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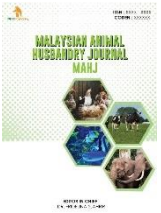

REVIEW ARTICLE

PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF KARAKUL SHEEP UNDER RANGE MANAGEMENT SYSTEM OF BALOCHISTAN, PAKISTAN

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ABSTRACT

Data on productive, reproductive and wool traits of Karakul sheep that are raised under range management system at Karakul Sheep Breeding Farm situated in Maslakh rangelands Balochistan Pakistan was used to evaluate their performance. For this retrospective study, six years (2015 to 2020) farm records are used. The research areas covered in the study mainly focused on three traits with underlying characteristics including firstly the; Growth Traits (birth weight, weaning weight, weight at six months age, twelve months weight and adult weight); secondly the Reproductive Traits (age at puberty, age at first service/breeding, breeding season, lambing season, lambing and fertility percentage, lambing interval and sex ratio) and lastly the Wool Traits (wool yield, staple length and fiber fineness). The data was statistically analyzed using standard analysis of variance procedures. Findings showed that the average birth weight was 4.53±0.021 and 3.72±0.02 kgs, weaning weight 20.20±0.06 and 18.49±0.12 kgs in male and female lambs, respectively and the difference between both the sexes were significant (P<0.05). Live weight at six months age averaged 27.58±0.07 and 24.05±0.04 kgs; at twelve months of age averaged as 37.70±0.29 and 34.24±0.11 kgs and at maturity 46.67±0.14 and 43.02±0.13 kgs in male and female animals, respectively, while the differences between the sexes were significant (P<0.05). Age at first breeding was 773.76±0.58 days, lambing interval as 373.58±6.34 days with 75% lambing percent, fertility percent was 78% and male to female ratio in the breed was 33:67. The grease fleece weight yield averaged 1.43 and 0.99 kgs in male and female with staple length of 6.35 cm having fineness of 42.60 micron at the time of shearing. It was analyzed that for further enhancement of the sheep's productive and reproductive traits in the province, effective breeding plan, improved management and feeding practices may be followed that can lead in getting improved production, profitability and desired outcomes.

KEYWORDS

Karakul sheep, Productive traits, Reproductive traits, Wool traits, Maslakh range, Balochistan

1. INTRODUCTION

In Balochistan, small ruminants play an important role in the livestock sector of the province, as evident from the fact that a total of 16.44 million (50.28%) of the total country's sheep (32.7 million) population reside in the province (GoP, 2023–2024). Here small ruminants are traditionally and customary kept almost in every household of the province for a number of reasons/ purposes to be served while it also supports in the provincial economy for alleviating poverty among the livestock farmers at grassroots level (Achakzai and Amjad, 1996). From the commercial point of view, a diversity of native sheep breeds are reared of which, the prominent breads include Bivrigh, Balochi, Rakhshani, Harnai and Mengali (FAO, 1985).

To overcome the policy of curbing the demand and supply gaps of mutton, wool and fur, prompt investigation on provincial level was initiated, aimed at induction of new animal breeds which show reasonable prospects of finding a profitable place in the livestock sector. For this very articulated alignment, the Livestock and Dairy Development Department Balochistan imported the founder Karakul sheep from Afghanistan and stationed at Karakul Sheep Breeding Farm (KSBF) at Maslakh, Quetta in 1982. The objective of this experiment was to promote and support this sheep in the area and as to see whether inheritance of Karakul characteristics took place in Mendelian manner and or not; if possible, to combine the best fur quality of the Karakuls with the best quality of mutton and wool of the breed on which they were crossed, thus for producing new breed.

Primarily, Karakul sheep is bred for its lamb pelts / fur production suitability, but also produces a range of products like meat, milk and wool. The breed is native of South-Central Asian country (Uzbekistan), and the name "Karakul" is taken from the village of Karakul in Bokhara means "Black Lake". Bokhara has a high elevation, mostly in excess of eight thousand feet with a very little rainfall and limited vegetation. Under such condition, only very hardy sheep breeds could survive. Karakul sheep breed is very resistant to harsh conditions and are mostly raised under semi nomadic management system. One of the unique quality and characteristics of Karakul evidenced is that although most of its lambs are black at birth, however, its coat turns brownish or gray in color, at an age of one year.

The animals of this breed have angular body, tall and long in size, face and legs are black and / or brown in color with drooping ears. The rams have dark, ripple horns turned toward in spirals while ewes are hornless. Karakul is a fat-tailed sheep and heavy fat accumulation frequently causes the tail to weight 2 to 2.5 kgs. It has an extended breeding season by having three lamb crops in two years and mostly one lamb, though twining is not uncommon (Nsoso and Madimabe, 2003; Sefidbakht et al., 1978). The majority fur color of Karakul sheep is black and / or gray, while sapphire,

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white and mixture of these colors are also found, of which, the sapphire color pelts fetch good market price (Raja, et al., 2012; Ibrahim, et al., 2011).

