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ENVIRONMENTAL FACTORS AFFECTING POSTWEANING TRAITS OF BUCHI SHEEP IN PAKISTAN

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ABSTRACT

The aim of the current study was to investigate the environmental factors potential sources of variation for postweaning traits in Buchi sheep maintained at the Livestock Experiment Station Jugaitpir, Pakistan. Data were collected from 1986 through 2010. Means ± SE were 16.58 ± 0.04 kg for weight adjusted to 180 days of age, 22.62 ± 0.05 kg for weight adjusted to 270 days of age and 33.78 ± 0.067 kg for weight adjusted to 365 days of age. Statistical analyses were performed by using the mixed procedure of the SAS statistical package. The model included the effects of year and season of birth, sex, type of birth, parity, age and weight of dam at lambing, and two-way interactions between these factors. Results showed that all postweaning traits were significantly ($P < 0.05$) affected by year, interaction between year and season, and interaction between year and sex of lamb. A significant interaction ($P < 0.05$) between season and sex existed for the weights adjusted to 180 and 365 days of age. These two traits were also affected ($P < 0.05$) by sex of lamb. Season, type of birth, parity, age and weight of dam were not important sources of variation for postweaning traits in this population. These results suggested that the feeding and management would need to be flexible to face any harsh climate and feed scarcity situation to maintain a productive and profitable sheep production system with Buchi sheep.

Key Words: Buchi, environmental factors, growth, interaction, postweaning, sheep

INTRODUCTION

Pakistan supports 28.4 million sheep that are a big source of income for thousands of people in the country (Anonymous, 2012). There are 28 recognized sheep breeds in Pakistan (Hasnain, 1985). Despite these vast genetic resources, sheep are largely unappreciated by public sector in Pakistan. Buchi is one of the well-adapted hot-region Cholistani (desert area) sheep breeds of Pakistan. The breed is mainly raised for meat and wool. A purebred flock has been kept at the Livestock Experiment Station Jugiatpir District Bahawalpur since 1986. However, a large population of Buchi sheep exists in Cholistan and other hot regions of southern Punjab. There is a wide diversity in various production traits of this breed which suggests that there is a great scope for improvement of performance traits. This variability in performance traits could be due to several genetic and environmental influences. Breed development programs are based on the exploitation of genetic variation. Variation in production and reproduction traits can be skillfully exploited if the extent of genetic and environmental sources of variation in these traits is accurately known. The observed performance of each animal for each trait is the result of the heredity that it receives from both parents and the environment in which it is raised. Performance records of animals should be adjusted to reduce or eliminate known environmental factors affecting performance so that genetic differences among animals can be recognized and used for effective breed improvement plans. Thus, the objectives of this study were to evaluate the effect of known environmental factors on three postweaning traits in Buchi sheep: weight adjusted to 180 days of age, weight adjusted to 270 days of age and weight adjusted to 365 days of age.

MATERIALS AND METHODS

a) Animals and data: Data were collected from 1986 to 2010 in a flock of Buchi sheep kept at the Livestock Experiment Station Jugaitpir District Bahawlpur Punjab, Pakistan. Data recorded included identification of the ewe, service sire, and lamb, date of birth of the lamb, birth type, birth weight of the lamb, sex, and lamb weights at approximately six months of age, nine months of age and one year of age. Lambs were weaned at about 120 days of age. Because postweaning ages in days at approximately 6^{th} months, 9^{th} months and at one year of age varied across lambs, weights were adjusted to 180, 270 and 365 days of age using the following formula:

$$\text{Weight adjusted to 180 days of age} = \text{Birth weight} + \frac{\text{Six month weight} - \text{Birth weight}}{\text{Age in days at Six month weight}} * 180$$

Adjusted weights to 270 and 365 days of age were computed by substituting corresponding nine-month and one-year weights and ages in days for these traits. Codes for sex of lamb were: 1 = female and 2 = male, for type of birth were: 1 = single and 2 = twin, and for seasons were: 1 = spring, and 2 = autumn. Dams were assigned to three groups each for parity, age at lambing, and weight at lambing. Dam parity groups were 1 = first and second parity, 2 = third and fourth parity, and 3 = fifth and more parities. The lambing age of dam was grouped as young=1 (<4 years), mature=2 (4 to 6 years) and old=3 (>6 years). Weights of dams at lambing were grouped as low=1 (<32 kg), medium=2 (32to34 kg) and heavy=3 (> 34 kg). Microsoft Excel was used for data entry and editing.

