Research Article

EVALUATION OF REPRODUCTIVE PERFORMANCE AND LITTER TRAITS OF KHARI, JAMUNAPARI AND SIROHI CROSSBRED GOATS IN SURKHET DISTRICT OF KARNALI PROVINCE, NEPAL

N. Bhattarai[1], J. Poudel[2], M. R. Kolakshyapati[3], M.P. Sharma[1], N. A. Gorkhali[4], A. Sigdel[5], S. Upadhayaya[1], and S. Sapkota*[4]

[1] Agriculture and Forestry University, Rampur, Chitwan, Nepal

[2] Ghorahi Sub-metropolitan City, Dang, Province-5, Nepal

[3] Tribhuvan University, Rampur Campus, Nepal

[4] NARC, Khumaltar, Lalitpur, Nepal

[5] University of Wisconsil-Madison, USA.

* Corresponding author: sarose.sapkota@gmail.com

Received date: 13 January 2022, Accepted date: 14 May 2022

ABSTRACT

Goat produces 20.36% of meat, ranking in second position after buffalo meat production in Nepal and contributes 4% in agriculture GDP. Making out the influence of non-genetic factors on the phenotypic expression of reproductive and litter traits of goat is important to develop selection/evaluation criteria with healthier precision. Khari, Jamunapari and Sirohi crosses were considered for the comparative study of their reproductive and litter traits. Data obtained from the study of different reproductive and litter traits were firstly entered into the computer via excel package programs. The data were analyzed by Mixed Model Least-square and Maximum Likelihood Computer Program PC-2statistical package developed by Walter R. Harvey and the means were compared by Duncan's Multiple Range Test (DMRT). Results revealed that the pooled means for AFC, AFK, PPE, GL, and KI were 344.31, 493.69, 173.42, 148.93, 319.58 days respectively. Similarly, pooled means for LSB, LWB, LSW, and LWW were 1.43, 5.16 kg, 1.37 and 28 kg respectively. Production system and breed were important non-genetic factor affecting reproductive traits significantly whereas parity is the most important non genetic factor affecting litter traits of goat. Almost all of the reproductive traits (except PPE) were observed better under the grazing system in Khari breed. Winter kidding goat had better PPE. Likewise, all the litter traits were significantly better in later parities with almost similar performance in all the breeds. To summarize, Khari was explored as a high potential goat regarding its reproductive traits with a massive scope of improvement in its litter weight trait through effective selection measures within the population.

Keywords: Breed, parity, production system, season, weight

INTRODUCTION

Irrespective of caste, religion, ethnicity, gender and economic status of farmers, goat farming is most commonly adopted in Nepal due to several things like low initial investment and quick economic return without any marketing problem for family food and nutrition security. In these days, increasing trend of commercial goat farming in Nepal has been seen since last decade with increased number of goat population from 7847624 in 2006/07 producing 44933 Mt. to 11,165,099 in 2016/017 producing 67706 Mt. with average annual increment of 3.52% (DLS, 2019). Goat alone produces 20.36% of meat, ranking in second position after buffalo meat production in Nepal and contributes 4% in agriculture GDP and ranks third in livestock GDP sharing after buffalo and cattle (DLS, 2019). 5.1 million households are keeping one or more number of goats either for family nutrition or income (CBS, 2012).

Khari is our native breed available across hill from east to west sharing 56% in total population (Kharel & Neopane, 1997), and considered the most productive breed of goats (Kharel & Neopane, 1997; Neopane, 1997; Kunwar, 2000; Kolachhapati, 2006; Parajuli, 2012). This breed is one of the well adapted having best indigenous genetic resources of goat in Nepal with higher prolificacy, multiple kidding abilities and carcass quality (Neopane, 1997; Kunwar, 2000). But, such a valuable genetic resource of Khari has been given low value by the farmers due to the large and attractive body size of exotic pure breeds and their crossbred kids (Kolachhapati, 2006) of goats such as Jamnapari and Boer. Despite some better characteristics of indigenous Khari breed, it has lower body weight. Sapkota (2007) reported the adult weight of goat from multi-location as

26.07±0.30 kg. Parajuli (2012) also reported lower adult body weight of 27.79±0.31 kg. Even after continual growth of goat population, the demand of its meat is yet not fulfilled by domestic production as a result, the import of an average 412034 number of goat is done annually since the last 11 years (CAQO, 2017). In another study by Rajwar (2012), the import from India alone was estimated to be US$ 37.5 million sharing 15% of the goat meat market. Similarly, per capita consumption of meat is 12 kg and still we are far away from meeting the recommendation (DLS, 2016). To fulfill the domestic requirements of meat and to check the import of bucks, these poor productive goat should be upgraded through selection or cross breeding. These days, Boer could be a choice of breeds to improve the productive performance of local goats through crossing with it. Boer goats have been recognized worldwide as the goat having excellent body conformation, fast growing and good carcass quality. Boer goat has heavier body weight, faster growth rate, higher prolificacy with litter size not less than 2 and able to improve productive performance of indigenous breeds through cross breeding (Lu, 2001). Limited number of studies have been conducted on the performance evaluation of F1 crossbred with Boer at Goat Research Station (GRS) Bandipur, Tanhun. Whatever the studies were carried out, most of them were target oriented rather than real problem based. Those were conducted in research stations rather than in farmer's fields.

