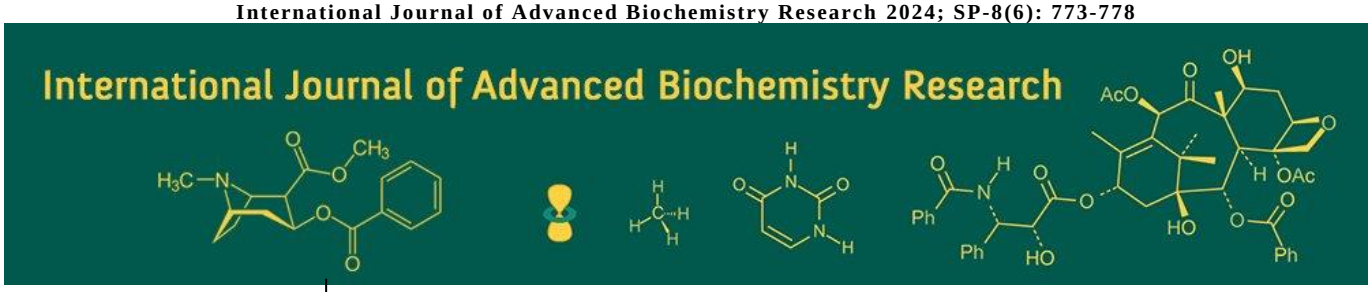

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Impact of non-genetic factors on Sonadi sheep body weight

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Abstract
The present study was conducted to assess the effect of non-genetic factors on body weight of Sonadi sheep of different age. In this study data on 1396 Sonadi sheep maintained over the period of 2012-2019 under the Mega Sheep Seed Project, College of Veterinary and Animal Science, Navania, Vallabhnagar, Rajasthan were analysed to assess the effect of non-genetic factors (year of birth, season of birth, sex, type of birth,) on body weight at birth, 3, 6, 9 and 12 months age. The overall least-squares mean along with standard error for of body weight were observed as 2.82±0.03, 10.06±0.27, 14.62±0.38, 17.41±0.43, 21.96±0.55 kg at birth, 3, 6, 9 and 12 months of age respectively. Year of birth had highly significant (p≤0.01) effect on all age. Effect of season of birth on body weight was also highly significant (p≤0.01) effect on all age. Sex of lamb showed s highly significant (p≤0.01) effect on all age whereas effect of type of lamb on body weight was found to be highly significant at birth, 3, 9 and significant at 6 and non-significant at 12 month of age.

Keywords: Body weight, least square mean, non-genetic factors, significant, Sonadi

Introduction
Sheep with its multi-faceted value for fleece, meat, milk, skin and compost form a significant segment of rustic economy, especially in dry, semi-dry and hilly zones of the nation where atmosphere stays unfavourable. Sheep husbandry play an important role in the livelihood of rural masses and a crucial function in the financial upliftment of a large portion of the under privileged communities and ranchers. They contribute greatly to the agrarian economy, especially in areas where crop and dairy farming are not economical. India ranks 8th in the world in terms of total meat production; out of India's total meat produced during 2022-23 about 10.51% was contributed by sheep along with 33.61 million kg wool (DAHD, 2012) [1]. As per NBAGR (2024) [19], Rajasthan which is also the 4th biggest sheep rearing state of India has 8 well defined breeds out of total 44 enlisted breeds.
Sonadi breed of sheep is reared for mutton purpose because towards mutton there is no prejudice by any community in India. Meat is a nutritious food that has a significant part in human balanced diet. Accordingly, there is an interest to increase the rate of meat production and utilization all through the world. Consequently, an expansion in small ruminant production could add to the achievement of food self-sufficiency in the nation especially because of protein necessity for the increasing human population and improve the export of mutton. Attributes identified with growth are of intricate qualities. They reflect the impacts of an intricate net of gene actions affected by the climate. Accordingly, to improve the growth performance of animals, improvement in both their hereditary structure and the climate they are encircled by is required. Growth profile attributes are acceptable markers of versatility of an animal to the current ecological conditions. In this manner, better growth is fundamental for suitable proliferation, creation and survivability in sheep

Materials and Methods
The data on growth of 1396 animals (Sonadi sheep) spread over period of 8 years from 2012-2019 were taken from Mega Sheep Seed Project coordinating Sonadi sheep unit, Vallabhnagar, Udaipur (Rajasthan) where they are maintained under semi-intensive system management.