Efforts were being made to introduce this breed into the arid areas of the country, and establishment of Karakul Farm near Quetta was one of these efforts in order to evaluate this breed under conditions of rearing at Maslakh range. This study was designed to see the productive and reproductive status of Karakul sheep under range management system of rearing. Data regarding its growth and reproductive traits of each individual sheep were collected from the farm reports and record sheets over a period from 2015 to 2020 on a proforma designed for this purpose.

2. Materials and Methods

2.1 Study Area

Data were obtained from the Karakul Sheep Breeding Farm situated at Maslakh range. This rangeland is 20 km in the West of Quetta city Balochistan Pakistan and lies at a Latitude of 30° 3´ N and 30° 21´ and 66° 31´ E and 66° 49´ E Longitude covering 4000 hectares of land. Topography of the site is relatively leveled and slope on this site varied from 7.0% to 13.0%. There is no information available about the soil characteristics, however, the color of the soil varies from light brown to somewhat yellowish brown and is well drained homogenized, mainly due to its sandy loam and low in organic matter contents.

Fairly persistent and desiccating winds blow during most part of the year, coming from North and North-West that has the potential of Eva-transpiration which exceeds the mean annual rainfall. The water balance shows a continuous water deficit during the months of December to February. Weather records of the previous year's indicate that winter are cold and the air temperature may fall as low as -8.6 ^{0}C to -12.0 ^{0}C. While summer are usually dry and normal daily temperature is below 35 ^{0}C.

The dominated vegetation of the range has desert shrub type like *Artemisia maritime and Haloxylon ariffitthii,* which is considered to be at mid seral to late seral stage. While the common shrubs present in the rangeland are *Artemisia maritima, Haloxylon griffithii, Couinia stocksii*, *Acantholimon rongiflorum*, *Acantholimon rongiflorum*, *Acantholoimon munroanum*, *Convolvulus reiocalycinus*, *Astragalus stocksii*, *Sophora mollis* and *Hertia intermdia*, *Napeta Tulipa montna*, *Scorzondera pusilla*, *Alyssum desertorum*, *Malconia torulosa* are annual forbs, along with it was observed that perennial grasses are rare on the study site.

2.2 Animal Management and Breeding

The main objective of establishing this Farm was to develop and improve the Karakul sheep performance through identification of best rams for introduction in different flocks separated according to their fur coat color.

To ensure the identification of dam and sire of the new young one, controlled mating system was followed for each ewe that was bred for two lambing seasons (Spring and Autumn): i.e. dry season breeding in September to October (Spring lambing) and wet season breeding in April to June (Autumn lambing) per year were performed. Breeding started from 27th October to 29th November. Sometimes due to un-favorable seasonal conditions, the breeding was allowed once a year. Lambing usually started from 1st March till 1st April. Soon after lambing, newly born lambs were fed colostrum; and within twenty-four hours of lambing, they were ear tagged and weighed. Lambs were allowed with their dams for ninety days after which they were weaned. Weaning usually started in mid of June till mid of July with an average weaning period of about 90 days, after that, lambs were placed on stall feeding till the Monsoon rains started from the month of September.

2.3 Feeding

Flocks were managed under range management system, in summer season they were allowed to graze and reared on the rangeland during the daytime and housed in night, while during winter season i.e. from November to February due to excess cold and dryness - quality and quantity of the available range vegetation subsequently became low, thus necessitating for the provision of housing and stall feeding of the available concentrates. Consequently, the animals were kept indoor in this season and fed according to the NRC (1985) recommendations. Routinely used concentrate at the Farm were cotton seed cake, wheat bran, barley, molasses, commercially prepared sheep rations along with barley and / or wheat straw that were purchased from local market, while hay was prepared from the seasonal green fodder (barley, Lucerne and maize) produced on the Farm was also fed. Rock salt was placed for licking in the mangers.

Rainfall mostly concentrated in the month of December to February, and after rains abundant spring vegetation became available. Flocks were allowed for grazing on these areas during summer and a few months in winter till the availability of grasses on the ranges. In the major part of winter season, the bushes and grasses remained dry and it was difficult for the flocks to be fed on range vegetation. Thus, they were partially stall fed by offering them the concentrate ration. In summer season, only those animals were put on concentrate ration that became very weak during winter due to any feeding stress. All such weak animals were selected from the overall flocks and fed as a separate group by providing them access to the concentrate ration, while rams were also put on concentrate ration in both the seasons (summer and winter).

2.4 Disease Control Measures

Animal's flocks were vaccinated twice per annum against Anthrax spore, Sheep Pox, *Peste des Petits Ruminants* (PPR) and *Enterotoxaemia* disease, while on regular basis the Farm animals were dewormed against intestinal worm, lung worm and liver fluke according to the chalked-out schedule at the Farm.

