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Estimation of Growth Curve Parameters using Non-Linear Growth Curve Models in Sonadi Sheep

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ABSTRACT: The present investigation was undertaken to estimate the effect of different non-genetic factors affecting the growth performance traits of Sonadi sheep. The detailed information of 1396 Sonadi sheep regarding growth performance traits maintained over the period of 2019-2023 under the Mega Sheep Seed Project (ICAR) at College of Veterinary and Animal Science, Navania, Vallabhnagar, Udaipur district of Rajasthan was collected. The various growth performance traits like body weight, relative growth rate (RGR) and growth efficiency (GE) were studied and data's were classified into different groups (year of birth, season of birth, sex of animal and type of lambing) for different traits (BWT, 3WT, 6WT, 9WT, 12WT, 0-3, 3-6, 6-9, 9-12, 0-3, 3-6, 6-9, and 9-12) under investigation. Lambings were categorized into three seasons as monsoon, winter and summer lambing season. On the basis of year data was categorized into eight categories and coding from 1-8. The data related to gender of lamb was classified according to male and female and coded as 1 and 2, respectively while according to type of lambing, data was categorized into 2 categories i.e. single and twin and coded as 1 for single and 2 for twin. The data was analyzed using one two data set namely body weight and relative growth rate and growth efficiency. The effects of different non-genetic factors on the different body measurement were estimated through least square analysis method of Harvey (1990) software. The effects of different non-genetic factors on the growth performance were calculated from the general linear model.

Keywords: RGR Sheep Seed, Sonadi Sheep.

INTRODUCTION

The livelihood in rural India mainly depends on agriculture in the form of various land-based enterprises like crop farming. The constraints of low and irregular monsoon, lack of irrigation facilities etc. compelled the farmers of arid and semi-arid region to diversify from crop to livestock production to counter the risk of crop failure. Thus, livestock production is major activity of farmers in arid and semiarid region because livestock are more tolerant to harsh climatic conditions than crops. Large ruminant are less preferred by some of the community as well as landless and marginal farmers as it demands relatively large investment and higher maintenance cost.

Rearing of sheep and goat, which mainly depends on common property resources for meeting their feed and fodder requirements are a preferred option as self-employments by many rural resource poor.

Sheep (Ovis aries) rearing is an important source of income and occupation to the weaker strata of Indian society, because its multi-faceted value for fleece, meat, milk, skin compost. Further, it also possesses a special ability of thriving on natural grasses and except during certain physiological stages of life, do not need any supplemental feed. They are capable of living in all kind of environment and thrive well in hot and arid regions. Besides, they are also known for its adaptability to the harsh environment and potential for high meat production (Magotra *et al.,* 2023). In fact there is no substitute for sheep as a class of livestock for utilizing wasteland or weeds and residues from the field. No domestic or wild animal are capable of existing on more different sorts of food, weeds, grasses, shrubs, roots, cereals, leaves, barks and even in times of scarcity, fish and meat all furnish subsistence to this wonderful animal. Moreover, sheep is economical converter of grass in to meat and wool. Further, the structure of their lips helps them to clean grain lost at harvesting time, and thus convert waste feed in the profitable products. Sheep mutton is one kind of meat towards which there is no prejudice by any community in India and further, improvement in breeds for mutton production will have a great scope in the developing economy of India. The demand for meat and meat products is ever growing, owing to rise of per capita income in developing countries. Among the various

livestock products exported from India, more than 70% is contributed by meat and meat products.

India ranks 3rd in sheep population having a number of 74.26 Million (Livestock Census, and contributes for 13.8% of India's total livestock population. Total sheep population has increased by 14.13% over the previous Livestock Census (Tahtali *et al*., 2020). In all, 677.99 million kg meat contributed by sheep during 2018-2019 in the country. Moreover, India is largest exporters of sheep and goat meat to the world. The country has exported 14,128.85 metric tons of sheep and goat meat to the world, worth of Rs. 646.69 Crores during the year 2019-20. On the other hand, sheep also contributed 40.42 million kg wool during 2018-2019 in the country. This is mainly due to the fact that the average wool production per sheep per annum in India is considerably lower (0.5-1.5 kg) than world as whole (2.7 kg).