MATERIALS AND METHODS

The study was carried out in Surkhet district, Nepal choosing two specific altitude i.e. upper altitude (Birendranagar Municipality-16 and Lekbesi Municipality-10) at the height of 1170 to 1675 masl and lower inner Terai altitude (Lekbesi Municipality- 3, 4 and 6) at the height of 450 to 750 masl from October 2016 to September 2018. The dams used in this study were locally available goat breeds including Khari, Jamnapari cross and Sirohi cross reared under stall feeding as well as grazing systems. Altogether 640 goats were taken into account, identified through ear tagging and data on reproductive and litter traits were recorded 3 years from 2015 to 2018. The litter traits considered in the study were litter size at birth (LSB), litter weight at birth (LWB), litter size at weaning (LSW) and litter weight at weaning (LWW). Likewise, the reproductive traits of different does under the study were age at first conception (AFC), kidding interval (KI), gestation period (GI or GP) and postpartum estrus (PPE).

The recorded data of selected goats of different genetic groups and their kids were firstly entered into the computer via excel package programs. The data were analyzed by Mixed Model Least-square and Maximum Likelihood Computer Program PC-2statistical package (Harvey, 1990) developed by Walter R. Harvey and the means were compared by Duncans' Multiple Range Test (DMRT) (Duncan, 1955).

Age at first conception/service and Age at first kidding was analyzed using following fixed effect model i.e.

$$Y_{ijkl} = \mu + a_i + b_j + c_k + e_{ijkl}$$

Where,

Y_{ijkl} is the adjusted mean for age of the dam

μ is overall mean

a_i is the effect of i^{th} breed (i=1,2 and 3) 50-100% Khari, Jamnapari cross and Sirohi cross

b_j is the effect of j^{th} location (j=1 and 2) upper and lower

c_k is the effect of k^{th} production system (k=1 and 2) grazing and stall feeding

e_{ijkl} is the random element (error mean) assumed to be normally and independently distributed among the sampled population.

Similarly, post-partum estrus, kidding interval and gestation length was analyzed using following fixed effect model i.e.

$$Y_{ijklmno} = \mu + a_i + b_j + c_k + d_l + f_m + g_n + e_{ijklmno}$$

Where,

μ is the overall mean

a_i is the effect of i^{th} genetic group/breed (i=1,2, and 3) Khari, Jamunapri cross and Sirohi cross

b_j is the effect j^{th} parity (j=1 2 and 3) early (1-2) parity, mid (3-6) parity and late (7 and above parity)

c_k is the effect of k^{th} season of conception (k =1, 2, 3 and 4) spring, summer rainy, autumn and winter

d_l is the effect of l^{th} location (l=1 and 2) upper and lower

f_m is the m^{th} production systems (m=1 and 2) Grazing and stall feeding

g_n is the n^{th} herd size (n=1,2 and 3) small medium and large

$e_{ijklklmno}$ is the random element (error mean) assumed to be normally and independently distributed among the sampled population.

And litter size and litter weight traits at birth and at weaning were analyzed using the fixed effect model i.e.

$$Y_{ijklmno}= \mu+a_i+b_j+c_k+d_l+f_m+g_n+e_{ijklmno}$$

Where, μ is the overall mean

a_i is the effect of i^{th} genetic group/ breeds (i=1, 2 and 3) Khari, Jamnapari cross and Sirohi cros and Boer 100%

b_j is the effect of j^{th} number of parities of does (j = 1, 2 and 3)

c_k is the effect of k^{th} season of kidding (k= 1, 2)

d_l is the effect of l^{th} location (i= 1and2) upper and lower

f_m is the effect of m^{th} production system (m=1 and 2) grazing and stall feeding

g_n is the effect of n^{th} herd size (n=1,2 and 3) small, medium and large

$e_{ijklmno}$ is the random element (error mean) assumed to be normally and independently distributed among the sampled population.