2.5 Data Collection

For this study, the raw data was collected from Karakul Sheep Breeding Farm stationed at Maslakh rangeland for the period from 2015 to 2020, which was then standardized by eliminating outliers and incorrect and / or inadequate data with the objective to bring the data in a normal distribution. Also missing records / information was deleted.

The collected data included Growth traits like birth weight (BW), weaning weight (WW), six-month weight (SMW), yearling weight (YW) and adult live weight (AW). Reproductive traits included age at puberty, age at first breeding, breeding season, lambing season, lambing percentage, fertility percentage, lambing interval and sex ratio, while Wool traits included wool yield, staple length and fiber fineness was collected.

2.6 Statistical Analysis

Raw data were entered and compiled using Microsoft Excel spreadsheet and analyzed for means and standard errors by using the procedures defined by Becker (1984).

3. Results and Discussion

3.1 Productive Traits

3.1.1 Birth Weight

In sheep production enterprise, the birth weight is an important economic growth feature as it is highly associated with future weight gain up to weaning weight; as they both equally predict the whole post weaning growth and carcass performance. Along with this, live weight is a factor used for the growth performance of lambs in all production type field activities (Assan, 2020; Simeonov and Pamukova, 2017).

Data on birth weight of Karakul lambs under study revealed that birth weight averaged 4.53 kgs in male and 3.72 kgs for female lambs (Figure 1 and Table 1a). Statistical analysis manifested that the effect of sex was significant on birth weight (Table 1b). The birth weight data regarding both male and female animals were in line with those reported by the researchers, who observed average birth weights of 4.52±0.08 kgs, 4.45±0.04 kgs, and 4.80±0.07 kgs, respectively (Khatamov, 2023; Safarovich, 2019; Karynbaev, 2014). These values were relatively higher than those reported in some other studies, where ranges and values were between 3.18 to 5.05 kgs, 4.3±0.1 kgs, 3.9 to 4.4 kgs, 3.81±0.28 kgs in males and 3.48±0.15 kgs in females, and 4.08 kgs, respectively (Maloș and Ianițchi, 2024; Shaptakov et al., 2021; Erol et al., 2020; Buzu, 2014; Sahani et al., 2009; Gökdal et al., 2006). Similarly, our study revealed a relatively lower overall average body weight of 6.39 kgs as compared to 5.95 kgs reported by researchers (Mohammad Ali and Altaei, 2023).

The review of literature on growth variables however shows much variation in the parameter due to breed differences as reported by various workers (Hysi et al. 2023; Khatamov, 2023; Baba, et al. 2020; Buzu, 2018). In the literature the values for birth weight of various breeds are reported to range between 3.05 to 7.28 kgs in male and 2.10 to 8.03 kgs in female lambs.

Male animals are born with higher birth weights as compared to female counterparts and reach a higher growth intensity due to course skeletal development, higher daily weight gain and anabolic action of male sex hormone (Janoš et al. 2018; OjohMomoh et al. 2013; Abbas, et al. 2010; Rashidi et al. 2008; Kuchtik and Dobes 2006; Babar et al. 2004; Macit et al. 2002). While opposing to this, reported that female lambs born with low birth weight than males got higher weight than males after six weeks of weaning (Idris et al., 2010). On the other hand, they found no significant difference among the live weights of male and female lambs (Panayotov et

al., 2018 and Mohammadi et al., 2010).

On comparing the present study results with those of the others, revealed a lower birth weight being recorded for the under study breed. This shows that Karakul breed need to be improved by improving the nutrition and management conditions and intensive selection.