Rajasthan with 7.9 million of sheep population (Livestock Census) is the 4th largest sheep (10.63% of total sheep in India) rearing state of the India. out of India's total 44 enlisted sheep breeds Rajasthan has 8 well defined sheep breeds (Sonadi, Chokla, Magra, Pugal, Malpura, Nali, Marwari and Jaisalmeri) producing fine, medium and coarse wool. Moreover, the biggest wool mandi of Asia is located at Bikaner (Rajasthan). The western districts of the state are the home tract of quality wool production sheep breeds *viz*., Chokla, Nali, Magra and pugal in addition to coarse carpet quality wool *viz*., Marwari and Jaisalmeri. The southern and eastern districts of the state are home tract of Malpura and Sonadi breeds known for triple purpose i.e. milk, meat and wool production. It prevails in southern sub-humid zone comprising Udaipur, Chittorgarh, Rajsamand, Dungarpur, Banswara districts. It is generally reared under semi extensive system. It has the unique characteristic of golden fibre and survival on scarce fodder condition during drought. The fleece of Sonadi sheep is extremely coarse and hairy. Belly and legs are devoid of wool. Very little attention has been paid on the overall improvement of Sonadi sheep which has good potential for milk (1-1.5 kg/day), wool (0.5-1.2 kg/annum) and meat (13.72 kg at slaughter) production.

After availability of synthetic fine wool in the market, the demand of sheep reduces day by day due poor quality of wool. In the present scenario, the sheep is reared for meat and manure only. This indicated from the report who calculates the economics of sheep rearing in Sonadi breeding tract and observed that out of total income from sheep rearing maximum at 41.09% from sale of animals followed by 34.46 % from manure, 20.50% from sale of milk and minimum at 3.95% from sale of wool (Tailor and Gupta 2008).

Across the different breeds of sheep, the overall least-squares means of birth to weaning average daily gain (ADG1) ranged from 63.84±0.75 g/day in Mecheri sheep to 342.61±1.17 g/day in Romney sheep, 3 to 6 months average daily gain (ADG2) ranged from 38.32±1.78 g/day in Nilagiri sheep to 152.5 g/day in Mehraban sheep 6 to 9 months average daily gain (ADG3) ranged from 30.43±2.27 g/day in Nilagiri sheep to 46.69±0.74 g/day in Madras Red sheep and 9 to 12 months average daily gain (ADG4) ranged from 24.25±1.44 g/day in Karakul sheep to 53.55±2.08 g/day in Sirohi goat.

Table 1: Least-squares means of various average daily gain in sheep/goat.

Breed/Cross	ADG1	ADG2	ADG3	ADG4
Avikalin	126.52±0.65	72.90±0.72	-	-
Bharat Merino	138±01	77±01	-	-
Deccani	123.28±0.82	83.17±1.07	-	-
	97.22±1.71	45.28±0.85	-	-
Madras Red	87.35±1.03	47.89±1.24	31.71±1.33	25.61±1.67
	90.38±0.25	47.68±0.21	46.69±0.74	32.76±1.06
	69.99±0.23	44.56±0.23	32.60±0.55	33.11±0.14
Marwari	133.59±1.43	-	-	-
Mecheri	63.84±0.75	-	-	-
Muzaffarnagari	127.8±3.9	-	-	-
Raeini Cashmere	89.73	42.16	-	-
Sonadi	91.31±1.10	66.07±0.82	-	-

Effect of Non-genetic factors on Body Weight at different stages of age

Sampling design for data collection. Collection of data for present investigation, two stage stratified sampling design was adopted. Different zones/Tehsils within the districts were identified which constituted different strata. Villages within the stratum constitute the first unit and breeders/farmers within the village, the second unit.