On the basis of year of birth, data was categorized into eight classes and coded from i_1- i_8 for the corresponding year. Season of birth was categorised into three seasons as j_1 (monsoon: July to October), j_2 (winter: November to February) and j_3 (summer: March to June).

To estimate the effect of various non-genetic factors on growth efficiency was estimated through the following model:

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

Where,

Y_{ijk} = Growth records of the k^{th} progeny belonging to, j^{th} season and i^{th} period of birth

μ = Population mean

A_i = Fixed effect of i^{th} period of birth (i = 1, 2, 3, 4, 5, 6, 7, 8)

B_j = Fixed effect of j^{th} season of birth (j = 1, 2, 3)

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

Duncan's Multiple Range Test (DMRT) was used to make pair wise comparison among the least squares means.

Result and Discussion

The overall least-squares mean along with standard error of body weight were observed as 2.82±0.03, 10.06±0.27, 14.62±0.38, 17.41±0.43, 21.96±0.55 kg at birth, 3, 6, 9 and 12 months of age respectively which are shown in table and figure 1.

Our findings of BWT at birth were found to be in close agreement with Sharma *et al.* (2003) [23, 25] as 2.88±0.01 kg in Malpura sheep, Reddy *et al.* (2009) [22] as 2.88 kg in Nellore sheep, However lower estimate from present findings of birth weight were reported as 2.05±0.59 kg by Tailor and Yadav (2011) [28] for Sonadi sheep Whereas higher estimate of birth weight were reported by Gowane and Arora (2010) [12] for Malpura x Kheri sheep as 3.47±0.01kg, BWT at 3 months of age were found to be in close agreement with Kumar *et al.* (2003) [15] as 10.33±0.11 kg in Malpura x Kheri sheep. However lower estimate from present findings of three months body weight were reported for Madras red sheep as 9.64±0.030 kg by Sivakumar *et al.* (2009) [27], While higher estimate from these findings of three months body weight were reported as 16.87±1.03 kg by Poonia (2004) [20] for Munjal sheep, while the findings of BWT6 months of age was in close agreement with Madras red sheep reported by Balasubramanayam *et al.* (2010) [7]. However lower estimate from present findings of six months body weight were reported as 11.37±0.11 kg by Thiruvenkadan (2011) [29] for Mecheri sheep.

While higher estimate of six months body weight were reported as 23.94±0.190 kg by Waghmode *et al.* (2008) [32] for Madgyal sheep. BWT at 9 months of age were found to be in close agreement with Sivakumar *et al.* (2009) [27] as 17.80±0.12 kg and Balasubramanayam*et al.* (2010) [7] as 17.55±0.055 kg in Madras red sheep. However lower estimate from present findings of nine months body weight were reported as 13.99±0.13 kg by Thiruvenkadan (2011) [29] for Mecheri sheep.

Whereas higher estimate of nine months body weight were reported as 21.74±0.15kg by Sharma *et al.* (2003) [23, 25] for Malpura sheep, while the findings of BWT12 months of age was in close agreement with in Madras red sheep reported by Balasubramanayam *et al.* (2010) [7] as 21.20±0.08 kg. However lower estimate from present findings at 12 months body weight were reported as 20.45±0.098 kg by Sharma *et al.* (2003) [23, 25] for Marwari x Nali sheep, Whereas higher estimate of 12 months body weight were reported as 31.00±0.226 kg by Waghmode *et al.* (2008) [32] for Madgyal sheep,

It was observed that the body weight at 12 months of age was higher as compared to birth, 3, 6, 9 months of age. This might be due to effect of dam's milk during suckling stage which serves as a complete nutritious food

Year of Birth

Year of birth had highly significant ($p \leq 0.01$) effect at birth, 3, 6, 9, 12 months body weight (Table 1 and Figure 1.1). Lambs born in the year 2015 (3.08±0.04 kg) had significantly ($p \leq 0.01$) higher body weight than lamb born in 2012 (2.47±0.04 kg). Similar findings had been reported by Kumar *et al.* (2003) [15] in Malpura x Kheri lambs, by Sharma *et al.* (2003) [23, 25] in Malpura lambs, by Reddy *et al.* (2009) [22] in Nellore lambs and by Poonia (2004) [20] in Munjal sheep for birth weight. While significant effect of year of birth on body weight was observed by Chikurdekar *et al.* (2012) [8] in Deccani sheep and by Rao *et al.* (2004) [21] in Nellore sheep at birth weight. Whereas in contrast to our findings, Waghmode *et al.* (2008) [32] and Mane *et al.* (2014) [16] observed non-significant effect on birth weight in Madgyal sheep and Deccani sheep respectively.