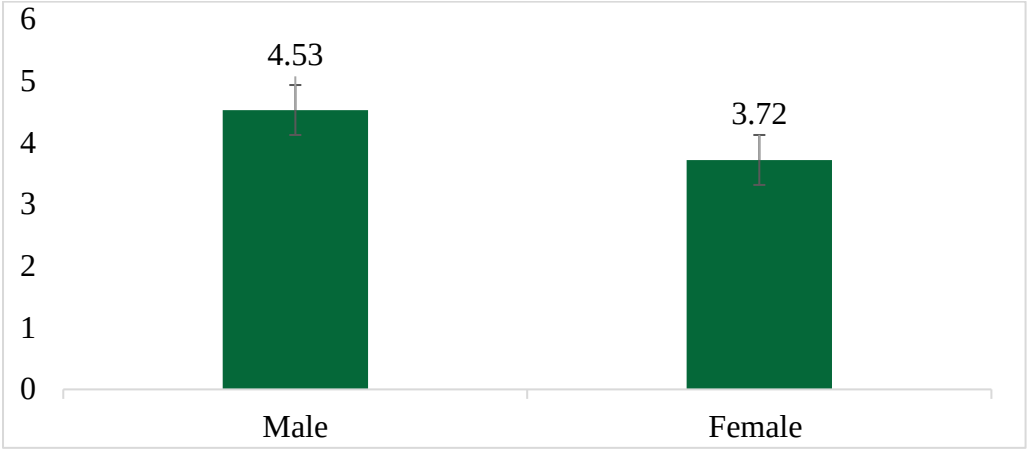

Figure 1: Means and standard errors of birth weights of Karakul Sheep

Table 1(a): Effect of year on birth weight of Karakul Sheep				
Year	**Sex**		**Mean Weight (Kgs)**	**CV**
	Male (Kgs)	**Female (Kgs)**		
2015	4.60	4.10	4.35	8.43
2016	4.57	3.90	4.23	7.34
2017	4.53	3.82	4.17	6.66
2018	4.54	3.64	4.08	6.09
2019	4.50	3.75	4.12	5.93
2020	4.34	3.37	3.90	5.87

Table 1(b): Analysis of variance of data on birth weight of Karakul Sheep				
Source of Variance	**Degree of Freedom**	**Sum of Square**	**Mean Sum of Squares**	**Fisher's Ratio**
Years	5	14.81	2.96	5.10**
Sex	1	81.55	81.55	140.60**
S x Y	5	93.04	18.60	32.06**
Error	552	324.51	0.58	------
Total	**563**	**513.91**		
N.S = Non-Significant, * = Significant, ** = Highly Significant				

3.1.2 Weaning Weight

Data on weaning weights of the Karakul breed under study revealed that the average weaning weight was 20.70 kgs in male and 18.47 kgs in female lambs (Figure 2 and Table 2a). Statistical analysis showed significant differences in weaning weights of lambs due to sex (Table 2b). The overall weaning weight in the present study was found to be 19.70 kgs, which was relatively higher than the figures reported at 17.55±0.47 kgs for males and 17.47±1.31 kgs for females, 20.0±0.26 and 15.62±0.89 kgs for females, and by a researcher, and was found comparatively lower than 29.6±0.44 kgs and 20 kgs (Mohammad Ali and Altaei, 2023; Sahani et al., 2009; Shaptakov et al., 2021; Karynbaev, 2014; Schelton, 1990). Literature reviewed on this parameter showed such variations being attributable to breed differences (Baba et al., 2020). In the literature, values for this variable ranged between 11.0 to 37.3 kgs in male and 12.6 to 34.7 kgs in female lambs

The comparison of study results with those of the other workers revealed weaning weights recorded by the breed under study on the lower side of the scale. This shows that the breed needs to be improved through excessive scientific technical progress in rangeland management.

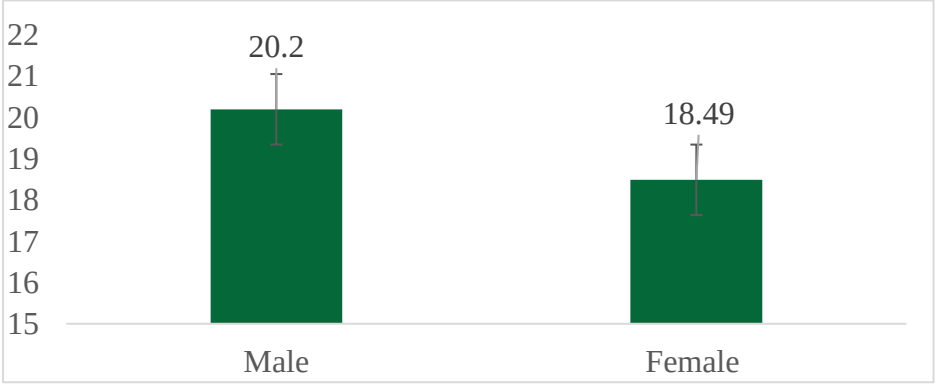

Figure 2: Means and standard errors of weaning weights of Karakul Sheep

Table 2a: Effect of year on weaning weight of Karakul Sheep				
Year	**Sex**		**Mean Weight (Kgs)**	**CV**
	Male (Kgs)	**Female (Kgs)**		
2015	20.81	19.72	20.26	6.54
2016	20.83	19.15	19.99	5.12
2017	20.82	18.98	19.90	3.99
2018	20.77	18.64	19.70	4.96
2019	20.45	18.16	19.30	4.71
2020	20.30	17.86	19.08	4.85

Table 2b: Analysis of variance of weaning weight data of Karakul Sheep				
Source of Variance	**Degree of Freedom**	**Sum of Square**	**Mean Sum of Squares**	**Fisher's Ratio**
Years	5	70.18	14.03	155.89**
Sex	1	449.51	449.51	4994.56**
S x Y	5	543.62	108.72	1208**
Error	504	45.42	0.09	------
Total	**515**	**1108.73**		
N.S = Non-Significant, * = Significant, ** = Highly Significant				