Farm location, soil, climate, general management and feeding practices have been described elsewhere (Akhtar *et al.*, 2012)

b). Statistical analysis: Data were used to estimate the effect of year of birth, season of birth, sex of lamb, type of birth, parity of dam, age of dam at lambing, weight of dam at lambing and two way interactions between these factors on 3 postweaning traits: weight adjusted to 180, weight adjusted to 270 and weight adjusted to 365 days of age. The mathematical model used to analyze the 3 postweaning traits was as follows:

$$Y_{ijklmnp} = \mu + yob_i + sob_j + sex_k + tob_l + dalc_m + dwlc_n + parity_p + (yob^*sob)_{ij} + (yob^*sex)_{ik} + (sob^*sex)_{jk} + (sob^*tob)_{jl} + (sex^*tob)$$

Where

$Y_{ijklmnp}$= observation on a trait
μ = population mean
yob_i = year of birth
sob_j = season of birth
sex_k= sex of lamb
tob_l= type of birth
$dalc_m$= age of dam at lambing
$dwlc_n$= weight of dam at lambing
$Parity_p$= dam parity group
$(yob^*sob)_{ij}$= interaction between year and season of birth
$(yob^*sex)_{ik}$= interaction between year of birth and sex of lamb
$(sob^*sex)_{jk}$ = interaction between season of birth and sex of lamb
$(sob^*tob)_{jl}$ = interaction between season and type of birth
$(sex^*tob)_{kl}$ = interaction between sex of lamb and type of birth
$e_{ijklmnp}$ = random residual assumed to be normally and independently distributed with mean zero and variance σ^2.

Data were analyzed with the mixed procedure of the Statistical Analysis System (SAS, 2011).

RESULTS AND DISCUSSION

Means ± SE, standard deviations, minimums and maximums for the 3 postweaning traits are shown in Table 1. Means ± SE were 16.58 ± 0.04 kg for weight adjusted to 180 days of age, 22.62 ± 0.05 kg for weight adjusted to 270 days of age and 33.78 ± 0.067 kg for weight adjusted to 365 days of age.

Environmental Factors Affecting Postweaning Weight Traits:

a) Weight adjusted to 180 days of age: The level of significance of environmental factors and two-way interactions among these factors on weight adjusted to 180 days of age is shown in Table 2. The only significant main effect ($P < 0.0001$) was year of birth. The interactions between year and season of birth, between year of birth and sex ($P < 0.001$) and between season of birth and sex of lamb were also significant ($P < 0.041$). The effects of season, sex, type of birth, parity, age and weight of the dam at lambing on this trait were non-significant.

Comparable results to those found here were reported at various locations for other meat sheep breeds. Hussain *et al.* (2013) for Thalli and Kakar *et al.* (2011) for Balochi and Bibrik breeds of sheep in Pakistan reported that year of birth was a significant source of variation for lamb weight adjusted to 180 days of age. In addition, these authors reported significant season, sex and type of birth effects that were non-significant here. Further, Cloete *et al.* (1998) in Dhone Merino, Lawaf and Noshary (2008) in Lori, Vatankhah and Talebi (2008) in Lori Bakhtiari and Thiruvenkadan *et al.*(2011) in Mecheri breeds of sheep found significant effects for year of birth of lamb as well as season, sex, type of birth and age of dam for the weight at six months of age (about 180 days). In Iran, Behzadi *et al.* (2007) and Mokhtari *et al.* (2008) in Kermani and Kesbi *et al.* (2008) in Mehraban breeds of sheep also reported similar results. However, in addition to significant year effect, non-significant effect of birth type on this trait in these studies was also in agreement with the present study.