For selection of tehsil within district, different strata were formed based on sheep population as per 20th livestock census. Details of different strata/Tehsil in Bhilwara district is depicted in Finally 2 strata were formed in Bhilwara districts based on sheep population. One tehsil in each stratum was randomly selected. Again for selection of villages within tehsil, four strata were formed based on sheep population in the village. Selected villages in tehsils and districts are depicted in Table 2. All the farmers having at least 15 sheep in selected villages were identified and registered for the purpose of collecting data on body weight and measurements. Finally, the data collected on 1376

animals maintained by 32 shepherds belongs to nine villages from two tehsils of Bhilwara district (Mokhtari *et al.*, 2019).

Classification of data. In order to study the effect of different factors, the data were classified accordingly. The factors included in the present study were Tehsils, Sex of lamb (male and female) and Breed (pure Sonadi and Crosses) .

Statistical Analysis

For young stock. The effect of different factors, *viz*., tehsils, sex of lamb and breed on the different body weight and measurement and growth rates for young stock were estimated through least- squares method (Harvey, 1990) using following mathematical model.

$Y_{ijkl} = \mu + T_i + S_j + B_k + e_{ijkl}$

Where,

Y_{ijkl} = body weight/ measurement/ growth rate of l^{th} lamb of k^{th} breed belongs to j^{th} sex and i^{th} tehsil

μ = overall population mean.

T_i= effect of i^{th} tehsil

S_j = effect of j^{th} sex of lamb

B_k = effect of b^{th} breed

e_{ijkl} = residual error, NID (0, σ^2)

For adult stock. The effect of different factors, *viz*., tehsils and breed on the different body weight and measurement and growth rates for adult animals were estimated through least- squares method (Bangar *et al*., 2020) using following mathematical model

$Y_{ijk} = \mu + T_i + B_j + e_{ijk}$

Where,

Y_{ijk} = body weight/ measurement/growth rate of k^{th} animal of j^{th} breed belongs to i^{th} tehsil

μ = overall population mean.

T_i = effect of i^{th} tehsil

B_j = effect of b^{th} breed

e_{ijk} = residual error, NID (0, σ^2)

Comparison of sub-means. Duncan's Multiple Range Test as modified by Anamika *et al*. (2019) used to make pair-wise comparison among the least-squares means

$$R_p = r_{\alpha\rho\gamma}\sqrt{\frac{MSE}{n}}$$

Where,

R_p = Least significant range for subsets of p sample mean.

$r_{\alpha\rho\gamma}$ = Duncun's Significant Range Value with parameter p (range-value), γ (MSE degree of freedom) and α (Significance level).

n = Sample size for each treatment.

Prediction of body weight. Prediction equations will be developed to study the predictive value of body conformation traits like body height, body length and heart girth to predict body weight at different stages of life using following regressions methods

Simple linear regression. The following model was fitted for i^{th} record

$$Y_j = a_{(i)} + b_j X_{(i)j} + e_{(i)j}$$

Where,

Y_j is the observed body weight of j^{th} animal, $a_{(i)}$ is the constant for i^{th} record, b_j is the regression coefficient of Y on X for the i^{th} record of the j^{th} animal and $e_{(i)j}$ is the residual random error associated with the i^{th} record of the j^{th} animal assumed NID (0, σ^2).

Multiple linear regression

$$Y_j = a_k + \sum_{i=1}^{k} b_{(i)} X_{(i)j} + e_{(i)j}$$

Step-wise regression equation

Where, and Step-wise regression- through Draper and Smith (1981) the efficiency of predictability by independent variable will be judged by the square of multiple correlation coefficients (R^2).

Overall least-squares means of body weight and conformation traits at birth. The overall least squares means along with standard error of body weight at birth was estimated as 3.22±0.044 kg in sheep maintained in Bhilwara district The results are in close agreement with in Malpura × Kheri sheep (3.47±0.01kg), Mane *et al.* (2014) in Deccani sheep (3.44±0.01 kg) and Sharma *et al.* (2019) in Sonadi sheep (3.07±0.02 kg). However, slightly lower birth weight in other breed Sof sheep were reported by as 2.88±0.01 kg in Malpura sheep,) as 2.88 kg in Nellore sheep, as 2.87±0.01 kg in Deccani sheep as 2.81±0.010 kg in Chokla sheep, while considerably lower body weight were observed as 2.05±0.59 kg by in Sonadi sheep and 2.24±0.01 kg by in Mecheri sheep.