3.1.3 Six Month Live weight

Results on six months weight of the Karakul breed under study are summarized in Figure 3 and Table 3a; it could be seen from these results that live weight averaged 27.58 kgs and 24.05 kgs respectively at the age of six months in male and female lambs. The difference in live weight at this age due to sex was also significant (Table 3b). The overall six months live weight in the present study was relatively higher than the figures reported as 23.107±0.087 to 26.251±0.010 kgs and 22.14±1.20 kgs for males and 19.57±0.76 kgs for females, while marginally lower than 30.34±0.32 kgs (Florea et al., 2021; Sahani et al., 2009; Erol et al., 2020). Review of literature on this parameter shows much variation due to breed differences, with reported values ranging from 24.18 to 28.17 kgs in female lambs (Charyulu and Munirathnem, 1984; Akcapinar and Aydin, 1984).

Comparison of the present results with those of foregoing workers revealed that the six months live weight recorded by the breed under study were on the lower side of the scale. This necessitates to devise long term rangeland management strategies for efficient utilization of rangeland resources in different seasons, cultivation of fodder crops in summer season and its effective preservation for feeding the flock to cover the period of scarcity of fodder during winter.

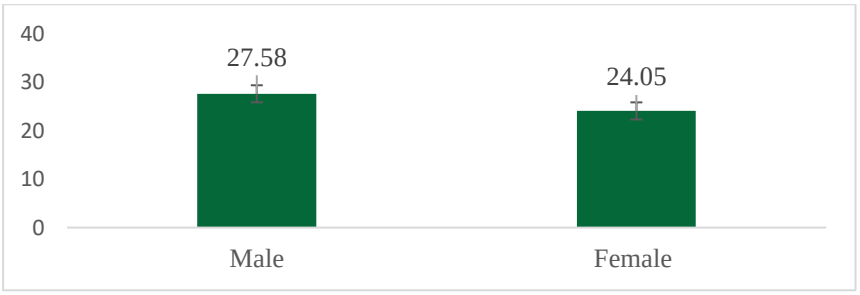

Figure 3: Mean and standard errors of six months age live weights data of Karakul Sheep

Table 3a: Effect of year on six month weight of Karakul Sheep				
Year	**Sex**		**Mean Weight (Kgs)**	**C.V.**
	Male (Kgs)	**Female (Kgs)**		
2015	27.18	24.59	25.88	4.42
2016	27.68	24.36	26.02	3.23
2017	27.26	24.24	25.75	4.17
2018	27.33	24.02	25.67	4.81
2019	27. 39	24.77	25.58	4.03
2020	27.19	24.58	25.38	5.45

Table 3b: Analysis of variance of data on live weight at six month age in Karakul Sheep				
Source of Variance	**Degree of Freedom**	**Sum of Square**	**Mean Sum of Squares**	**Fisher's Ratio**
Years	5	18.55	3.71	2.21
Sex	1	1391.98	1391.98	829.54
S x Y	5	1422.17	284.43	169.5
Error	480	805.74	1.628	-----
Total	**491**	**3638.44**		
N.S = Non-Significant, * = Significant, ** = Highly Significant				

3.1.4 Twelve Month Live weight

Data in Figure 4 and Table 4a show the results on twelve months live weight of Karakul sheep under study with an average of 37.70 kgs and 34.24 kgs in male and female lambs, respectively. Statistical analysis in Table 4b revealed a significant difference in twelve months weight of lambs due to sex. The twelve-month live weight in the present study was relatively higher than that reported as 33.058±0.114 to 38.041±0.180 kgs, 29.5±0.28 kgs, 30.8±0.37 kgs, and 23.75±6.75 kgs for males and 22.50±1.57 kgs for females (Sahani et al., 2009; Florea et al., 2021; Shaptakov et al., 2021; Khatamov, 2023). The literature reviewed shows an obvious variation being reported on this parameter due to breed differences (Khatamov, 2023; Baba et al., 2020). The figures reported by these workers ranged between 17.5 to 38.1 kgs in male and 30.32 to 39.20 kgs in female lambs.

The comparison of the results obtained in the study under discussion, revealed that the weight recorded at one year age during the study period was almost comparable with those reported by other workers. This suggests that sheep breed in present study do possess the potential towards higher weight gain if managed properly.