None of the referenced studies above estimated the interaction between year and season of birth, and the interaction between year of birth and sex of lamb. A significant interaction between year and season of birth existed here for weight adjusted to 180 days of age of lamb suggesting that season effects differed across years. Least squares means for year-season combinations ranged from 14.15 ± 0.33 kg to 18.92 ± 0.347 kg in autumn seasons of years 2009 and 1996. The study also revealed a significant interaction between year of birth and sex of lamb for this trait. This reflected that these two factors were not independent and that different estimates of sex effects were obtained during the years of the study. The minimum and maximum values estimated for least squares means by year-sex combinations were14.81 ± 0.213 kg and 17.59 ± 0.757 kg for males born in 2007and 1987.The changes in value of least squares means over the years for the interactions between years and seasons (spring and autumn) and years and sexes (female and male) from 1986 to 2010 are shown in Figure 1 and Figure 2 for weight adjusted to 180 days of age.

The significant interaction between season of birth and sex of lamb found here indicated that sex effects were not same in the spring and autumn seasons for weight adjusted to 180 days, thus different estimates of sex effects were obtained in different combination of seasons and sexes. The least squares means estimated for the interaction (season – sex)ranged from 12.447 ± 0.131 kg for females born in spring season to 17.99 ± 0.551 kg for males born in autumn season for this trait. Hussain *et al.* (2013) reported a significant interaction between season of birth and sex of lamb, and a non-significant interaction between sex and type of birth for Thalli sheep in agreement to the present study. However, he also found a significant interaction between season and type of birth contrary to results here for this trait.

b) Weight adjusted to 270 days of age: Levels of significance of environmental factors and two-way interactions on weight adjusted to 270 days of age are presented in Table 2. The main effects of year of birth ($P < 0.0001$) and sex of lamb ($P < 0.035$), and the interactions between year and season of birth ($P < 0.0001$) and between year and sex of lamb ($P < 0.0001$) were significant for this trait. In contrast, season, type of birth, parity, age and weight of the dam at lambing were not found to be important for weight adjusted to 270 days of age. The significant effects of year of birth and sex of lamb obtained here were in agreement with results from previous studies in four breeds of sheep (Dhone Merino, Thalli, Balochi, Bibrik and Mengali) kept at various locations for weight adjusted to 270 days of age (Cloete *et al;* 1998; Kakar *et al.* 2011; Hussain *et al.*, 2013; Tariq *et al.*, 2013). However, contrary to this study, these authors observedsignificant season and typeof birth effects on this trait. Behzadi *et al.* (2007) and Mokhtari *et al.* (2008) for Kermani and Kesbi *et al.* (2008) for Mehraban breeds of sheep in Iran estimated significant effects for year, season, sex, and age of dam for weight at 9^{th}monthsof age (about 270 days). Thiruvenkadan (2011) also reported the comparable results for the Mecheri breed of sheep in India. Non-significant effects of birth type found in the previous three studies were in agreement with the present study.

A significant interaction was found here between year and season of birth for weight adjusted to 270 days of age. This suggested that season (spring and autumn) effects were changed across years and variation among different combinations of years and seasons existed for this trait. Least squares means for year-season combinations ranged from 21.04 ± 0.334 kg in the spring of 2004 to 25.64 ± 0.494kg in autumn of 1998. Similarly, the significant interaction between year of birth and sex of lamb estimated here depicted different effects by different combinations of sexes and years. The values of least squares means for the interaction between year and sex ranged from 20.66 ± 0.373 kg for females born in 1990 to 26.81 ± 0.38kg for males born in 1998.The graphical representations below display trends of least squares means by year and season combinations (Figure 3) and by year and sex combinations (Figure 4) from year 1986 to 2010.

