Journal of Animal and Veterinary Advances 10 (9): 1158-1165, 2011
ISSN: 1680-5593

Reproductive Performances and Survival of Washera Sheep under Traditional Management Systems at Yilmanadensa and Quarit Districts of the Amhara National Regional State, Ethiopia

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Abstract: On-farm data were collected to evaluate reproductive performance and survival of Washera sheep raised under traditional smallholder production systems in the North-Western highlands of the Amhara National Regional State, Ethiopia. The data were from flocks of 110 households from October, 2004 to September, 2007. Mean age and weight at first lambing were 464.2±14.0 days and 24.7±0.5 kg, respectively. None of the fixed effects considered affected age at first lambing although, weight at first lambing was affected ($p<0.05$) by district and parity. Ewes from primiparous ewes and from Quarit district had heavier weight at their first lambing. Lambing interval (269±6.2 days) was affected by district, lambing season, parity and birth type. The average number of lambs per ewe lambing was 1.19±0.02 and varied ($p<0.0001$) with lambing year and postpartum ewe body weight. Mean postpartum ewe body weight was 31.0±0.2 kg and influenced ($p<0.01$) by district, year, season, parity and type of birth. Cumulative survival from birth to 30, 90, 180, 270 and 365 days was 98.4±0.6, 93.6±0.9, 91.2±1.1, 90.0±1.2 and 89.9±1.2 days, respectively. Except at the age of 30 days, district, season, birth type and birth weight affected ($p<0.05$) survival. No interactions between any fixed effects were significant and thus were removed from the model. Postpartum ewe body weight as a covariate did not affect litter size. The higher survival rate indicates that the area is of low disease load and the farmers practice to decrease lamb mortality need to be encouraged and improved. The influence of different fixed effects on reproductive performances indicated that through different management and breeding practices it is possible to increase the productivity of these breed of sheep.

Key words: Washera breed, reproduction, survival, smallholder production, postpartum, Ethiopia

INTRODUCTION

Sheep production is an important agricultural activity in the mixed crop livestock farming systems of Ethiopia, by providing cash income from sale of live sheep, meat and skin, manure and social and cultural functions for the farm household. There are >9 distinct breeds of sheep (Gizaw *et al*., 2007) and 21 million sheep in Ethiopia of which 70% are found in highland areas (Alemayehu Mengistu, 2003). However, due to environmental factors such as seasonal variation in feed availability, poor management and diseases (including internal and external parasite), animal productivity is very low.

Reproductive performance and survival rate are the most important traits in all sheep production enterprises because productivity is the combined result of reproductive efficiency (including young and adult mortality) and yield and quality of the final products (Mukasa-Mugerwa and Lahlou-Kassi, 1995; Matika *et al*., 2003b). This study reports the reproductive performances and survival of Washera sheep and the most important

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factors affecting these traits to identify areas for increased research and/or extension attention under the traditional management systems of the Amhara National Regional State, Ethiopia.

MATERIALS AND METHODS

Study area: The study was conducted in two districts, Yilmanadensa and Quarit in the North-Western highlands of Ethiopia. The project site in the Yilmanadensa district was the Mentadebir Peasant Association (PA), located approximately 60 km south-east of Bahir Dar, capital of Amhara National Regional State (11°10'-11°15'N and 37°30'-37°40'E). Yilmanadensa has an altitude of 2300 m.a.s.l., a uni-modal type of rainfall with an annual mean of 1270 mm occurring primarily from May to October. The second project site in the Quarit district was the Enangiashime PA. Enangiashime is located approximately 280 km south of Bahir Dar (11°00'N and 37°20'-37°30'E). Enangiashime has an altitude of 2100 m.a.s.l. and receives an average annual rainfall of 1400 mm. Estimated average minimum and maximum air temperatures in the two districts are 13 and 24°C, respectively.

Animals and management

Description of the breed: Washera sheep are also called Dangla. This breed is characterized by large body size, a wide fat-tail usually curved upward at the tip, horizontally carried or semi-pendulous long ears, hornless and a slightly concave facial profile. These sheep have long and thin legs, long neck and a prominently protruding brisket. Three patterns of coat colour are observed (plain, patchy and spotted) in which they have reddish brown coats with white patches or spots usually on the forehead and lower parts of the legs; plain reddish brown and plain white are dominant colour types (Lemma, 2002).

