Performance of Awassi lines in Bedouin sheep flocks in the Negev, Israel

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Abstract

Crossbreeding with new genotypes is used by Bedouins in the Negev in an attempt to increase productivity of their flocks. But the suitability of these new lines under the harsh environment and different production conditions is not known. An on-farm-performance testing in 14 Bedouin farms in the Negev in Israel was therefore started in 2007. A total of 2420 ewes were ear-tagged and recording was done up to 2 years. Afec Awassi (BB) rams were distributed in 7 Bedouin flocks with recording of birth and weaning weights of lambs. Lambing rate of the local Awassi ranged by farm from 63% to 100%, with Assaf and crossbred ewes showing similar results. Prolificacy was significantly affected by farm, breed and parity. Afec Awassi (B+) ewes had a significantly ($p<0.05$) higher number of lambs born per ewe lambing (LB/EL) and lambs born alive per ewe lambing (LBA/EL) with 1.74 LB/EL and 1.57 LBA/EL, than Assaf ewes (1.34 LB/EL; 1.24 LBA/EL), Assaf crossbred ewes (1.27 LB/EL; 1.17 LBA/EL) or local Awassi ewes (1.18 LB/EL; 1.08 LBA/EL). Highest prolificacies and lowest lamb mortalities at birth were found in farms with good feeding and high labor input. The mortality rate of lambs at birth ranged by farm from 1.3% to 17.2% and from birth to weaning from 5% to 23.3% and was similar between breeds. Significant differences ($p<0.05$) in litter weight of lambs at birth and at weaning were found between B+ ewes and local Awassi ewes with an average of 7.8, 31.3 kg and 5.3, 18.2 kg respectively. Thus, B+ ewes outperformed the local Awassi in weaned kg per ewe. Due to the very restricted number of farms with B+ ewes in this survey, further studies of the performance of B+ ewes under all production conditions are suggested.

1 Introduction

Changing environmental and socio-economic conditions force Bedouin sheep farmers in Middle Eastern countries continuously to adjust their production system and their respective inputs to market settings. Thus, for market oriented Bedouin farmers, the choice of the right sheep breed is very essential in order to justify increased inputs. In Israel, the harsh environmental conditions of the Negev desert together with financial and management constraints of farmers are influencing the suitability of the different breeds in use. As the local Awassi breed shows a low prolificacy (Epstein, 1985), Bedouin farmers in the Negev try to improve the prolificacy of their flocks with out-of-season breeding and the introduction of new genotypes (Gootwine et al., 2009). Gootwine et al. suggested already in 2001 an increase in profitability by the introduction of the FecB gene into the local Awassi in semi-intensive sheep farms. Performance data on Improved Awassi, crossbreds or Afec Awassi were however only generated on station conditions with intensive management so far. The comparative performance of local or exotic breeds and crossbreds kept under divers Bedouin sheep production conditions is not yet known. Thus, an on-farm-performance testing was carried out to assess the performance of different Awassi lines under their respective production conditions of Bedouins in the Negev.

2 Material

The fieldwork took place in the Negev in Israel, a desert area with about 12.500 km^2. This desert area can be divided into two climatic zones: The semi-arid northern part of the Negev, with a precipitation of 200-300 mm per year and the arid southern and eastern part with a range of 50 to 200 mm precipitation (Danin & Orshan, 2001). Bedouin settlements and township can be found from Rahat in the North-West to Arad in the North-East and till Mizpe Ramon in the South, showing varying distances to Beer Sheva (31.2° N, 34.8°E), the capital of the Negev.

14 Bedouin sheep farms in a radius of 37 km from Beer Sheva were selected for the survey. Three of these farms (6, 11, 14) are located in the arid zone, the other farms are in the semi-arid zone. Four farms belong to rural villages (7, 8, 10,11), whereas the others are located in spontaneous settlements. All farms kept their sheep flock in semi-open or fixed stables built of metal pillars and with zinc or aluminum roofs. They are divided in several paddocks by wooden pallets or metal grates. Two farmers (4, 15) kept their flocks year-round at the stable, while all other farmers practiced spring grazing and 10 practiced adjacent stubble grazing, supplementing a grain mix once a day. Flock sizes ranged from 100 to 620 ewes with the total of 2420 ewes being included in this study.

The predominant breed in Bedouin flocks is since centuries the local, fat-tailed Awassi (AW), due to its good adaptation to harsh desert conditions. But its low prolificacy of about 1.0 lamb per lambing ewe (Epstein, 1985) gave reason for genetic improvement programs. The Improved Awassi with high milk yield and 1.2 lambs per ewe and per lambing (LB/EL) resulted from a stringent selection on milk production of Awassi in Israel incorporating Hirra sheep from Turkey (Epstein, 1985). Later, the Assaf, a composite breed of Improved Awassi and East Frisian was developed. Assaf (AS) shows a higher prolificacy of 1.6 LB/EL, but the breed was found to be less adapted to harsh conditions (Gootwine and Goot, 1996). Further genetic improvement was done in Israel by the introgression of the *FecB* gene into the Improved Awassi, leading to the Afec Awassi breed (Afec), with 1.92 LB/EL for BB ewes (Gootwine et al., 2008). Bedouin farmers started during the last decade spontaneously to introduce these new genotypes into their flocks, kept under extensive to semi-intensive conditions. In the investigated farms, 87 % of the ewes belonged to the local Awassi (LA) type and the rest to Assaf (AS), AS x LA crosses and Afec Awassi (B+).