Non-significant interactions between sex and type of birth found here were in agreement with results reported by Hussain *et al.*, (2013) in Thalli sheep. However, contrary to results here, Hussain *et al.*, (2013) also obtained significant interactions of season by sex, and season by birth type.

c) Weight adjusted to 365 days of age: The significance levels of environmental factors and two-way interactions in the model for weight adjusted to 365 days of age have been depicted in Table 2. Year of birth ($P<0.0001$), sex of lamb ($P<0.002$) as well as the interactions between year and season of birth ($P < 0.0001$), year of birth and sex ($P<0.0001$) and season of birth and sex ($P<0.038$) were found to be important sources of variation for this trait.

Results obtained here were in agreement with previous studies involving different breeds of sheep in Pakistan. Hussain *et al.* (2013) for Thalli, Akhter *et al.* (2008) for Hissardale and Kakar *et al* (2011) for Balochi and Bibrik breeds of sheep reported year of birth and sex of lamb to be important factors for weight adjusted to 365 days of age. Research in Pakistan with Lohi (Iram, 2008) and Kajli breeds of sheep (Qureshi *et al.*, 2010; Farmanullah, 2011) found significant influences of these two factors on weight of lamb at the age of one year (about 365 days). In addition, these authors also found that weight of lamb at one year of age was significantly influenced by season of birth and age of dam. Results from several breeds in countries across the globe showed substantial variability in levels of significance of factors accounted for in the model for yearling weight adjusted to 305 days here. Cloete *et al.* (1998) for Dhone Merino in South Africa, Matica *et al.* (2003) for Sabi in Zimbabwe, and Ceyhan *et al.* (2009) for Sakiz sheep in Turkey reported significant effects of year, sex of lamb, season, type of birth and age of dam. Similar results were obtained in Merino Baharet and Mecheri breeds of sheep in India by Dixit *et al.* (2001) and Thiruvenkadan *et al.* (2011).Behzadi *et al.* (2007) and Mokhtari*et al.* (2008) in Kermani sheep and Kesbi *et al.* (2008) in Mehraban sheep found year, season, sex and age of dam to be significant factors for this trait. The findings of Borg *et al.* (2009) with Western Range sheep in USA were slightly different. In that study, this trait was influenced by year and sex of lamb but the effect of age of dam had no effect. The non-significant effect of birth type found here was in agreement with the majority of the referenced studies.

Table 1. Statistical description for postweaning traits in Buchi sheep[1]

Traits	No.	Mean ± SE	SD	Minimum	Maximum
Weight adjusted to 180 days of age (kg)	3205	16.58 ± 0.04	2.289	11.44	23.32
Weight adjusted to 270 days of age (kg)	3069	22.62 ± 0.05	2.743	15.24	34.03
Weight adjusted to 365 days of age (kg)	2299	33.78 ± 0.07	3.226	24.27	44.21

[1]SE = Standard error; SD = Standard Deviation.

Table 2. Significance level and F values for weight adjusted to 180, 270 and 365 days of age in Buchi sheep

		180 days	270 days	365 days
Sources of variation	DF	F value	F Value	F value
Year of birth (yob)	24	34.82^{**}	14.45^{**}	22.8^{**}
Season of birth (sob)	1	0.01^{ns}	0.04^{ns}	0.78^{ns}
Sex of lamb (sex)	1	0.16^{ns}	4.48^{*}	9.74^{**}
Type of birth (tob)	1	0.01^{ns}	0.25^{ns}	0.05^{ns}
Dam age at lambing (dalc)	2	1.02^{ns}	0.04^{ns}	0.17^{ns}
Dam weight at lambing (dwlc)	2	0^{ns}	0.59^{ns}	0.86^{ns}
Parity	2	1.6^{ns}	0.05^{ns}	0.18^{ns}
yob*sob	23	7.43^{**}	2.93^{**}	4.2^{**}
yob*sex	23	13.69^{**}	5.76^{**}	21.4^{**}
sob*sex	1	4.18^{*}	0.81^{ns}	4.29^{*}
sob*tob	1	0.9^{ns}	1.22^{ns}	0^{ns}
sex*tob	1	0.18^{ns}	0^{ns}	0.17^{ns}