Flock management: Farmers herd their sheep together in group on communal grazing land called sheha/amaga during the day and depart for the night-time enclosure to which they were housed together with other livestock separated by a woodlot. Some sheep in small flocks were tied to a peg. The main feed source in the study area was communal natural grazing pasture. During crop harvesting times, sheep had access to browse crop aftermath. Some farmers gave supplemental feed (straw, local brewery by product-Atela, salt and roasted bean) for pregnant, suckling and castrated rams.

Breeding was year-round. Rams were selected for their conformation (body size, color and appearance), with maternal history (e.g., dam color, twining rate and general health) sometimes considered. Rams were allowed to mate during the day with any ewe in heat. Ram lambs born in the flock not needed for breeding purposes were sold or castrated before reaching breeding age.

Animals were de-wormed three times annually (i.e., onset and end of the rainy season and middle of the dry season). They were sprayed for external parasites as needed. Vaccinations were given once yearly for pasteurellosis, anthrax and black leg.

Source and management of data: Data were collected from October, 2004 to September, 2007 as part of the Community and Conservation based Improvement Scheme (program) for Washera Sheep. Flocks of 110 households participated. On-site trained enumerators were supervised by researchers of the Andassa Livestock Research Center through monthly visits. Animal identification was with permanent plastic ear tags applied at birth or the time of purchase. Data collected within 24 h of birth included birth date, birth weight, postpartum ewe body weight, type of birth, sex of lamb and parity number of the dam.

Statistical analysis: Data on reproductive performances and survival were analyzed using least squares procedures of the General Linear Model procedure of Statistical Analysis System (SAS, 2003). Fixed effects considered were district, season, parity, type of birth (for age at first lambing and weight at first lambing) and year, Postpartum ewe body weight (PPwt) (for Lambing Interval (LI) and Litter Size (LS)) and birth weight and sex of lamb (for survival). Interactions between fixed effects were not significant and thus were removed from models. Likewise, PPwt as a covariate for survival was not significant.

Wet and dry seasons were May-October and November-April. Ewe postpartum body weight was categorized as light, medium and heavy for the lower 25%, middle 50% and upper 25%, respectively. Type of birth or litter size was single or multiple. Birth weight was classified as light, medium and heavy with values of <2, 2-3 and >3 kg, respectively. The statistical model used was:

$$Y_{ijklmnopq} = \mu + D_i + Y_j + S_k + P_l + T_m + PPwt_n + G_o + Bwt_p + e_{ijklmnopq}$$

Where:

$Y_{ijklmnopq}$ = The observation on age and weight at first lambing, LI, LS, PPwt and Surival
μ = Overall mean
D_i = Effect of district (i = Yilmanadensa, Quarit)
Y_j = Effect of year (j = 2004, 2005, 2006, 2007)

S_k = Effect of season (k = Dry, Wet)
P_l = Effect of dam parity (l = 1, 2 … ≥6)
T_m = Effect of lamb birth type (m = Single, Multiple)
PPwt = Effect of postpartum ewe body weight (n = Light, Medium and Heavy)
G_o = Effect of lamb sex (o = male, female)
Bwt_p = Effect of birth weight (p = Light, Medium and Heavy)
$e_{ijklmnopq}$ = Effect of random error

RESULTS AND DISCUSSION

Age and weight at first lambing: The least squares mean of age and weight at first lambing is shown in Table 1. The mean age At First Lambing (AFL) obtained (464.2±14.0 days) is within the range of values reported for other breeds of sheep in the tropics (Demeke *et al*., 1995; Mukasa-Mugerwa and Lahlou-Kassi, 1995; Osuho *et al*., 1997; Gbangboche *et al*., 2006; Guangul, 2007).

None of the fixed effects considered influenced (p>0.05) age at first lambing in Washera sheep. This is in agreement with Osuho *et al*. (1997) who reported non-significant effect of year of lambing, litter size and birth weight in Yankasa sheep. This result however, dis-agrees with results of Galina *et al*. (1996) and Gbangboche *et al*. (2006) who reported significant effect of season of birth and type of birth on AFL, birth weight (Galina *et al*., 1996) and year of birth (Gbangboche *et al*., 2006).