RESULTS AND DISCUSSION

Effect of non-genetic factors on reproductive traits of does

Age at first conception (AFC)

The overall mean age at first conception was 344.31±5.56 days (Table 1) and this was almost similar to the findings presented by Pokhrel and Khanal (2006), as 342.44±94.21 days in hill goats. In similar studies, different researchers reported different levels of effect due to location on AFC. Among them, Waiz *et al.* (2018) reported significant effect (P<0.05) of location, Sharma *et al.* (2017) reported significant (P<0.05) relation between location and AFC, goats of higher altitude come earlier in conception as compared to lower altitude. Parajuli *et al.* (2015) also observed that location had significant (P<0.001) effect on AFC showing that goats reared at the altitude of 1000 meter with the facility of forest grazing system showed better productive and reproductive traits. Sapkota (2007) reported a significant effect (P<0.001) of location (Chitwan, Udayapur, Siraha and Tanahun district of Nepal) showing goats in Chitwan having lowest AFC. A highly significant effect of the production system (P<0.001) on age at first conception had been noticed in this study. Goats reared under grazing had come earlier (50 days) in heat. Likewise, Gautam (2017) reported a highly significant effect of production system (P<0.001) on AFC (240.75±4.01 and 233.04±3.89 days) for the goats reared under intensive and semi-intensive systems. Breed/genetic group also played a highly significant effect (P<0.001) on AFC. Similar result was obtained by Rasali and Khanal (1998), in a study on Khari and its cross with Sinhal reporting 229.2 and 367.6 days showing a highly significant (P<0.01) effect due to breed. While Gautam (2017) reported no effect of breeds on age at first conception.

Age at first kidding (AFK)

From the study, it was revealed that the overall least square mean of the age at first kidding was 493.69±5.5 days (Table 1). It was also seen that the altitude had an impact on AFK. In lower altitude, goats get more concentrate ration, scheduled de-worming and vaccination. In a similar study, many researchers had found different level of significant effect and among them, Waiz et al. (2018), Sharma *et al.* (2017), Yadav et al. (2017), Parajuli et al. (2015), Sapkota (2007) reported significant effect (P<0.05), (P<0.05), (P<0.001), (P<0.05) and (P<0.001) of location on AFK in Sirohi, hill goats (Khari), Sirohi, Khari and the goats of multi-location (Chitwan, Udayapur, Siraha and Tanahun), respectively. Kolachhapati (2006), in his study, the goats in Surkhet, Kavre and Udayapur of Nepal, had different AFK i.e. 442.13, 320.41 and 405.00 days, respectively with significant effect (P<0.001) of location. Production system had significant (P<0.05) effect on AFK (Table 8). In grazing, does kids earlier i.e. at 469.05±6.95 days while of those does reared under stall feeding kidded later i.e. at 518.33±10.75 days, respectively. Similar, report (P<0.001) had been reported by Pandey (2007) in the study on goat breeds (Khari=549.50±18.69, Khari-Jamunapari cross= 696.36±18.69 and Khari-Barbari 588.05±18.69 days).

Table 1. Effect of non-genetic factors on age at first conception (days), age at first kidding (days) of Khari, Jamnapari cross and Sirohi cross (LS Mean±SEM)

Factors	No.	AFC	AFK
Overall mean	446	344.31±5.56	493.69±5.56
Location		**	**
Upper	299	361.67±9.02	511.06±9.02
Lower	147	326.95±7.55	476.32±7.55
Production system		***	***
Grazing	352	319.45±6.94	469.05±6.95
Stall-feeding	94	369.17±10.75	518.33±10.75
Breeds		* * *	***
Khari	263	293.06±6.09[b]	442.31±6.09[b]
Jamnapari cross	134	372.59±7.68[a]	521.97±7.68[a]
Sirohi cross	49	367.27±11.97[a]	516.79±11.97[a]
CV		26.18	17. 79

Note: **: Significant at 1% level (P<0.01); ***: Significant at 0.1% level (P<0.001); Means, within an effect, with the different superscript are significantly different; LS mean: Least square means; SEM: Standard error of Means; No: Number of observations; CV: Coefficient of variation

Postpartum estrus (PPE)