DF= degrees of freedom; * = Significant (P < 0.05); ** = Significant (P < 0.01); ns = non significant

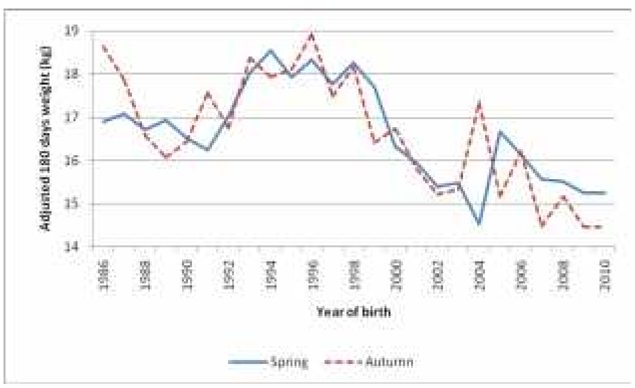

Figure 1. Least squares means by year-season subclass for weight adjusted to 180 days of age

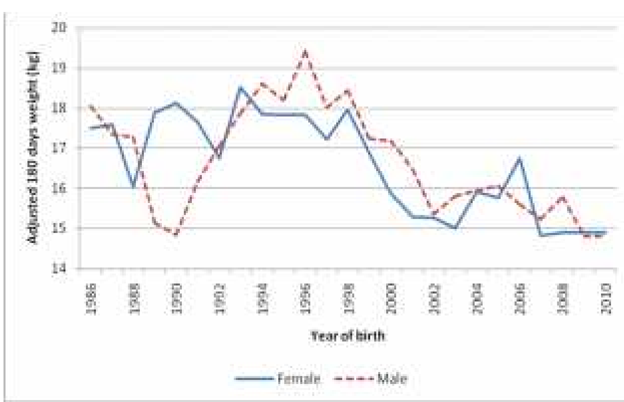

Figure 2. Least squares means by year-sex subclass for weight adjusted to 180 days of age

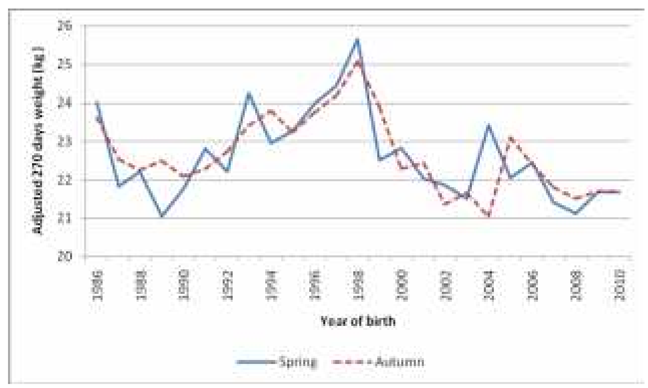

Figure 3. Least squares means by year-season combination for weight adjusted to 270 days of age

The lack of independence of year and season of birth (significant year-season of birth interaction) pointed out that season effects varied across years for this trait. Least squares means for year-season combinations were estimated from 1986 to 1999. The minimum and maximum values of these estimates were 32.09 ± 0.481 kg and 38.18 ± 0.468 kg in spring seasons of the years1990 and 1999. The fluctuation in least squares means by year and season of birth combinations for the years 1986 to 1999 is shown in Figure 5. Similarly, the significant interaction between year of birth and sex of lamb indicated that the combined effect of these factors were more important than their individual effects on this trait. Estimates of least squares means for the interaction

between year and sex were computed for all years (1986 to 1999). They ranged from 33.1 ± 0.549 kg (males born in 1988) to 39.62 ± 0.538 kg (males born in 1998). The fluctuation in least squares means by year-sex combinations for years 1986 to 1999 is illustrated in Figure 6.
Et al.