3 Methods

The 14 farms were selected according to herd size (≥100 ewes), willingness to participate and the possibility of access by car. On-farm performance testing started 2007 and ended in spring 2009. Screening of the flocks with ear-tagging of all animals was done from January till April 2007 with the registration of the breed, the performance status and the history of the ewe (e.g. last lambing date, parities and health condition). The data was used to set up a flock data base and datasheets were distributed to all farmers for direct registration of further hormonal synchronization, date of mating or artificial insemination (AI), pregnancy diagnosis (PT), lambing date, litter size born and born alive (after 48 h), abortions, exit date of ewes and reason of exit. Up-dates were taken every two months. Direct recording started together with the distribution of data sheets to the farmers in spring 2007. At the end of the year, six farms (1 to 4, 10, 12) stopped recording due to the time effort needed and only eight farms continued till February 2009. Thus, lambing rates of the flocks (number of lambings by number of ewes exposed) were only derived for those eight farms with at least one year of recording. Prolificacy was calculated, dividing the number of lambs born (LB) or born alive (LBA) by the number of ewes lambing (EL). Mortality rate of lambs at birth was calculated as the ratio of lambs dead by lambs born. An overview of the number of lambings per farm and breed is given in table 1.

Table 1: Number of lambings per farm and breed of ewes in 14 Bedouin sheep flocks in the Negev

Breed[1] / Farm[2]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
LA	158	204	153	168	456	547	282	289	146	94	306	72	18	65	***2959***
AS	---	4	7	4	3	---	17	---	4	1	---	6	27	4	***77***
AA	---	---	---	7	1	140	2	7	---	---	---	---	---	---	***157***
ASLA	6	17	---	6	10	---	3	18	77	---	---	7	72	2	***218***
Total	***164***	***226***	***160***	***185***	***470***	***687***	***304***	***314***	***227***	***95***	***306***	***85***	***117***	***71***	***3411***

1 Breed: LA– local Awassi; AS – Assaf; AA – Afec Awassi(B+); ASLA – Assaf x Awassi cross
2 Recording: Farms 1-4, 10, 12 April to December 07; Farm 5,6-9,11,13,14 April 07 to March 09

Lambs were weighted in six farms, following lambings that resulted from controlled mating or artificial insemination from March 2007 till October 2008. Lambings were registered from July 2007 till February 2009. Fresh semen of homozygote (BB) or heterozygote (B+) Afec rams was used for artificial insemination. Pregnant ewes were separated from the flock. Local Awassi (LA) rams were instead used in the non-synchronized flock to have a contemporary comparison of LA and AA (B+) lambs. At birth, lambs were ear-tagged and sex, litter size, pedigree and weight was recorded for a total of 630 lambs within 24 hours after birth. To confirm the pedigree and presence of the B-allele, genotyping of lambs was performed before weaning, except in cases were lambs have been sold before this time. Till weaning, the lambs stayed in the corral with their mothers, which received about 1.5 kg of grain mix and 0.7 kg of hay per head and day, with the exception of two flocks still staying on stubble fields during July and August. In these flocks, lambs were allowed to suckle at noon for about 2 h and during the night. Ewes were not milked. Lambs were weighted at weaning, except in farm 5 and in cases of early sale. Pre-weaning lamb mortality (lambs died till weaning per lambs born alive) and litter weaning weights could be calculated for 316 lambs. Since time to weaning varied, the weaning weight was adjusted to the mean of 52 days.
Descriptive analysis was done for lambing rate and mortality rate of lambs. A loglinear model was used for prolificacy with “proc genmod” in SAS 9.2 (2002) and with the fixed effects: farm (confounded with year and season), breed and parity. Litter weight at birth and at weaning was analyzed by a general linear model in SAS 9.1 (2002) with breed as a nested effect in the farm and parity as fixed effect. The age of lambs at weaning was included as covariate in the model for litter weight at weaning.

4 Results & Discussion

4.1 Lambing rate

All investigated farms used hormonal synchronisation. Lambing rates varied between farms from 61% to 98% for the whole flock and from 63% to 100% for the local Awassi ewes in those flocks. Table 3 gives an overview on lambing rate by farm and by breed, ranging in the frame of reported lambing rates for Awassi lines: Abu-Zanat & Tabaa (2004) found lambing rates with an average of 66% in Jordanian Awassi during a dry year and Tabaa et al. (2008) reported some years later 62% under natural mating and 72% with use of artificial insemination in Jordan. A lambing rate of 89% with use of hormonal synchronisation was also reported by Atsan et al. (2007) for Turkish fat-tailed sheep. Lambing rate (Table 3) was similar between the local Awassi and the Assaf and lower in the crossbreds and the Afec. However, the number of ewes belonging to other Awassi lines than the local was still small and confounding effects of environment, breed and parity should be considered. Kridli et al. (2007) also reported no significant differences between the lambing rate of local Awassi and of crossbreds with Romanov in Jordan.