The overall least squares mean weight at first lambing found in this study (24.7±0.5 kg) is greater than the value reported for Menz sheep (Demeke *et al*., 1995). District and parity of the dam to which the primiparous ewe was born showed a significant (p<0.05) effect on the weight at first lambing. Ewes at Yilmanadensa had significantly lower weight than their Quarit contemporaries (23.7±0.7 vs. 25.7±0.7; p<0.05). This may be partially because though not significant, primiparous ewes at Yilmanadensa gave birth at earlier age (18 days earlier on average) than ewe in Quarit. The positive correlation between body weight and age at first lambing showed considerable variation in Djallonke sheep, ewes with the lowest age and body weight lambed prematurely (Gbangboche *et al*., 2006).

Table 1: Factors affecting age and weight at first lambing of Washera sheep

	Age at first lambing (days)		Weight at first lambing (kg)	
Source of variation	N	LSM±SE	N	LSM±SE
Overall	103	464.2±14.0	82	24.7±0.5
District		NS		*
Yilmanadensa	44	455.2±19.3	43	23.7±0.7
Quarit	59	473.1±17.1	39	25.7±0.7
Birth season		NS		NS
Dry	55	475.5±16.3	45	25.0±0.6
Wet	48	452.8±18.4	37	24.4±0.7
Parity		NS		*
1	10	448.2±37.6	8	27.5±1.5[a]
2	19	476.4±25.5	15	23.5±1.0[b]
3	21	463.1±22.6	16	26.0±0.9[ab]
4	23	473.5±21.6	17	23.4±0.9[b]
5	14	457.8±28.0	11	24.1±1.1[b]
≥6	16	465.9±28.0	15	23.7±1.0[b]
Birth type		NS		NS
Single	62	454.5±13.7	51	25.2±0.5
Multiple	41	473.8±22.0	31	24.2±0.8

Means with different letters (a-c) within a trait in a column are different at indicated p-value; N Number of observations, NS Non-Significant (p>0.05); *p<0.05

Lambing Interval (LI): The overall least squares mean lambing interval (268.57±6.22 days) is within the range of values obtained for tropical breeds of sheep. Guangul (2007) found 199.2±33.9 days for Gumuz sheep while Seabo *et al*. (1996) reported 365±28.5 days for Tswana sheep. The variation between estimates reflects the effect of different management practices, nutrition, lactation, control of reproduction management and level of genetic makeup on possibilities for prompt re-conception after lambing (Mukasa-Mugerwa and Lahlou-Kassi, 1995; Gbangboche *et al*., 2006).

The lambing interval was longer for ewes at Yilmanadensa than Quarit (285.05±6.84 vs. 252.09±7.78; p<0.0001). This could be associated to flock management differences in the two areas. For example in Quarit farmers wean lambs when suckling is prolonged while in Yilmanadensa weaning is not a common practice. Positive correlation between lactation and lambing interval has been reported earlier by Galina *et al*. (1996).

Year and season exerted a significant (p<0.05) influence on lambing interval. Ewes that lambed during the wet season had shorter interval than those lambed in dry season. This is in agreement with previous findings (Mukasa-Mugerwa and Lahlou-Kassi, 1995; Galina *et al*., 1996; Maria and Ascaso, 1999) and could be related to availability of nutrition during parturition and lactation as affecting ewes recovery (weight gain and improvement in body condition) to come to heat early (i.e., short anoestrus interval). The interval from lambing to conception largely determines the lambing interval (Mukasa-Mugerwa and Lahlou-Kassi, 1995). Nutritional status of the ewe during the last third of gestation and early lactation also play an important role in the return to activity postpartum (Galina *et al*., 1996). Song *et al*. (2006) also reported a significant effect of season on the kidding interval of Korean native goats explaining the differences of sexual activity of does between the seasons.