The least squares means for body length, height at withers and heart girth were 32.88±0.290, 36.97±0.367 and 34.55±0.365 cm, respectively

Table 2: Mean, SD, SE and CV of body weight and conformation traits of adult pregnant sheep.

FIRST PARITY

Traits	Mean		SD	SE	CV%
Body Length	65.92		4.70	4.37	6.63 √ H
Height at wither	66.54		3.24	3.21	4.83
Heart girth	69.37		4.22	3.28	4.72 √ L
Body weight	29.21		3.95	3.53	12.08 √ L

SECOND PARITY

Traits	Mean	SD	SE	CV%
Body Length	67.22	3.48	3.25	4.83
Height at wither	66.61	3.10	3.00	4.50 √ L
Heart girth	70.60	4.43	3.87	5.48
Body weight	30.37	4.41	4.01	13.21 √ H

THIRD PARITY

Traits	Mean	SD	SE	CV%
Body Length	67.69	3.53	3.47	5.12
Height at wither	67.16	3.67	3.62	5.39 √ H
Heart girth	71.04	4.44	3.99	5.61 √ H
Body weight	30.65	4.05	3.75	12.24

FOURTH PARITY

Traits	Mean	SD	SE	CV%
Body Length	67.77	3.86	3.82	5.64
Height at wither	66.79	3.59	3.59	5.38 √ L
Heart girth	71.27	3.97	3.70	5.20
Body weight	30.99	4.08	3.97	12.81

FIFTH PARITY

Traits	Mean	SD	SE	CV%
Body Length	68.40	3.13	2.99	4.37 √ L
Hieght at wither	67.15	3.42	3.37	5.02
Heart girth	72.10	3.94	3.67	5.10
Body weight	31.89	4.43	3.86	12.11

Overall least-squares means of body weight and conformation traits at 3 months of age. The overall least-squares means along with standard error of body weight at 3 month was estimated as 10.90±0.048 kg Similar body weight at 3 months was also reported as 10.33±0.11 kg in Malpura × Kheri sheep and as 10.67±0.21 kg in Sonadi sheep. However, lower body weight at 3 months of age were reported in Madras red sheep as 9.64±0.030 kg 9.69±0.028 kg by Meena *et al.* (2019).

The least squares mean for body length, height at withers and chest girth were 46.97±0.144, 49.16±0.139 and 47.12±0.136 cm, respectively (Table 3).

Overall least-squares means of body weight and conformation trait at 6 month of age. The overall least square mean along with standard error of body weight at 6 months was estimated as 15.84±0.088 kg (Table 4). Similar body weight was also reported by as 14.34±0.035 kg and 14.80±0.02 kg respectively in Madras red sheep. However, lower 6 months body weight than that observed in the present study was reported as 11.37±0.11 kg by for Mecheri sheep. While higher estimate of 6 months' body weight was reported as 23.94±0.190 kg by for Madgyal sheep, 22.14±0.17 kg by for Magra sheep, 22.04±0.13 kg by Mahala *et al.* (2019) for Deccani sheep.

The overall least squares- means along with standard error of body weight, body length, height at withers and heart girth of adult non pregnant sheep of second parity were estimated as 29.84±0.136 kg, 66.98±0.148 cm, 66.71±0.126 cm and 70.56±0.141 cm, Khadda *et al.* (2019) respectively in sheep maintained in Bhilwara district (Table 5).

The overall least squares- means along with standard error of body weight, body length, height at withers and heart girth of adult non pregnant sheep of third parity were estimated as 29.38±0.164 kg, 66.53±0.172 cm, 66.30±0.150 cm and 69.98±0.181 cm, respectively in sheep maintained in Bhilwara district (Table 6).

Table 3: Least-squares means of body weight and body conformation traits at birth.