The result of this study revealed that the overall mean of postpartum estrus was 173.42±5.82 days (Table 2). This is longer than the findings Gautam (2017), Bhattarai (2017), Sapkota et al. (2017) Location did not play any significant role in PPE. In contrast, Gautam (2017), Sharma et al. (2017), Parajuli et al. (2015) and Sapkota (2007) reported significant effect of location and PPE at different level. In two locations does were almost of similar genetic makeup and mixed up by crossing, kids were not weaned forcibly and does auto wean the kids in similar time periods. There was non-significant effect of production system on PPE. The reason not be significant different may be does received similar nutrition in grazing as like install feeding practice. The breed also did not play any significant role in post partum estrus. Similar report was presented by Gautam (2017) and Pandey (2007) in a study on Khari and its cross with Jamnapari and Barbari does. Likewise, parity did not play any significant role in the PPE. Similar report was presented by Sapkota et al. (2017), and Sapkota (2007). However, in a similar study, Gautam (2017), Bhattarai (2017) and Parajuli (2012) and Bhattarai (2007) showed different level of significant effect of dam's parity (p<0.05; p<0.001; p<0.001 and p<0.01) on PPE duration, respectively. But season of conception had highly significant effect (P<0.001) on the PPE. Bhattarai (2017) and Sapkota et al. (2017) also obtained significant (p<0.01 and p<0.05) effect of season of conception on PPE. While, Bhattarai (2007), Pandey (2007) and Sapkota (2007) reported non-significant effect of parity on postpartum estrus of does.

Gestation length (GL)

In this study, it was revealed that the overall least square mean of gestation length was 148.93±0.24 days (Table 2). Location had non-significant effect on the GL of does. However, production systems showed significant (P<0.05) effect on the GL with the difference of exactly a day between does reared under grazing and reared under stall feeding (148.44±0.28 against 149.44±0.39 days). However, breed had no significant effect on the GL of does. Similar result (non-significant) was obtained by Gautam (2017) and Pandey (2007) in hill goats and its cross with Jamnapari and Barbari cross. Likewise, parity did not play any significant role in GL. But result of this study revealed that the season of conception of does had significant (P<0.001) effect on the GL. The spring conceived does have shortest GL whereas autumn conceived had longest gestation length (147.36±0.32 vs. 150.35±0.29 days) (Table 2).

Kidding interval (KI)

Result of this study revealed that the overall least square mean of kidding interval was 319.58±5.47 days (Table 2). In this study, location and production system did not play significant role in the KI. However, study discovered that the breeds/genetic groups of does had significant (P<0.001) effect on the KI. Khari had shortest kidding interval than Jamnapari cross followed by Sirohi cross. Similar report (P<0.001) was presented by Pandey (2007). Likewise, dams' parity had significant (P<0.01) effect on the KI. There was inverse relation between dams' parity and KI of dams. As the number of parity increases the kidding interval decreases. Also, the season of conception of dams had significant (P<0.01) effect on the KI. Winter conceived goat had shorter kidding interval than another season (Table 2).

Table 2. Effect of non-genetic factors on post partum estrus (days), gestation length (days), kidding interval (days) (LS mean±SEM)

Factors	No	Post partum estrus	Gestation length	Kidding interval
Overall mean	563	173.42±5.82	148.93±0.24	319.58±5.47
Location		NS	NS	NS
Upper	376	175.54±8.88	148.27± 0.37	328.89±8.35
Lower	187	171.29±7.99	149.60±0.33	310.28±7.52
Production system		NS	*	NS
Grazing	438	180.06±6.79	148.44±0.28	318.00±6.39
Stall-feeding	125	166.78±9.53	149.44±0.39	321.17±8.96
Breeds		NS	NS	***
Khari	150	168.67±5.66	149.17± 0.24	303.22±5.32[c]
Jamnapari cross	168	167.13±7.31	148.59±0.30	315.71±6.89[b]
Sirohi cross	56	184.46±10.49	149.05±0.44	339.83±9.87[a]
Dam's parity		NS	NS	**
Early	209	182.43±7.05	148.85±0.29	333.68±6.40[a]
Mid	281	175.07±5.9	149.13±0.25	316.45±5.60[b]
Late	73	162.75±9.96	148.83±0.41	308.63±9.38[c]
Season of Conception		***	***	***
Spring	127	190.86±7.75[b]	147.36±0.32[c]	328.14±7.29[b]
Summer rainy	237	198.45±5.98[a]	148.42±0.25[b]	339.69±5.62[a]
Autumn	171	159.10±7.02[c]	150.35±0 .29[a]	330.74±6.60[b]
Winter	28	145.26±14.59[d]	149.62±0 .61[a]	279.78±13.73[c]
CV		19.74	2.04	21.14

Note: *: Significant at 5% level (P<0.05); **: Significant at 1% level (P<0.01); ***: Significant at 0.1% level (P<0.001); NS: Non-significant at 5% level (P≥0.05); Means, within an effect, with the different superscript are significantly different; LS mean: Least square means; SEM: Standard error of Means; No: Number of observations, CV: Coefficient of variation

Effect of non-genetic factors on litter traits

Litter size at birth (LSB)