The effect of parity on lambing interval was significant (p<0.05). Maiden ewes had the longest lambing interval and fifth parity ewes lambed with shortest interval (308.2±9.0 vs. 245.5±7.1; $p<0.0001$). Similar observation was reported for Djallonke sheep (Gbangboche *et al*., 2006). The longer lambing interval for young ewes suggests that young ewes take longer to regain condition after lambing (Ibrahim, 1998).

Ewe postpartum body weight did not have a significant ($p>0.05$) effect on lambing interval although there was a slight trend that indicated that lambing interval decreased as postpartum weight increased. Gbangboche *et al*. (2006) observed a negative correlation between lambing interval and postpartum ewe body weight suggesting that lambing interval tend to decrease with heavy ewes.

The number of lambs that the ewe gave in the previous lambing showed a significant difference on lambing interval. This finding is in general agreement with the results of Maria and Ascaso (1999). Ewes that gave birth to singles had shorter ($p<0.001$) interval than multiple born ewes. It has been shown that ewes suckling twin/multiple lambs produce more milk and hence may have to mobilize their body reserves to sustain milk production for the young's (Maria and Ascaso, 1999). This would lead in prolonged postpartum breeding and subsequently to long lambing interval.

Seasonality of lambing: As other tropical sheep breeds, Washera sheep are not seasonal breeders and there were a considerable number of births every month (5.5-11.8%) with a peak occurring in August (11.8%) which is a big rainy season and February (11%), dry season (Fig. 1). Chi-square test showed that there was no significant difference ($p>0.05$) in the number of lambings between the two seasons in the study areas. The effect of season on birth was less pronounced for most African small ruminants where lambs are born year round (Legesse, 2008).

Prolificacy (litter size): The overall least squares mean litter size in the present study (1.19±0.02 lambs per ewe lambing) is in agreement with the literature for Menz and Horro sheep (Mukasa-Mugerwa and Lahlou-Kassi, 1995; Mukasa-Mugerwa *et al*., 2002; Berhan and van Arendonk, 2006) and for Gumuz sheep (Guangul, 2007) but lower than the reports for Horro sheep (Abegaz *et al*., 2000; Solomon and Gemeda, 2000) and Legesse (2008) for Adilo and Kofele sheep.

Lambing year and postpartum ewe body weight had significant ($p<0.0001$) influence on litter size whereas the difference in litter size due to district, lambing season and parity were not significant ($p>0.05$). Ewes lambed during the year 2004 were more prolific than ewes lambed in other following years. There was a clear decreasing trend in litter size from year 2004-2007. This might partly because the lambing interval was decreasing which could decrease body condition at mating. Abegaz *et al*. (1996) and Abegaz *et al*. (2002) also found a significant effect of year on prolificacy.

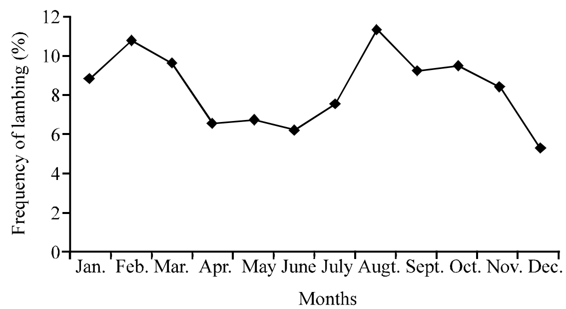

Fig. 1: Monthly lambing frequencies of Washera sheep at Yilmanadensa and Quarit districts

Unlike the current result, a significant effect of season and parity on litter size is reported in the literature (Maria and Ascaso, 1999; Mourad *et al*., 2001; Suleiman *et al*., 2005; Berhan and van Arendonk, 2006; Legesse, 2008; Ali *et al*., 2009).

Postpartum ewe body weight was a significant source of variation in litter size. Heavy ewes gave higher ($p<0.01$) litter than light weight ewes. This might partly because of the better body condition of ewes at conception which affect the number of ova shed and fertilized (Mellado *et al*., 2006). In addition, during gestation there would be less embryonic mortality with those good condition ewes. Ewes that have been flushed and gain in weight just before breeding will usually shed more ova and thus deliver more lambs. Michels *et al*. (2000) found out a positive and significant correlation between pre-mating ewe weight and prolificacy. This finding is in agreement with Segura *et al*. (1996) who reported that ewes with weights lower than the mean of their group had fewer multiple births than ewes with higher weight in Pelibuey and Blackbelly sheep.