Lambs body weight at 3month age was significantly ($p \leq 0.01$) higher in the year 2018 (13.50±0.34 kg) than in 2013 (5.95±0.34 kg). Similar findings had been reported by Kumar *et al.* (2003) [15] in Malpura x Kheri lambs, by Sharma *et al.* (2003) [23, 25] in Malpura sheep, by Reddy *et al.* (2009) [22] in Nellore sheep, by Poonia (2004) [20] in Munjal sheep and Waghmode *et al.* (2008) [32] in Madgyal sheep for 3month body weight. While significant effect on 3 month body weight were also observed by Chikurdekar *et al.* (2012) [8] in Deccani sheep and by Rao *et al.* (2004) [21] in Nellore sheep at 3 month body weight. Whereas in contrast to our findings, Mane *et al.* (2014) [16] observed non-significant effect of year in Deccani sheep for 3month body weight.

Lambs body weight at 6month age was significantly ($p \leq 0.01$) lower in the year 2013 (10.25±0.47 kg) than in 2015 (16.95±0.52 kg). Similar findings had been reported in Malpura x Kheri sheep by Kumar *et al.* (2003) [15], in Malpura lambs by Sharma *et al.* (2003) [23, 25], in Nellore sheep by Reddy *et al.* (2009) [22], by Poonia (2004) [20] in Munjal sheep and in Madgyal sheep by Waghmode *et al.* (2008) [32] for 6month body weight. While significant effect on 6months body weight were also observed by Chikurdekar *et al.* (2012) [8] in Deccani sheep and by Rao *et al.* (2004) [21] in Nellore sheep. Whereas in contrast to our findings, Mane *et al.* (2014) [16] observed non-significant effect in Deccani sheep on 6 months body weight.

Lambs body weight at 9month age was significantly ($p \leq 0.01$) lower in the year 2013 (13.42±052 kg) than in 2018 (19.24±0.50 kg). Similar findings had been reported in Malpura x Kheri sheep by Kumar *et al.* (2003) [15], in Malpura lambs by Sharma *et al.* (2003) [23, 25], in Nellore sheep by Reddy *et al.* (2009) [22], by Waghmode *et al.* (2008) [32] in Madgyal sheep and in Deccani sheep by Mane *et al.*

(2014) [16] for 9 month body weight. While significant effect on 9 months body weight were also observed by Ganesan *et al.* (2015) [11] in Madras red sheep and Chikurdekar *et al.* (2012) [8] in Deccani sheep.

Lambs body weight at 12 month age was significantly ($p \leq 0.01$) lower in the year 2013 (19.70±0.63 kg) than in 2012 (23.56±0.68 kg). Similar findings had been reported in Malpura x Kheri sheep by Kumar *et al.* (2003) [15], in Malpura lambs by Sharma *et al.* (2003) [23, 25], in Nellore sheep by Reddy *et al.* (2009) [22], by Waghmode *et al.* (2008) [32] in Madgyal sheep and in Deccani sheep by Mane *et al.* (2014) [16] for 12 month body weight. While significant effect on 12 month body weight were also observed by Ganesan *et al.* (2015) [11] in Madras red sheep and Chikurdekar *et al.* (2012) [8] in Deccani sheep. Whereas in contrast to these findings, Meena *et al.* (2019) [24] and Sharma *et al.* (2019) [17, 24] observed non-significant effect in Sonadi sheep on 12 month body weight.

The effect of year on body weight was might be due to variation in management practices and uneven rainfall over years.

Season of Birth

Season of birth had highly significant ($p \leq 0.01$) effect on all age groups of body weight (Table and Figure 2).