In this research, liter size at birth was 1.43±0.04 kids/parity (Table 3). Similar report (1.45±0.02) was presented by Bhattarai (2017) in a study on morphometric characters of hill goat. Larger value (1.49±0.047, 1.51±0.05, 1.76±0.08, 1.7±0.66, 1.70±0.05, 1.49±0.04, 1.63±0.06 and 1.57±0.084) was obtained by Bhattarai (2007), Sharma et al. (2017), Gautam (2017), Menezes et al. (2016), Rhone (2014), Pandey (2007), Sapkota (2007) and Shrestha (2002) in a study on Terai goats, Khari goats, Khari and its cross with Jamnapari, pure Boer, Boer-Spanish cross breeds and kids from multi-location (Chitwan, Udayapur, Siraha and Tanhun) of Nepal respectively. In this study, location did not play any significant role in the LSB and similar report (non- significant) was also presented by Gautam (2017) in a study on Khari and its cross with Jamnapari. In contrast, Bhattarai (2017), Sharma et al. (2017), Sapkota (2007) and Pandey (2007) reported highly significant effect ($P<0.001$) of location on LSB. Similarly, production system had played non insignificant effect in the LSB. Likewise, non-significant effect of breeds with respect to LSB was seen in this study. Similar report (non-significant) was obtained by Okere (2011) in a study on reproductive performance of Boer and Kiko (2.08±0.16 and 2.17±0.03), Browning et al. (2011), in a study on Boer (1.83±0.06), Kiko (1.84±0.06) and Spanish (1.93±0.06) and Shrestha (2002) in Terai and Barbari goats (1.61±0.214 and 1.53±0.283), respectively

But highly significant ($P<0.001$) effect of parity on LSB was seen in this study. A highly significant ($P<0.001$) effect was also obtained by Pandey (2007) in a study on hill goats and Sapkota (2007), in a study on goats from multi-location of Nepal while Bhattarai (2007), in the study on Terai goat of Nepal, obtained non-significant effect of parity on the LSB. Similarly, kidding season had significant effct ($p<0.05$) on LSB was seen in this research. Similar report ($P<0.05$), ($P<0.001$) and ($P<0.001$) was also obtained by Gautam (2017) in study on Khari and Khari-Jamnapari cross, Pandey (2007) Khari, Khari-Jamnapari cross and Khari-Barbari cross does and Sapkota (2007) in the does from multi-locations (Chitwan, Udayapur, Siraha and Tanhun district) of Nepal. While, Bhattarai, (2007) in a study on hill goats in Nawalparasi district of Nepal, obtained non-significant effect of season with respect to litter size at birth.

Litter weight at birth (LWB)

Result of this research revealed that the overall least square mean of litter weight at birth was 5.16±0.11 kg Table 3). Several authors found lower LWB and among them, Bhattarai et al. (2015), Bhattarai (2007), Pandey (2007), Sapkota (2007) and Shrestha (2002) obtained as 3.97±0.06, 3.41±0.09, 3.03±0.07, 3.14±0.12 and 2.62±0.124 kg, respectively. Location as a non-genetic factors played non-significant effect on LWB. Similar report (non-significant effect of location) was reported by Gautam (2017), Bhattarai et al. (2015) and Pandey (2007) in the study on hill goats and Terai local goats. However, production system had played highly significant effect ($P<0.001$) on the LBW. While in similar study, non-significant effect of production system was reported by by Gautam (2017) in a study on Khari and its cross with Jamnapari breed. Breed/genetic group had significant ($P<0.05$) effect on LWB. In contrast, Pandey (2007) had obtained non-significant result while studying the hill goats and its cross with Jamnapari and Barbari goats and Shrestha (2002) had also obtained non-significant result while studying Terai and Barbari goats. Similarly, highly significant effect of parity ($P<0.001$) with respect to LWB was observed in this study as observed by Pandey (2007) and Gautam (2017) in a study on hill goats. LWB being higher at later parities might be because of better reproductive efficiencies and mature reproductive system in later parities. But non-significant effect of of kidding season was seen with regard to LWB. Similar report (non-significant) was presented by Gautam (2017) in a study on litter weight born in different months (March, April, May and June). Bhattarai (2007) and Shrestha (2002) also studied the effect of kidding season dividing the whole year into 3 consecutive season and obtained non-significant results. Even after dividing the whole year into two season (wet and dry), Pandey (2007) and Sapkota (2007) reported non-significant effect of kidding season.