Postpartum ewe body weight: The overall least squares mean postpartum ewe body weight is shown in Table 2. The fixed effects considered significantly affected postpartum ewe body weight. Quarit ewes were heavier after lambing than Yilmanadensa ewes (32.5±0.2 vs. 29.4±0.2; $p<0.0001$). The influence of year of lambing was the worst for the year 2007 and best for 2004 (29.5 vs. 32.6; $p<0.0001$). There was a decreasing trend in weight with increasing year. This might be because the lambing interval is decreased with years which could have effect on the body weight of ewes. Ewes lambed during the dry season had heavier ($p<0.01$) weight than their wet season

Table 2: Factors affecting lambing interval, litter size and postpartum ewe body weight of Washera sheep

	Lambing interval (days)		Litter size (number)		Postpartum ewe body weight (kg)	
Source of variation	N	LSM±SE	N	LSM±SE	N	LSM±SE
Overall	511	268.57±6.22	1080	1.19±0.02	924	31.0±0.2
District	-	****	-	****	-	****
Yilmanadensa	313	285.05±6.84	656	1.13±0.01	544	29.4±0.2
Quarit	198	252.09±7.78	424	1.24±0.02	380	32.5±0.2
Lambing year	-	***	-	NS	-	****
2004	34	300.90±14.24[a]	68	1.20±0.04	41	32.6±0.5[a]
2005	185	276.01±6.68[ab]	287	1.22±0.02	247	31.2±0.2[b]
2006	250	267.88±5.93[b]	392	1.18±0.02	365	30.7±0.2[b]
2007	42	229.49±12.71[c]	333	1.15±0.02	271	29.5±0.2[c]
Lambing season	-	**	-	NS	-	**
Dry	290	279.80±6.41	569	1.19±0.01	488	31.3±0.2
Wet	221	257.35±7.91	511	1.18±0.02	436	30.7±0.2
Parity	-	*	-	NS	-	****
1	71	307.01±11.22[a]	179	1.11±0.03	75	26.2±0.4[c]
2	73	268.46±10.60[b]	168	1.18±0.03	135	30.4±0.3[b]
3	87	264.91±10.06[b]	162	1.18±0.03	152	31.4±0.3[a]
4	100	256.53±9.84[b]	174	1.21±0.03	160	32.2±0.3[a]
5	79	256.20±10.58[b]	139	1.21±0.03	138	32.9±0.3[a]
≥6	101	258.32±9.65[b]	258	1.23±0.02	264	32.8±0.2[a]
Postpartum ewe body weight[1]	-	NS	-	*	-	-
Light	81	282.46±12.28	249	1.14±0.03[b]	-	-
Medium	300	262.33±6.65	591	1.17±0.01[ab]	-	-
Heavy	130	260.92±8.08	240	1.25±0.02[a]	-	-
Birth type	-	*	-	-	-	****
Single	405	259.06±5.85	-	-	641	30.4±0.2
Multiple	106	278.08±8.98	-	-	283	31.5±0.2

Means with different letters (a-c) within a trait in a column are different at indicated p-value; N number of observations, NS Non-Significant (p>0.05) *p<0.05; **p<0.01; ***p<0.001; ****p<0.0001; [1]Postpartum ewe body wt: Light (lower 25% quartile), Medium (the middle 50%), Heavy (upper 25% quartile)

lambed contemporaries. Gbangboche *et al.* (2006) had reported a similar effect of season and year in Djallonke sheep.

Increased parity resulted in increased postpartum body weight. It has increased from 26.2±0.4 kg at first parity to 32.9±0.3 kg at fifth parity and the difference was significant ($p<0.0001$). This is because young ewes are still growing; weight could increase to a certain age which is in agreement with Matika *et al.* (2003a) and Gbangboche *et al.* (2006).

Type of birth exerted a significant effect on postpartum ewe body weight. Multiple lambed ewes were heavier than single lambed ewes (31.3±0.2 vs. 30.7±0.2; $p<0.0001$). This might partly be related to the positive correlation between ewe body weight and prolificacy as heavier dams produced larger litter size (Mellado *et al.*, 2006). In contrast, Gbangboche *et al.* (2006) reported that single bearing ewes were heavier.