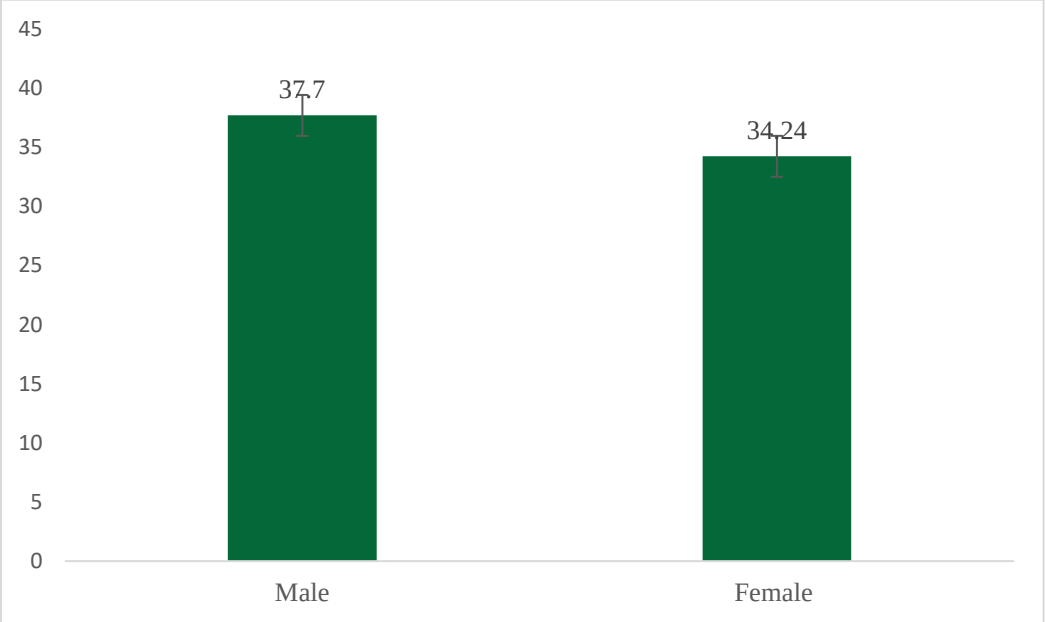

Figure 4: Mean and standard errors of twelve month age live weight data of Karakul Sheep

Table 4a: Effect of year on twelve month weight of Karakul Sheep

Year	Sex		Mean Weight (Kgs)	CV
	Male (Kgs)	Female (Kgs)		
2015	37.65	35.40	36.52	5.27
2016	37.68	34.89	36.28	4.68
2017	37.68	34.52	36.10	4.95
2018	37.65	33.94	35.79	5.61
2019	37.18	33.34	35.26	4.67
2020	36.94	33.22	35.08	4.40

Table 4b: Analysis of variance of data on live weight at twelve month age in Karakul Sheep

Source of Variance	Degree of Freedom	Sum of Square	Mean Sum of Square	Fisher's Ratio
Years	5	167.02	33.40	24.02**
Sex	1	1339.07	1339.07	963.35**
S x Y	5	1574.24	314.84	226.50**
Error	468	654.19	1.39	-----
Total	**479**	**3734.49**		

N.S = Non-Significant, * = Significant, ** = Highly Significant

3.1.5 Adult Weight

Results of live weights attained at adult age by Karakul sheep during the present study (Figure 5 and Table 5a) revealed that adult body weight averaged 46.67 kgs in male lambs of Karakul, while the similar weight for female lambs in the same breed order averaged 43.02 kgs. The statistical analysis in Table 5b revealed the significant difference due to sex.

Adult live weight of female Karakul sheep was found to be in line with the average figure of 45 kgs reported in the Karakul Compendium (CABI, 2019). However, the revealed figure of 46.6 kgs for male Karakul lambs in this study was not in line with the reported figure of 70 kgs (ranging from 60–90 kgs) in the previously quoted source (CABI, 2019). The literature reviewed on this parameter shows that the variation is due to breed differences. Some workers reported values such as 42.2±0.34 kgs, while others reported a range of 34.59 to 66.2 kgs for males and between 29.0 to 58.0 kgs for females (Shaptakov et al., 2021; Buzu, 2018; Baba et al., 2020).

The comparison of the results of the present study revealed that the value recorded by the breed under study were lesser than those reported from the other countries for improved breeds. Since, the breed under study are raised on range conditions and are managed on natural pastures mostly without any intervention for their improvement, it is therefore obvious that live weight of the animals will remain on a lower side of the scale. This necessitates that during the period of scarcity, the feeding and management ought to be adequately monitored and further improved, as required.