Table 3. Effect of non-genetic factors on litter size and weight (kg) at birth and weaning (LS Mean±SEM)

Factors	No	Litter size at birth	Litter weight at birth	No	Litter size at weaning	Litter weight at weaning
Overall mean	640	1.43±0.04	5.16±0.11	613	1.37±0.36	28.00±0.68
Location		NS	NS		NS	**
Upper	437	1.36±0.05	5.02±0.17	417	1.30±0.05	26.04±1.02
Lower	203	1.49±0.05	5.29±0.16	196	1.44±0.05	29.98±0.98
Production system		NS	***		NS	**
Grazing	506	1.41±0.04	4.67±0.12	480	1.38±0.04	26.17±0.81
Stall feeding	134	1.44±0.06	5.64±0.18	133	1.36±0.06	29.85±1.11
Breeds		NS	*		NS	*
Khari	392	1.44±0.04	4.92±0.11[b]	380	1.38±0.03	26.91±0.66[c]
Jamunaari cross	186	1.42±0.05	5.14±0.14[b]	177	1.36±0.04	29.16±0.85[a]
Sirohi cross	62	1.42±0.07	5.41±0.21[a]	56	1.38±0.07	27.94±1.28[b]
Dams' Parity		***	***		***	***
Early	232	1.28±0.04[c]	4.64±0.25[b]	217	1.25±0.04[c]	25.83±0.80[c]
Mid	316	1.41±0.04[b]	5.08±0.29[ab]	309	1.37±0.04[b]	27.89±0.70[b]
Late	92	1.58±0.06[a]	5.74±0.19[a]	87	1.50±0.06[a]	30.29±1.14[a]
Kidding Season		*	NS		*	NS
Spring	94	1.42±0.06[c]	4.99±0.17	92	1.39±0.05[b]	27.47±1.03
Summer rainy	36	1.40±0.09[b]	5.18±0.26	34	1.35±0.08[c]	28.08±1.61
Autumn	285	1.37±0.04[b]	5.14±0.19	270	1.31±0.04[d]	27.59±0.73
Winter	225	1.51±0.04[a]	5.32±0.13	217	1.44±0.04[a]	28.88±0.73
CV		16.13	23.00		35.72	35.24

Note: *: Significant at 5% level (P<0.05); **: Significant at 1% level (P<0.01); ***: Significant at 0.1% level (P<0.001); NS: Non significant at 5% level (P≥0.05); Means, within an effect, with the different superscript are significantly different; LS mean: Least square means; SEM: Standard error of Means; No: Number of observations, CV: Coefficient of variation

Litter size at weaning

The overall mean litter size at weaning was 1.37±0.36 kids/parity (Table 3) which was closer to observation of Bhattarai (2017) and Shrestha (2002) as (1.36±0.02 and 1.42±0.075) respectively. A non-significant effect of location on LSW was seen. Similar report of non-significant effect of location was also reported by Gautam (2017) and Bhattarai (2017). Production system and breed was also non-significant with regard to LSW. Regarding the breed, similar (non-significant) relation was obtained by Gautam (2017) in a study on kids born from Khari and Khari-Jamnapari cross does crossed with 100% Boer buck. But, does which were of late parity produce significantly higher (1.50±0.06) LSW. Bhattarai (2017) and Sapkota (2007) reported highly significant (P<0.001) effect of dam's parity on the LSW. Pandey (2007) also reported significant (P<0.05) effect of dam’s parity on litter size at weaning. Similarly, kidding season had played significant (P<0.05) effect on the LSW. Gautam (2017), in a study on LSW, born in different months (March, April, May and June) found non-significant and Pandey (2007) and Spakota (2007) also found non-significant effect of kidding season on liter size at weaning.

Litter weight at weaning

The overall mean of litter weight at weaning was 28.00±0.68 kg (Table 3). In the study on Nepalese hill goats by Bhattarai et al. (2015), hill goats and its 50 % (crossed with Jamnapari and Barbari) goat by Pandey (2007) and Terai goats by Bhattarai (2007) reported LWW as 18.21±0.34, 11.94±0.64 and 13.83±0.55 kg, respectively. Significant influence of location on the LWW (p<0.01; and p<0.001) was presented by Bhattarai et al. (2017) and Sapkota (2007) while studying the effect of location on LWW as in the line of this study. Production system also had played significant (P<0.01) role on the LWW. The kids born in stall feeding were of large size. Breed too played significant (P<0.05) role in LWW. Here, the reason behind significant was that the larger breeds get better management and have higher milking ability than other (Khari and Sirohi). Similarly, dams' parity had significant effect (P<0.001) on the LWW. The effect of dams' parity to LWW was also observed significant by, Bhattarai et al. (2015) (P<0.001), Bhattarai (2007) (P<0.001) and Sapkota (2007) (P<0.001) too. But non-significant effect of kidding season on LWW was seen in this study. Similar report (non-significant) was presented by Sapkota (2007) and Pandey (2007) whereas, Gautam (2017), Bhattarai et al. (2015) and Shrestha (2002) reported significant effect (P<0.01) of kidding season on liter weight at weaning.