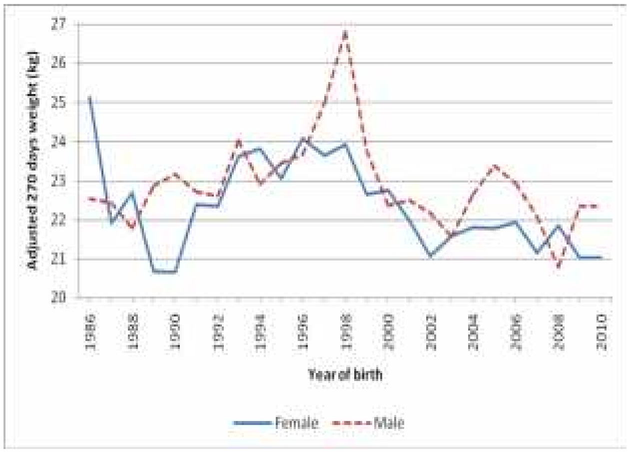

Figure 4. Least squares means by year-sex combination for weight adjusted to 270 days of age

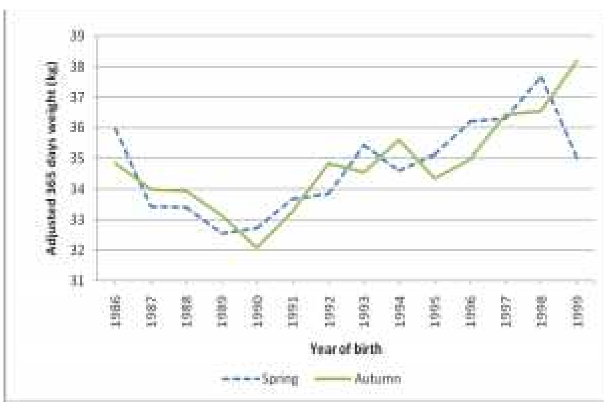

Figure 5. Least squares means by year-season combination for weight adjusted to 365 days of age

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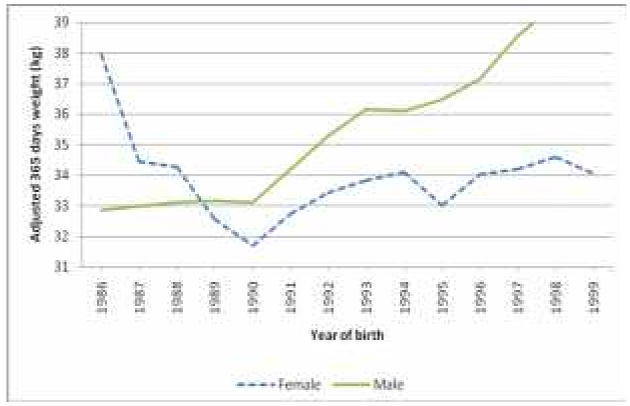

Figure 6. Least squares means by year-sex combinations for weight adjusted to 365 days of age

Conclusions: The findings of the present study revealed that the combined effect of two environmental factors particularly year-season of birth, and year-sex of lamb were important for all postweaning traits in this nucleus flock of Buchi sheep. This suggests that management practices of the Buchi flock at the experiment station should include special measures to face harsh climatic conditions and be prepared to overcome feed scarcity during crunch periods. This would contribute to maintain a productive and profitable sheep production system. It is further suggested that the current system of culling of animals and data recording at different postweaning ages in the flock be revised to help maintain a reasonable ratio between sexes at all postweaning ages. Having postweaning weights at all ages for both males and females would increase the probability of identifying the best males and females as parents of the next generation.

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