Survival (mortality): The overall least squares mean cumulative survival from birth to 30, 90, 180, 270 and 365 days are shown in Table 3.

The mean survival in the present study was high as compared to the reports for other Ethiopian sheep breeds (Mukasa-Mugerwa *et al.*, 2000; Solomon and Gemeda, 2000; Mukasa-Mugerwa *et al.*, 2002; Gizaw, 2002) under station conditions. This is partly because in the present study we did not include abortions and stillbirths which would contribute to the overall lamb mortality. It should be noted however that the survival rate of lambs under field condition is higher than on-station.

The higher survival rate in the present study may partly be due to the practices of farmers in the study areas which includes keeping newborn lambs at home in the 1st week of life and giving them special care, ensuring strong ewe-lamb bonding and colostrum production by dams and increased intake by lambs (Mukasa-Mugerwa *et al.*, 2000). Moreover, there was provision of vaccines against prevalent diseases in the area and the practice of de-worming against internal and external parasites through the study period.

The fixed effect of district was not significant to the age of 30 days but thereafter Yilmanadensa lambs survived better ($p<0.001$) than their Quarit counterparts. The effect of year of birth was significant at the age of 270 and 365 days. Effect of year on death rate of lambs is reported somewhere in the tropics (Berhan and van Arendonk, 2006; Mandal *et al.*, 2007)

Season did not affect lamb survival to the age of 30 days but lambs born during the wet season (May-October) had better survival at 90, 180, 270 and 365 days than lambs born in dry season. This is in agreement with published literature for Menz and Horro sheep (Gizaw, 2002; Berhan and van Arendonk, 2006). This could be due to better nutritional status of the dam in the wet season affecting milk let down to the lambs.

Table 3: Least squares means of survival (%) to different ages by sources of variations in Washera sheep

	Survival from birth to					
Source of variation	N	30 days	90 days	180 days	270 days	365 days
Overall	1228	98.4±0.6	93.6±0.9	91.2±1.1	90.0±1.2	89.9±1.2
District		NS	**	****	****	****
Yilmanadensa	727	99.0±0.6	95.2±1.0	94.4±1.2	93.9±1.3	93.8±1.4
Quarit	501	97.7±0.7	92.1±1.1	87.9±1.4	86.1±1.5	86.0±1.5
Birth year		NS	NS	NS	*	**
2004	80	99.8±1.4	92.1±2.1	92.3±2.7	92.0±3.0[ab]	92.1±3.1[ab]
2005	343	97.0±0.7	93.6±1.1	89.8±1.4	87.8±1.5[b]	87.4±1.6[b]
2006	443	97.3±0.7	93.3±1.0	89.2±1.3	87.4±1.4[b]	87.2±1.4[b]
2007	362	99.2±0.7	95.6±1.1	93.4±1.4	92.8±1.5[a]	92.9±1.6[a]
Birth season		NS	*	*	*	*
Dry	660	97.8±0.6	92.6±0.9	89.5±1.2	88.6±1.2	88.5±1.3
Wet	568	98.9±0.7	94.7±1.1	92.9±1.4	91.4±1.5	91.4±1.5
Parity		NS	NS	NS	NS	NS
1	183	99.2±1.0	94.8±1.5	93.6±2.0	92.1±2.2	92.4±2.2
2	183	98.2±1.0	94.9±1.4	92.9±1.9	91.2±2.1	91.5±2.1
3	190	99.1±1.0	90.9±1.5	87.8±1.9	87.1±2.0	87.4±2.1
4	208	99.4±0.9	95.0±1.4	92.5±1.8	92.2±2.0	91.0±2.1
5	164	96.1±0.0	92.6±1.5	90.2±2.0	88.9±2.2	88.5±2.2
≥6	300	98.3±0.8	93.5±1.2	90.0±1.6	88.7±1.7	88.8±1.8
Birth type		NS	*	**	***	***
Single	898	98.5±0.6	95.0±0.9	93.9±1.2	93.3±1.3	93.0±1.3
Multiple	330	98.2±0.8	92.2±1.2	88.5±1.5	86.8±1.7	86.8±1.7
Birth weight[1]		NS	****	**	*	*
Heavy	245	99.7±1.0	95.9±1.4[a]	94.4±1.9[a]	92.5±2.1[a]	92.7±2.1[a]
Medium	851	98.9±0.5	96.1±0.8[a]	93.2±1.0[b]	92.0±1.1[a]	91.6±1.1[a]
Light	132	96.5±1.1	88.9±1.7[b]	86.0±2.2[c]	85.6±2.4[b]	85.4±2.4[b]
Sex of lamb		NS	NS	NS	NS	NS
Male	652	98.7±0.6	94.0±1.0	91.5±1.2	90.6±1.4	90.7±1.4
Female	576	98.0±0.7	93.2±1.0	90.9±1.3	89.4±1.4	89.1±1.4