CONCLUSION

Production systems and breeds are important non-genetic factor affecting reproductive traits whereas parity is the most important non genetic factor affecting litter traits of goat. Almost all the reproductive traits were seen better in grazing system in Khari breed. Similarly, all the litter traits and performance in all the breeds were better in later parities. PPE is better in goats which kidded in winter. Hence, based on the findings of present study, it can be concluded that Khari is high potential goat with respect to its reproductive traits with a massive scope of improvement in its litter weight through selection within the population and cross breeding.

ACKNOWLEDGEMENTS

Authors would like to express their sincere gratitude to Directorate of Research and Extension, Agriculture and Forestry University, Rampur, Chitwan; Veterinary Hospital and Livestock Service Office, Birendranagar, Surkhet and goat rearing farmers of Surkhet for their respective support in carrying out this research and preparing this manuscript in its current form. In addition, we would also like to express our heartily acknowledgements to Mr. Surya Prasad Sharma for his invaluable time and effort while preparing this manuscript.

REFERENCES

AFSP (2016). Annual progress report of Agriculture and Food Security Project, Gairidhara, Kathmandul. 56.

Bhattarai, N. (2007). Morphological characterization and productive performance of terai goat in Siraha, Nepal. (Unpublished master's thesis). Tribhuvan University, Institute of Agriculture and Animal Sciences, Rampur, Chitwan. 89-99.

Bhattarai, N. (2017). Morphometric characterization and estimation of genetic parameters of Nepalese hill goat (*Capra hircus* L.) in Nawalparasi, Nepal. (Unpublished PhD Dissertation). Tribhuvan University, Institute of Agriculture and Animal Science, 113-312.

Bhattarai, N., Kolachhapati, M. R., Devkota, N. R., Thakur, U. C. & Neopane, S. P. (2017). Estimation of Genetic Parameters of Growth Traits of Khari Goat Kids (*Capra hircus* L.) in Nawalparasi, Nepal. *International Journal of Livestock Research*, *7*(1), 80-89. 10.5455/ijlr.20161218124223

Bhattarai, N., Kolachhapati, M. R., Devkota, N. R., Thakur, U. C., & Neopane, S. P. (2015). Estimation of genetic parameters of litter weights of Khari goats and their response towards different non-genetic factors under low input management system in Nawalparasi, Nepal. *Journal of the Institute of Agriculture and Animal Science*, *33-34*. 251-258. https://doi.org/10.3126/jiaas.v33i0.20712

Browning, R., Leite-Browning, M. L. & Byars, M. (2011). Reproductive and health traits among Boer, Kiko, and Spanish meat goat does under humid, subtropical pasture conditions of the southeastern United States. *Journal of Animal Science*. *89*(3), 648–660. http://doi.org/10.2527/jas.2010-2930

CAQO. (2017). Annual progress report of Central Animal Quarantine Office, Hariharbhawan, Lalitpur, Nepal. 25.

CBS. (2012). Brief Agriculture Statistics of Agri Census 2011. Central Bureau of Statistics, Nepal. 43.

Devkota, N. R. (2003). Production Problems and Potentials of Livestock Sub-system in the Hills of Nawalparasi District. *Nepal Journal of Science and Technology*, *5*(1), 31-35.

DLS. (2016). Annual Progress Report of Department of Livestock Service, Hariharbhawan, Lalitpur

DLS. (2019). Annual Progress Report of Department of Livestock Service, Hariharbhawan, Lalitpur

Duncan, D.B. (1955). Multiple Range and Multiple F Tests. *Bio-metrics*, *11*, 1-42.

Gautam, B. R. (2017). Comparative evaluation of growth performance of Khari and its crosses with different blood level of Boer goats in the western hills of Nepal. (Unpublished master's Thesis). Institute of Agriculture and Animal Science campus, Kritipur, 52-102.

Gautam, L., Nagda, R. K., Nehra, K. S., & Singh, M. K. (2018). Studies on average daily gains of Sirohi goats in the breeding tract. *Indian Journal of Small Ruminants*, *24*(2), 243-247.

Gautam, L., Waiz, H. A., & Nagda, R. K. (2018). Evaluation of the reproductive characteristics of Sirohi goats from Udaipur India. *6*(3): 13-17

GRS. (2014) Annual Progress Report, Goat Research Station, Bandipur, Government of Nepal, Nepal Agricultural Research Council. 13-14.

Harvey, W.R. (1990). Users' guide for LSMLMW and MIXMDL.PC-2 version. Mixed Model Least squares and Maximum Livelihood Computer Program.