Effects	Body length		Height at withers		Heart girth		Body weight	
	N	Mean±SE	N	Mean±SE	N	Mean±SE	N	Mean±SE
µ	196	32.88± 0.290	196	36.97± 0.367	196	34.55± 0.365	196	3.22± 0.044
Tehsils								
T1	125	31.82± 0.350	125	33.77± 0.443	125	33.62± 0.441	125	3.20± 0.053
T2	71	33.93± 0.460	71	40.18± 0.583	71	35.49± 0.580	71	3.24± 0.070
Sex								
Male	83	32.53± 0.430	83	37.06± 0.544	83	33.80± 0.541	83	3.25± 0.065
Female	113	33.22± 0.375	113	36.88± 0.475	113	35.31± 0.473	113	3.19± 0.057
Breed								
Sonadi	100	32.34± 0.398	100	36.52± 0.504	100	33.48± 0.501	100	3.29± 0.061
Crosses	96	33.41± 0.405	96	37.43± 0.512	96	35.63± 0.510	96	3.14± 0.061

Table 4: Least-squares means of body weight and body conformation traits at 3 months of age.

Effects	Body length		Height at withers		Heart girth		Body weight	
	N	Mean±SE	N	Mean±SE	N	Mean±SE	N	Mean±SE
µ	580	46.97± 0.144	580	49.16± 0.139	580	47.12±0.136	580	10.90± 0.048
Tehsils								
T1	283	46.01± 0.206	283	47.65± 0.198	283	47.36± 0.195	283	10.66± 0.069
T2	297	47.94± 0.198	297	50.68± 0.191	297	46.88± 0.188	297	11.13± 0.067
Sex								
Male	234	47.01± 0.223	234	49.32± 0.215	234	46.97± 0.211	234	10.92± 0.075
Female	346	46.94± 0.183	346	49.01± 0.176	346	47.26± 0.173	346	10.87± 0.062
Breed								
Sonadi	294	46.85± 0.201	294	49.21± 0.194	294	47.24± 0.191	294	10.85± 0.068
Crosses	286	47.10± 0.202	286	49.12± 0.195	286	47.00± 0.191	286	10.94± 0 068

Table 5: East-Squares means for body weight and body conformation traits non-pregnant sheep of first parity.

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Effects	**N**	**Mean±SE**			
		Body Length	**Height at wither**	**Heart girth**	**Body weight**
µ	1326	66.34±0.151	66.27±0.114	69.13±0.123	28.14±0.117
Tehsil	499	67.49±0.219^{a}	66.39±0.166^{a}	70.25 ±0.177^{a}	28.41±0.169^{a}
Tehsil	827	65.19±0.188^{a}	66.16±0.142^{a}	68.02 ±0.153^{b}	27.88 ±0.145^{b}
Sonadi sheep	676	66.47±0.191^{a}	66.28±0.145^{a}	68.85±0.155^{b}	28.03±0.147^{a}
Cross bred sheep	650	66.22±0.197^{a}	66.27±0.149^{a}	69.41±0.160^{a}	28.25±0.152^{a}
Month-0	152	65.37±0.363^{a}	66.27±0.275^{a}	68.43±0.293^{ab}	26.70±0.279^{b}
Month-1	145	66.01±0.374^{a}	66.31±0.283^{a}	68.39±0.303^{ab}	26.34±0.288^{b}
Month-2	115	66.24±0.421^{a}	66.30±0.319^{a}	67.74±0.341^{b}	26.42 ±0.324^{b}
Month-3	109	65.94±0.433^{a}	66.45±0.328^{a}	67.31 ±0.351^{b}	26.19±0.334^{b}
Month-4	94	66.48±0.465^{a}	66.46±0.352^{a}	67.63±0.376^{b}	26.22±0.358^{b}
Month-5	89	66.44±0.476^{a}	66.20±0.361^{a}	67.34 ±0.385^{b}	26.31±0.367^{b}
Month-6	80	66.37±0.503^{a}	66.28±0.381^{a}	67.64 ±0.407^{b}	26.99 ±0.388^{b}
Month-7	73	66.47±0.526^{a}	66.52±0.398^{a}	68.87±0.426^{ab}	28.51±0.406^{ab}
Month-8	70	66.55±0.537^{a}	66.43±0.407^{a}	69.74±0.434^{ab}	29.66±0.413^{a}
Month-9	61	66.14±0.573^{a}	66.32±0.434^{a}	70.13±0.463^{a}	30.33 ±0.441^{a}
Month-10	47	65.91±0.651^{a}	66.52±0.493^{a}	70.94±0.526^{a}	31.20 ±0.501^{a}
Month-11	15	66.72±1.152^{a}	65.81±0.873^{a}	69.16±0.932^{a}	29.75 ±0.887^{a}
Month-12	42	66.92±0.689^{a}	66.15±0.522^{a}	70.40 ±0.557^{a}	28.94±0.530^{ab}
Month-13	36	67.11±0.745^{a}	66.45±0.565^{a}	71.22±0.603^{a}	29.25±0.573^{a}
Month-14	30	66.43±0.818^{a}	65.89±0.619^{a}	70.68±0.661^{a}	28.59±0.629^{a}
Month-15	168	66.36±0.349^{a}	66.08±0.265^{a}	70.46±0.282^{a}	28.88±0.269^{ab}