Means with different letters (a, b, c) within a trait in a column are different at indicated p-value N number of observations, NS Non-Significant ($p>0.05$) *$p<0.05$; **$p<0.01$; ***$P<0.001$; ****$p<0.0001$; [1]Birth weight: Heavy (>3 kg), Medium (2-3 kg), Light (<2 kg)

Mukasa-Mugerwa *et al*. (2000) however, reported the other way round, lambs born in the dry season had better survival than lambs born in the wet season.

No significant difference was observed in survival rate of lambs of single and multiple births during the first month after lambing. However, there after single born lambs survived better ($p<0.001$) than the multiple-born lambs. This is in general agreement with literature (Mukasa-Mugerwa *et al*., 2000; Gemeda *et al*., 2002; Matika *et al*., 2003a). The lower survival in multiple-born lambs could be due to the effect of low birth weight and the competition for limited milk especially when the dam was in poor body condition during gestation and no supplementation was given after lambing (Matika *et al*., 2003a; Lehloenya *et al*., 2005).

The effect of birth weight was significant (at least $p<0.05$) for survival at 90, 180, 270, 365 days of ages. This agrees with published literature (Mukasa-Mugerwa *et al*., 2000; Rastogi, 2001; Gemeda *et al*., 2002; Gizaw, 2002; Matika *et al*., 2003a; Lehloenya *et al*., 2005; Mandal *et al*., 2007). Lambs having light birth weight had lowest survival at all ages followed by lambs with medium birth weight. The birth weight affect the lamb's ability to ingest colostrum and receive proper mothering shortly after birth and thus develop an ability to combat infections (Mandal *et al*., 2007). Improving lamb birth weight using different management interventions such as improving pre-partum feeding of ewes especially animals with poor body condition carrying twins may partially solve the problem (Gemeda *et al*., 2002).

CONCLUSION

The results obtained in this study indicated that the reproductive performance of Washera sheep is almost similar in most of the parameters considered with other tropical sheep breeds and other indigenous highland sheep breeds of Ethiopia such as the Menz and Horro sheep. The significant effect of fixed effects showed that these effects need to be considered in an effort to improve the production and productivity of sheep production in the highlands of Ethiopia. The higher survival rate obtained indicates that there is less disease load and the farmers practice to decrease lamb mortality need to be encouraged and improved. In addition, vaccination and strategic parasite control and prevention are essential. Integrated efforts combining improving nutrition, health and participatory community-based breeding would help smallholder farmers and the country to improve, utilize and conserve this immense sheep genetic resource more effectively and wisely.

ACKNOWLEDGEMENTS

The field research was fully financed by the Amhara Regional Agricultural Research Institute (ARARI) in Ethiopia. The International Livestock Research Institute (ILRI) provided graduate fellowship to the first author while undertaking his MSc research thesis. The authors are greatly indebted to Mr Zerihun Taddese for his meticulous biometrics support during the data analyses. We are grateful to the staff of Andassa Livestock Research Centre of ARARI, particularly to Dr. Hailu Mazengia and Mr. Yehalem Denekew for their interest in the research and support during the field work. Mr. Tesfaye Getachew, Mr. Likawent Yiheyis, Dr. Mekonnen Tefferi and Mr. Anteneh Girma have contributed during the initiation phase of this research to which we are highly grateful for.

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