Kharel, M. & Neopane, S. P. (1997). Goat Genetic Resources. J. N. B. Shrestha (edited), Proceedings of the First National Workshop on Animal Genetic Resources Conservation Genetic Improvement of Domestic Animals in Nepal, Nepal Agricultural Research Council Khumalatar, Lalitpur, Nepal. 48-54.

Kolachhapati, M. R. (2006). Phenological study on hill goats under different management systems and nutritional regimes. (Unpublished PhD thesis). Institute of Agriculture and Animal Sciences, Rampur, Chitwan. 131-187.

Kunwar, B. S. (2000). Identification of different types and sub-types through morphological and biochemical analysis, (Unpublished Master's Thesis). Institute of Agriculture and Animal Science, Rampur, Chitwan. 71-89

Lu, C. D. (2001). Boer goat production: Progress and perspective. In Proceedings of the 2001 International Conference on Boer Goats in China, Guizhou, China.

Menezes, L. M., Sousa, W. H., Filho,E. P. C. & Gama, L. T. (2016). Genetic parameters for reproduction and growth traits in Boer goats in Brazil. *Small Ruminant Research*. *136*. 247-256. https://doi.org/10.1016/j.smallrumres.2016.02.003

Neopane, S.P. (1997). Genetics of productive traits in a Nepalese Hill goat flock. (Unpublished PhD Thesis). University of London, UK. 278.

Okere, C., Streeter, J., Solaiman, S., & Gurung, N. (2011). Critical analysis of reproductive performance in Boer and Kiko meat goat herd under semi-intensive management system. *International Journal of Applied Agricultural Research*, *6*(2), 145-151.

Pandey, S. R. (2007). Performance of Khari goat and its crosses in the hills of Tanahun district, Nepal. (Unpublished master's thesis). Tribhuvan University, Institute of Agriculture and Animal Sciences, Nepal.

Parajuli, A. K. (2012). Morphometric Characterization and Performance Evaluation of Hill Goat in Mid Hills of Nawalparasi District of Nepal. Unpublished master's thesis). Institute of Agriculture and Animal Sciences, Rampur, Chitwan.

Parajuli, A. K., Kolachhapati, M. R., Bhattarai, N., & Devkota, N. R. (2015). Effect of non-genetic factors on reproductive performance of hill goat in Nawalparasi, Nepal. *Nepalese Journal of Animal Science*, 29-40.

Pokhrel, P.K. & Khanal, D.R. (2006). Reproductive efficiency of hill goats in Eastern Nepal. Proceeding of 6th National Workshop on Livestock and Fisheries Research in Nepal, Khumaltar, Lalitpur, 1-2 July, 29-32.

Rajwar, N. B. (2012). National Goat Development Strategies and Outcomes. Proceeding of the National Workshop on Research and Development Strategies for goat enterprise in Nepal. 1-6.

Rasali, D.P. & Khanal, R.C. (1998). Productive performance of indigenous strains of goats under Lumle Farm Management: Khari goats and Khari x Sinhal crosses. LARC working paper No. 98/1. Lumle Agricultural Research Centre, Kaski.

Rhone, J. A., Waldron, D. F., & Herring, A. D. (2014). Performance of Boer-Spanish and Spanish goats in Texas I: Body weight, fertility, prolificacy, and number of kids weaned. *Journal of Animal Science*, *91*(10), 4679-4683.

Sapkota, S. (2007). Comparative performances of goats representing eastern, central and western development regions of Nepal. (Unpublished master's thesis). Institute of Agriculture and Animal Sciences, Rampur, Chitwan. 40-79.

Sapkota, S., Shrestha, S., Gorkhali, N. A., Bhattarai, N., Kolachhapati, M. R., & Shrestha, Y. K. (2017). Estimation of genetic parameters and effect of non-genetic factors on weight and reproductive traits of goat from Central Terai region of Nepal. *Nepalese Journal of Agricultural Sciences*, *15*, 107.

Sharma, S.P., Bhattarai, N., & Sapkota, S. (2017). Evaluation of Reproductive Efficiency of Nepalese Hill Goat (*Capra hircus* l.) in Western Nepal. *International Journal of Livestock Research, 7*(9), 107-116. DOI: 10.5455/ijlr.20170716124713

Waiz, H. A., Gautam, L., Sharma, M. C., & Ashraf, S. (2018). Study on Female Reproductive Performance of Sirohi Goat Managed under Farm and Field Cluster in Southern Rajasthan, India. *International Journal Current Microbiology*, *7*(6), 885-890.

Yadav MC, Kumar A, Jinger SC, Lawania P, Bugalia HL, Jatolia P. (2017). Reproductive performance of Sirohi goat flock under field condition. *International Journal of Current Microbiology and Applied Sciences*, *6*(10), 4704-4708.