Lambs born in the winter season (2.73±0.03 kg) had significantly ($p \leq 0.01$) lower body weight than lamb born in the monsoon season (2.89±0.03 kg). Similar findings had been reported by Reddy *et al.* (2009) [22] in Nellore lambs, Meena *et al.* (2019) [24] and Sharma *et al.* (2019) [17, 24] on birth weight of Sonadi sheep. While significant effect on birth weight were also observed by Chikurdekar *et al.* (2012) [8] in Deccani sheep, by Rao *et al.* (2004) [21] in Nellore sheep and by Mane *et al.* (2014) [16] in Deccani sheep at birth weight. Whereas in contrast to our findings, Waghmode *et al.* (2008) [32] in Madgyal sheep, Sivakumar *et al.* (2009) [27] in Madras red lamb and Zaffer *et al.* (2015) [31] in Dorper x Rambouillet lambs observed non-significant effect of season on birth weight.

Lambs at 3month age had significantly ($p \leq 0.01$) lower body weight in the winter season (9.16±0.27 kg) than in summer season (11.03±0.35 kg). Similar findings on 3month weight had been reported by Reddy *et al.* (2009) [22] in Nellore sheep, Mishra *et al.* (2008) [18] in Garole x Malpura sheep and Mane *et al.* (2014) [16] in Deccani sheep. While significant effect on 3 month weight were also observed by Al-bial. and Singh J. (2012) [4] in Black boni sheep and Chikurdekar *et al.* (2012) [8] in Deccani sheep. Whereas in contrast to our findings, Rao *et al.* (2004) [21] in Nellore sheep, Waghmode *et al.* (2008) [32] in Madgyal sheep, Sivakumar *et al.* (2009) [27] in Madras red sheep, Meena *et al.* (2019) [24] and Sharma *et al.* (2019) [17, 24] in Sonadi sheep observed non-significant effect of season on 3month body weight.

Lambs at 6month age had significantly ($p \leq 0.01$) lower body weight in the winter season (14.06±0.39 kg) than in summer season (15.28±0.50 kg). Similar findings on 6month weight had been reported by Reddy *et al.* (2009) [22] in Nellore sheep, Sivakumar *et al.* (2009) [27] in Madras red sheep and Mishra *et al.* (2008) [18] in Garole x Malpura sheep. While significant effect on 6month body weight were observed by Chikurdekar *et al.* (2012) [8] in Deccani sheep, Mane *et al.* (2014) [16] in Deccani sheep, Meena *et al.* (2019) [24] and Sharma *et al.* (2019) [17, 24] in Sonadi sheep. Whereas in contrast to our findings, Rao *et al.* (2004) [21] in Nellore sheep and Waghmode *et al.* (2008) [32] in Madgyal sheep observed non-significant effect of season on 6month body weight.

Lambs at 9month age had significantly ($p \leq 0.01$) lower body weight in the winter season (16.54±0.44 kg) than in summer season (18.17±0.56 kg). Similar findings on 9month weight had been reported by Sivakumar *et al.* (2009) [27] in Madras red sheep and Dixit *et al.* (2001) [10] in Bharat Merino sheep. While significant effect of season on 9 month body weight were observed by Chikurdekar *et al.* (2012) [8] in Deccani sheep and Deccani sheep. Whereas in contrast to our findings, Mane *et al.* (2004) [16] in Deccani sheep, Waghmode *et al.* (2008) [32] in Madgyal sheep, Reddy *et al.* (2009) [22] in Nellore sheep, Meena *et al.* (2019) [24] and Sharma *et al.* (2019) [17, 24] in Sonadi sheep observed non-significant effect of season on 9month body weight.

Lambs at 12 month age had significantly ($p \leq 0.01$) lower body weight in the winter season (20.82±0.56 kg) than in summer season (23.58±0.68 kg). Similar findings on 12 month weight had been reported by Reddy *et al.* (2009) [22] in Nellore sheep and Dixit *et al.* (2001) [10] in Bharat Merino sheep. While significant effect of season on 12 month body weight were observed by Chikurdekar *et al.* (2012) [8] in Deccani sheep. Whereas in contrast to our findings, Mane *et al.* (2004) [16] in Deccani sheep, Waghmode *et al.* (2008) [32] in Madgyal sheep, Sivakumar *et al.* (2009) [27] in Madras red sheep, Meena *et al.* (2019) [24] and Sharma *et al.* (2019) [17, 24] in Sonadi sheep observed non-significant effect of season on 12 month body weight.