Table 6: Least-Squares means for body weight and body conformation traits non-pregnant sheep of second parity.

Effects	**N**	**Mean±SE**			
		Body Length	**Hieght at wither**	**Heart girth**	**Body weight**
µ	1309	66.98±0.148	66.71±0.126	70.56±0.141	29.84±0.136
Tehsil	672	68.13±0.172^{a}	66.90±0.146^{a}	72.22±0.1634^{a}	30.82±0.157^{a}
Tehsil	637	65.84±0.198^{b}	66.52±0.168^{a}	68.91 ±0.187^{b}	28.86±0.180^{b}
Sonadi sheep	611	66.52±0.189^{b}	66.15±0.161^{b}	70.44±0.179^{b}	30.10±0.172^{b}
Cross bred sheep	698	67.44±0.176^{a}	67.27±0.149^{a}	70.69±0.167^{a}	29.58±0.161^{a}
Month-0	167	66.68±0.295^{b}	66.85±0.251^{a}	70.02±0.280^{a}	28.70±0.269^{b}
Month-1	163	67.07±0.298^{ab}	66.96±0.253^{a}	69.81±0.283^{b}	28.48±0.272^{b}
Month-2	130	66.82±0.333^{b}	66.90±0.283^{a}	69.13±0.316^{b}	28.48±0.304^{b}
Month-3	133	66.86±0.330^{b}	66.67±0.280^{a}	69.13±0.313^{b}	28.35±0.301^{b}
Month-4	107	66.52±0.367^{b}	66.51±0.312^{a}	68.64±0.349^{b}	27.62±0.335^{b}
Month-5	96	66.51±0.388^{b}	66.36±0.329^{a}	68.82±0.368^{b}	27.86±0.354^{b}
Month-6	87	66.30±0.407^{b}	66.74±0.346^{a}	69.54±0.386^{ab}	28.41±0.371^{b}
Month-7	81	66.58±0.422^{b}	66.62±0.358^{a}	70.33±0.400^{a}	29.83±0.385^{a}
Month-8	75	66.80±0.438^{b}	66.76±0.372^{a}	71.12±0.417^{a}	30.94±0.401^{a}
Month-9	62	66.70±0.482^{b}	66.09±0.410^{a}	71.37±0.458^{a}	31.24±0.441^{a}
Month-10	35	66.34±0.642^{b}	66.32±0.545^{a}	71.58±0.610^{a}	30.81±0.587^{a}
Month-11	9	65.09±1.268^{b}	65.83±1.077^{a}	71.06±1.204^{a}	29.93±1.157^{ab}
Month-12	28	67.64±0.722^{ab}	67.23±0.613^{a}	72.34±0.685^{a}	30.86±0.659^{a}
Month-13	21	68.10±0.834^{a}	66.85±0.709^{a}	71.91±0.792^{a}	31.75±0.762^{a}
Month-14	21	68.64±0.833^{a}	67.12±0.707^{a}	72.46±0.791^{a}	32.01±0.760^{a}
Month-15	94	69.05±0.406^{a}	67.54±0.344^{a}	71.76±0.385^{a}	32.12±0.370^{a}

CONCLUSIONS

To determine the impact of various non-genetic factors impacting the growth performance features of Sonadi sheep, the current inquiry, named "Studies on growth performance traits of Sonadi sheep at farm condition", was conducted. The comprehensive data on 1396 Sonadi sheep's growth performance attributes was kept between 2019 and 2023 as part of the Mega Sheep Seed Project (ICAR) at the College of Veterinary and Animal Sciences in Navania, Vallabhnagar, Udaipur (Rajasthan).

