect was observed on BL at 9 and 12 months of ages and on HG at 12 months of age. Whereas, non-significant effects were observed on HAW at 9 and 12 months of ages and on HG at 9 months of age. Barhat *et al.* (2005) reported highly significant ($P \leq 0.01$) effect on all three morphometric traits in Marwari goats. Dudhe *et al.* (2015) reported highly significant on all three morphometric traits in Sirohi goats at 3 months of age. Summer born kids were heavier and larger as compared with winter and rainy season born kids during post weaning periods. This might be due to adequate biomass availability in grazing area and congenial environmental conditions. High parasitic infestation during rainy season made the kids vulnerable to various kinds of infections.

Effect of Types of Birth

The types of birth had highly significant effect ($P \leq 0.01$) on body weight and on all three morphometric traits at birth, 3, 6, 9 and 12 months of ages. These findings were in agreement to those of Dudheet *al.* (2015) for body weight and on all three morphometric traits at all stages of age and Tomar *et al.* (2001) for all three morphometric traits at birth, 3 and 6 months of ages in Sirohi goats. Sharma *et al.* (2010) reported highly significant effect ($P \leq 0.01$) of types of birth on all three morphometric traits at birth. However, non-significant effect of types of birth on HG, HAW and BL on all ages was observed by Kharkar *et al.* (2014). Single born kids were heavier and larger as compared with multiple born kids with regard to body weight and all three morphometric traits at all ages. This might be due to availability of more nutrients to the single born kid than those born in multiple births during pre and postnatal life and also single born kids get maximum uterine space than the multiple kids (Hafiz, 1962).

Effect of Cluster

Cluster had significant ($P \leq 0.01$) effect on body weight and all three morphometric traits at all ages. The present findings were in agreement with Dudhe *et al.* (2015_a 2015_b) in Sirohi goat. However, Sharma *et al.* (2010) observed highly significant ($P \leq 0.01$) effect of cluster on HAW and BL at birth and 3 months of age in Sirohi goats, HG at 3 month of age.

Field born kids were heavier and larger as compared to farm born kids at all growth phases. These differences in performances of kids between farm and field might be due to variation in grasses and

herbage availability. Moreover availability of grazing area and time under field conditions as the farmers pay more attention to small size flock. Labor component part play major role in performance at farm. Therefore, improvisation of performance of farm born kids would be possible by managerial intervention.

Dam's Weight at Regression

The linear regression on dam's weight at kidding were positive and significant ($P \leq 0.01$) for body weight and all three morphometric traits at birth, 3, 6 and on 9 months of age. However, significant ($P \leq 0.01$) effect also observed on 12 months body weight and body length. Dudhe *et al.* (2015_a) reported significant effect on 3, 6 and 12 months age body weight in Sirohi goat. However, Dudhe *et al.* (2015_b) also reported significant ($P \leq 0.01$) effect on HAW and BL at birth and 12 months of age and for HG at 12 months in Sirohi goat. Hence, Dudhe *et al.* (2015_b) observed significant ($P \leq 0.05$) effect for HG at birth. However, Kumar *et al.* (1992) reported non-significant effect of dam's weight at kidding on all morphometric traits at 6, 9 and 12 months of ages in Jamunapari goats.

The results suggested that heavy pregnant doe delivered heavier and larger kids. It also indicates that the milk yield is more in heavier dams as compared to lower weight dams and body weight gain in pre-weaning stage mainly depends on milk yield. Therefore, heavier kids at birth had better growth during subsequent ages.

Conclusion

The trends of these significant results revealed that the effect of sex, type of Kidding, cluster and dam's weight at kidding significantly affected body weight and body measurements viz. heart girth, height at withers and body length at birth, 3, 6, 9 and 12 months of ages. The highest body weight and body measurements were recorded in field cluster at all ages indicating that favorable environment and improvement in management practices leads to higher body weight and body measurement. However the effect of season on body weight and body measurements showed fluctuating performances on body weight and body measurements at birth, 3, 9 and 12 months of ages. Influence of season was highly significant on 6 months body weight and body measurements suggesting that selection of kids may be done on the basis of 6 months body weight and body measurements in order to obtain higher values of body weight and body measurements at later stages by providing optimum management and feeding to goats to obtain higher profit from goat rearing.

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