The effect of season of birth on body weight might be due to regional differences in the climatic conditions, availability of pasture during different seasons and classification of seasonal data. The changes in nutritional factors due to season have more effect of season on body weight. Availability of pasture grass directly affects the nutritional status to dam during late gestation period.

Table 1: Least square mean and standard error of body weight (kg) trait of Sonadi sheep across different years

Effect	BWT	3 MWT	6 MWT	9 MWT	12 MWT
µ	2.82±0.03	10.06±0.27	14.62±0.38	17.41±0.43	21.96±0.55
N	1396	1066	857	696	589
Year	**	**	**	**	**
2012	2.47^{a}±0.04 (183)	10.71^{bc}±0.36 (130)	14.89^{c}±0.50 (97)	18.26^{c}±0.57 (78)	23.56^{d}±0.68 (69)
2013	2.49^{a}±0.04 (243)	5.95^{a}±0.34 (188)	10.25^{a}±0.47 (163)	13.42^{a}±0.52 (138)	19.70^{a}±0.63 (121)
2014	2.84^{bc}±0.04 (198)	6.34^{a}±0.34 (127)	11.73^{b}±0.48 (106)	15.78^{b}±0.52 (94)	21.42^{b}±0.62 (81)
2015	3.08^{de}±0.04 (131)	11.63^{cd}±0.38 (99)	16.95^{d}±0.52 (85)	19.03^{cd}±0.58 (72)	22.94^{cd}±0.69 (66)
2016	2.88^{c}±0.04 (193)	11.09^{cd}±0.33 (157)	15.53^{c}±0.49 (100)	18.55^{cd} ±0.54 (83)	22.28^{bcd}±0.65 (75)
2017	2.97^{d}±0.04 (167)	11.12^{c}±0.35 (135)	15.21^{c}±0.49 (113)	17.54^{c}±0.55 (83)	22.10^{bc}±0.69 (66)
2018	3.02^{d}±0.04 (165)	13.50^{e}±0.34 (152)	16.93^{d}±0.46 (140)	19.24^{d}±0.50 (128)	21.36^{b}±0.61 (103)
2019	2.77^{b}±0.04 (116)	10.13^{b}±0.39 (78)	15.45^{c}±0.57 (53)	17.46^{c}±0.82 (20)	22.28^{abcd}±1.40 (8)

**=Highly significant ($p \leq 0.01$), *=Significant ($p \leq 0.05$), NS= Non-significant ($p > 0.05$)
Figures in parentheses are the number of observations

Table 2: Least square mean and standard error of body weight (kg) trait of Sonadi sheep across different seasons

Effect	BWT	3 MWT	6 MWT	9 MWT	12 MWT
µ	2.82±0.03	10.06±0.27	14.62±0.38	17.41±0.43	21.96±0.55
N	1396	1066	857	696	589
Season	**	**	**	**	**
Season I (Monsoon)	2.89^{b}±0.03 (493)	9.98^{b}±0.28 (413)	14.51^{a}±0.39 (360)	17.51^{b}±0.44 (298)	21.47^{b}±0.56 (259)
Season II (Winter)	2.73^{a}±0.03 (711)	9.16^{a}±0.27 (518)	14.06^{a}±0.39 (394)	16.54^{a}±0.44 (317)	20.82^{a}±0.56 (256)
Season III (Summer)	2.83^{b}±0.04 (192)	11.03^{c}±0.35 (135)	15.28^{c}±0.50 (103)	18.17^{b}±0.56 (81)	23.58^{c}±0.68 (74)

**=Highly significant ($p \leq 0.01$), *=Significant ($p \leq 0.05$), NS= Non-significant ($p > 0.05$)
Figures in parentheses are the number of observations