The present experiment was conducted to study the growth performance of Sonadi sheep in terms of body weights, relative growth rate and growth efficiency along with the study of effect of non-genetic factors on growth related traits of Sonadi sheep at an organized farm. The various growth performance traits like body weight, relative growth rate (RGR) and growth efficiency (GE) were studied after that data was classified into different groups (year of birth, season of

birth, sex of animal and type of lambing) for different traits i.e., BWT, 3WT, 6WT, 9WT, 12WT, RGR1 (0-3), RGR2 (3-6), RGR3 (6-9), RGR4 (9-12), GE1 (0-3), GE2 (3-6), GE3 (6-9), and GE4 (9-12) under investigation.

REFERENCES

Anamika, C. D., Azhar, P. M., Kumar, H., Taggar, R. K., Kumar, D., Mahajan, V., Gupta, P. and Kumar, N. (2019). Non-genetic factors affecting growth rate traits in Rambouillet sheep. *Veterinary Research International*, *7*(2), 84-87.

Bangar, Y. C., Magotra, A. and Yadav, A. S. (2020). Estimates of covariance components and genetic parameters for growth, average daily gain and Kleiber ratio in Harnali sheep. *Tropical Animal Health and Production, 52*, 2291–2296.

Harvey, A. C. (1990). *The econometric analysis of time series*. Mit Press.

Khadda, B. S., Singh, B., Singh, D. V., Singh, S. K., & Singh, C. B. (2019). Factors affecting relative growth rate of Pantja kids under field conditions. *Indian Journal of Small Ruminants (The)*, *25*(1), 37-40.

Mahala, S., Saini, S., Kumar, A., Prince, L. L. L., & Gowane, G. R. (2019). Effect of non-genetic factors on growth traits of Avikalin sheep. *Small Ruminant Research*, *174*, 47-52.

Magotra, A., Bangar, Y. C., & Yadav, A. S. (2023). Modelling the growth curve and estimation of associated genetic parameters in Munjal sheep. *Tropical Animal Health and Production*, *55*(3), 205.

Mane, P. M., Pachpute, S. T. and Nimase, R. G. (2014). Growth and reproductive performance of Deccani sheep in an organised farm. *Indian Journal of Small Ruminants*, *20*(2), 23-27.

Meena, R., Sharma, P. C., Khichar, S., Bhat, K. K. and Meena, S. K. (2019). Impact of Non-Genetic Factors on Growth Traits in Sonadi Sheep. *Int. J. Curr. Microbiol. App. Sci.*, *8*(04), 1289-1292.

Mokhtari, M. S., Razmkabir, M., Ghiasi, H., & Mohammadi, Y. (2019). Genetic evaluation of growth rate and efficiency related traits in Raeini Cashmere Goat. *Iranian Journal of Applied Animal Science*, *9*(2), 275-282.

Sharma, P. C., Khichar, S., Bhat, K. K. and Meena, S. K. (2019). Impact of non-genetic factors on growth traits in sonadi sheep. *International Journal of Current Microbiology and Applied Sciences*, *8*(4), 1289-1292.

Smith, L. C. (1981). Citation analysis.

Tahtali, Y., Sahin, M., & Bayyurt, L. (2020). Comparison of different growth curve models in Romanov lambs. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi.*, *26*(5).

Tailor and Gupta (2008). Factors affecting post-weaning average daily gain and kleiber ratio in Muzaffarnagari sheep. *Indian Journal of Small Ruminants (The)*, *25*(2), 148-150.

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