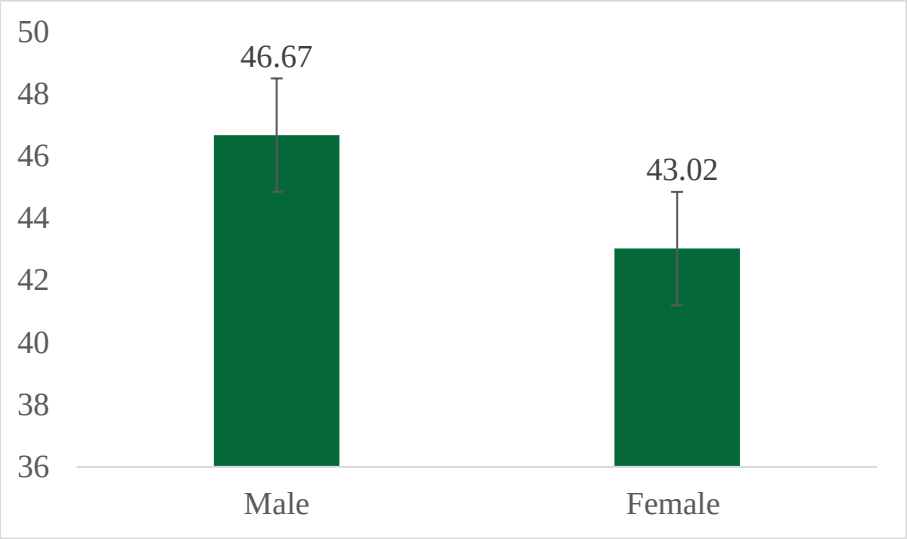

Figure 5: Mean and standard errors of data on live weights at adult age of Karakul Sheep

Table 5a: Effect of year, sex and their interaction on adult weight of Karakul Sheep

Year	Sex		Mean Weight (Kgs)	CV
	Male (Kgs)	Female (Kgs)		
2015	46.50	44.31	45.40	4.77
2016	47.19	43.64	45.41	4.27
2017	46.69	43.36	44.81	4.37
2018	46.74	43.07	44.90	4.72
2019	46.75	42.03	44.39	3.76
2020	46.27	41.62	43.94	4.32

Table 5b: Analysis of variance of data on live weight at adult age in Karakul Sheep

Source of Variance	Degree of Freedom	Sum of Square	Mean Sum of Square	Fisher's Ratio
Years	5	208.03	41.6	67.09**
Sex	1	1296.53	1296.53	2091.17**
S x Y	5	1699.01	339.8	548.06**
Error	468	291.13	0.62	------
Total	**479**	**3494.70**		

N.S = Non-Significant, * = Significant, ** = Highly Significant

3.2 Reproductive Traits

The reproductive characters are more challenging traits which are influenced by various components that include animal's direct genetic effect and other factors like puberty, estrus, ovulation, fertilization, pregnancy, lambing, lactation and rearing ability and each of this component is again controlled by the direct genetic effects (Safari et al., 2005; Snowder, 2008). But the expression of genetic effects are then affected mainly by the environmental factors like climatic condition, season, animal management, nutrition, breeding ratio of ram to ewe and / or ram's libido and fertility, because of interaction between gene-environment, which is a complicated phenomenon (Snowder, 2008).

3.2.1 Age at First Service / Breeding

Data on age at first service/breeding of the Karakul sheep under study (Table 6) depict that age at first service/breeding averaged 773.76 days, as compared with 493.54±11.17 days in Kashmir Merino sheep, 526.7±107.1 days in Pelibuey sheep, 731.67±0.3 days in Balochi sheep, 691.45±15.45 days in Iranian Afshari sheep, 622.4±55.6 days in Djallonke sheep, and 633 days (Schoeman and Albertyn, 1991; Gbangboche et al., 2006; Mohammadi et al., 2011; Rather et al., 2022; Canché et al., 2015; Jahan et al., 2012). This much conflict in reported age at first breeding may be due to breed differences that may be decreased by improving the prevailing management and feeding practices.

3.2.2 Lambing Interval

Findings of the present study on lambing interval in this breed are summarized in Tables 6 and 7, which show that the average lambing interval was 373.58 days. The inter-lambing period in the present study was relatively on the higher side compared to the reported figures of 256.60±0.3 days in Balochi sheep, 306.24±10.16 days in Iranian Afshari sheep, 253.1±2.9 days, and 317 days (Schoeman and Albertyn, 1991; Jahan et al., 2012; Mohammadi et al., 2011; Awemu et al., 2000).

3.2.3 Lambing Percentage

Data summarized in Table 8 regarding the lambing percentage shows a 75%, and review of literature on this parameter are not in line with the findings of a researcher with 95.8±0.60%; this difference may be due to the season, mating system and / or overall farm management conditions (Erol, et al., 2020).

3.2.4 Fertility Rate

Results in the present study regarding fertility rate averaged 78% (Table 8). These findings are lower than the findings of 94.72%, 95.45%, 92.67%, and 81.65%, respectively, while higher than the findings of 72.54% in Iraq (Duričić et al., 2021; Erol et al., 2020; Jahan et al., 2012; Pascal et al., 2009; Al-Sharify and Altaei, 2020). All these variations in this variable may be due to breed differences.