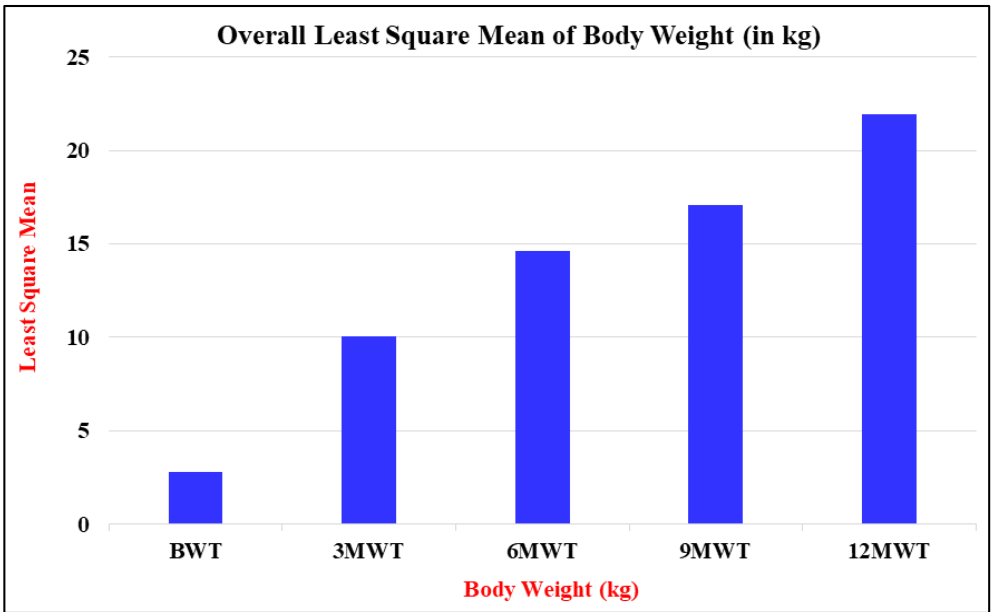

Fig 1: Overall Least Square Mean of Body Weight (in kg) of Sonadi sheep at different age groups

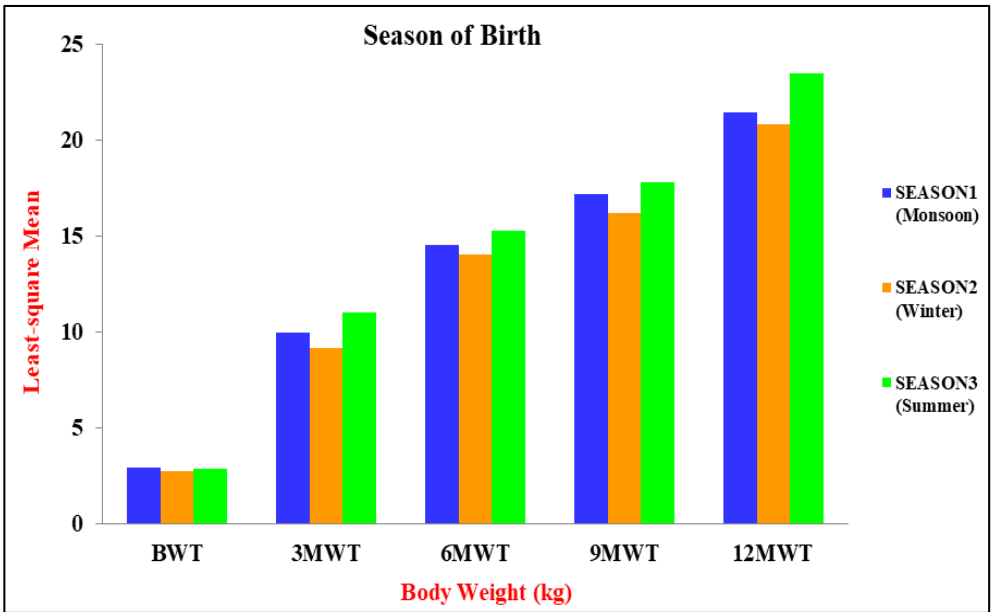

Fig 2: Least square mean and standard error of body weight (kg) trait of Sonadi sheep across different seasons

Conclusion

The findings of this study highlight the significant impact of non-genetic factors, particularly the year and season of birth, on the body weight of Sonadi sheep. The observed least square means and standard errors for body weight were 2.82±0.03 kg at birth, 10.06±0.27 kg at 3 months, 14.62±0.38 kg at 6 months, 17.0±0.43 kg at 9 months, and 21.96±0.55 kg at 12 months. The year of lambing and season of birth were found to have a highly significant effect ($p \leq 0.001$) on body weight across all age groups. Consequently, understanding and assessing these non-genetic factors are crucial for developing effective breeding programs aimed at enhancing the growth performance of Sonadi sheep. Additionally, measures should be implemented to standardize flock management practices to ensure sustainable production

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