3.2.5 Sex Ratio

The results on sex ratio of Karakul sheep under study (Table 8) shows that the sex ratio seen averaged 33:67 male and female. While literature reviewed shows this ratio as 50.33:49.67 (male: female) in Balochi sheep (Jahan, et al. 2012).

Table 6: Means and standard errors of reproductive traits of Karakul Sheep			
No. of Observation	**Age at First Breeding (Days)**	**No. of Observation**	**Lambing Interval (Days)**
80	773.76 ± 0.58	73	373.58 ± 6.34

Table 7: Effect of year on lambing interval Karakul Sheep	
Year	**Mean for Year (Days)**
2015	379.66
2016	370.34
2017	386.74
2018	361.13
2019	370.07
2020	364.09

Table 8: Lambing percent, sex ratio and fertility value of Karakul Sheep				
No. of Observation	**Lambing Percentage**	**No. of Observation**	**Sex Ratio (Male : Female)**	**Fertility Value**
224	75%	224	33 : 67	78%

3.3 Wool Traits

3.3.1 Wool Yield

It could be seen from the data (Table 9) that wool yield averaged 1.43 kgs in males and 0.99 kg in females in the sheep breed under study. Present study findings revealed much lower wool yield compared to those reported by other researchers: 2–2.5 kg/clip (Musavi et al., 2022), 2.04±0.01 and 3.48±0.06 kgs in ewes and rams, 2.254±0.58 kgs, 2.2 kgs wool/ewe (Degen, 2013), and 1.76 kgs (Makarechin et al., 1977; Erol et al., 2020; Ismailov et al., 2018); while the results of this study are on the higher side compared to those reported as 1062.8±21.8 and 1899.6±36.6 gms (Safarovich, 2021).

Different studies also support the study findings, reporting that male animals gave higher wool yield than females, as males are heavier than females and have more skin surface area for wool growth; male sex hormones, differences in sex chromosomes, dimorphism in favor of males, and breed/strain are all contributing factors, while age may also play a role in this phenomenon (Rather et al., 2021; Rather et al., 2019; Lalit et al., 2016; Gupta et al., 2015; Khan et al., 2015; Das et al., 2014; Mousa et al., 2010; Dixit et al., 2009; Sarkar et al., 2008; Rashidi et al., 2008; Mehta et al., 2004; Mandal et al., 2002; Mir et al., 2000). Furthermore, along with these factors, the ewe also has to compensate for physiological stresses such as pregnancy, lambing, and milking.

The review of literature on this parameter shows much variation in this trait due to breed differences. The reported value of this parameter in the literature range between 2.21 to 6.70 kgs in improved breeds and lowest value between 1.36 and 3.02 kgs (Rather, et al. 2022; Qureshi, et al. 2013; Rather et al. 2022; Rather et al. 2021; Rather, M. A. 2021).

3.3.2 Fiber Fineness (Diameter)

Results on fiber fineness / diameter of Karakul sheep (Table 9) under study shows that the fiber fineness averaged 42.60 microns (µ). The comparison of the results showed variation in this parameter mainly due to breed differences. The values reported for this parameter by Malik, et al. 2021 in Changthangi sheep as 31.19±0.71 microns (µ). Since, the Karakul is a coarse wool breed and therefore has its fiber diameter is relatively on higher scale.

3.3.3 Staple Length

Data in Table 9 regarding staple length of Karakul sheep under study averaged 6.35 cm, while review of literature on this variable shows a result of 9.4±0.15 cm (Safarovich, 2021). Comparison of the results showed variation in this parameter mainly due to breed differences. The values reported for this parameter were 7.66±0.44 cm in Kashmiri sheep and 11.34±0.55 cm in Changthangi sheep (Qureshi et al., 2013; Malik et al., 2021).

Table 9: Staple length means and fiber diameter of Karakul Sheep					
Wool Yield				**Staple Length (cm)**	**Fiber Finesse (micron µ)**
Male		**Female**			
Mean (Kgs)	**S.E**	**Mean (Kgs)**	**S.E**		
1.43	0.09	0.99	0.01	6.35	42.60

4. Conclusion

Present study was carried out to assess and evaluate the important economic traits of Karakul sheep under range management system in Maslakh, Balochistan Pakistan. The findings revealed by the study suggest that the breed in the present scenario is performing well, however adequate measures are needed to improve its performance. Furthermore, it is also suggested that a comprehensive range vegetation monitoring and evaluation strategy be devised with a livestock carrying capacity estimation protocol be designed on permanent basis. This pragmatic approach can further improvise the breed performance and can lead to identification of remedies in overcoming the seasonal shortfalls. This also creates the dire need in enhancing the overall technical uplift of the managing / professional staff through advance learning techniques regarding sheep management and production, at large.

Conflict of Interest

All the authors declare that there is no conflict of interest associated with this publication.

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