Table 3: Lambing rate[1] in Bedouin sheep flocks in the Negev

Farms	N all	%	Farms	N LA[2]	%	Breed[2]	N	%
5	*280*	98	**5**	*270*	99	**LA**	*1278*	87
7	*265*	94	**7**	*235*	98	**AS**	*58*	85
8	*306*	84	**8**	*293*	82	**AA**	*168*	62
9	*138*	61	**9**	*82*	73	**ASLA**	*153*	62
11	*189*	86	**11**	*189*	86			
12	*151*	78	**12**	*96*	82			
13	*97*	89	**13**	*13*	100			
14	*104*	62	**14**	*100*	63			

1 Number of lambings per year/average number of exposed breeding ewes in the same year (April 07-March 08)
2 Breed: LA– local Awassi; AS – Assaf; AA- Afec Awassi (B+); ASLA – Assaf x Awassi cross

4.2 Prolificacy

All three effects in the model were significant with breed (χ^2=122.49***) having the strongest impact on the number of lambs born per ewe (LB/EL), followed by the effect of the farm (χ^2=79.95***) and the parity (χ^2=15.06**) (Deviance, V/DF=1.0838). In contrast, the farm had the strongest influence on the number of lambs born alive (LBA/EL) (χ^2=115.71***), followed by the impact of breed (χ^2=84.03***) and parity (χ^2=10.97*) (Deviance, V/DF==1.8933). Least square means (LSM) for prolificacy are given in Table 4.
The effect of the breed shows the same clear and significant differences for LB and LBA with lowest values for LA, intermediate for Assaf and crossbreds and the highest for Afec (Table 4). Farm differences ranged from 1.18 LB/EL in farm 14 to 1.55 LB/EL in farm 7 and were more pronounced for LBA. The ranking between the farms was thus not consistent around birth, since management effects on the postnatal mortality led to considerable differences between LB and LBA in some farms (e.g. farms 4 and 13). Parity effects were relatively smaller and similar for LB and LBA.
Comparable values for the local Awassi were reported by Iñiguez & Hilali (2009) for Syrian Awassi with 1.15 LB/EL and with 1.19 LB/EL for Iraqi lines by Alkass et al. (2004). Lower values were given with 1.11 LB/EL for Jordanian Awassi in a dry year and with 1.12 LB/EL in a normal year (Abu-Zanat &Tabaa, 2004). Significant differences between Awassi lines were reported by Iñiguez & Hilali (2009), where the crossbreds of Turkish x Syrian Awassi outperformed with 1.23 LB/EL the Turkish Awassi (1.03 LB/EL). Gootwine et al. (2008) found significant differences between breeds for prolificacy on station, with highest values for Afec, intermediate for Assaf and lowest for Improved Awassi (AA:1.90 LB/EL, AS: 1.68 LB/EL, IA:1.28 LB/EL). Thus, the breeds displayed the same ranking in prolificacy in Bedouin farms as under intensive conditions, but on a lower level. The same could be observed for LBA: AA (B+) ewes outperformed here LA ewes ($p<0.0001$) with 0.56 lambs born and 0.49 lambs born alive per lambing ewe in our study and Gootwine et al. (2008) reported differences of 0.62 LB/EL and 0.52 LBA/EL between IA and AA (B+) on station. With the better management on station, the full potential of prolific breeds could be exploited. The difference in prolificacy alive in our study between AA (B+) and LA was with 0.49 LBA still considerable for the Bedouin farmers.

Table 4: Prolificacy (LB/EL and LBA/EL) of Bedouin sheep in the Negev by farm, breed and parity

	LB/EL			LBA/EL		
Farms	*N*	**LSM**	**S.E.**	*N*	**LSM**	**S.E.**
1	*164*	1.39 [ab]	±0.04	*164*	1.24 [abce]	±0.04
2	*226*	1.30 [ae]	±0.03	*226*	1.14 [a]	±0.04
3	*160*	1.40 [b]	±0.03	*160*	1.31 [bc]	±0.04
4	*185*	1.38 [ab]	±0.03	*185*	1.16 [a]	±0.04
5	*470*	1.35 [ab]	±0.02	*470*	1.25 [bc]	±0.03
6	*687*	1.34 [ab]	±0.02	*687*	1.29 [b]	±0.02
7	*304*	1.55 [c]	±0.03	*304*	1.50 [d]	±0.03
8	*314*	1.51 [cd]	±0.03	*314*	1.47 [d]	±0.03
9	*227*	1.37 [ab]	±0.03	*227*	1.29 [b]	±0.03
10	*95*	1.27 [be]	±0.05	*95*	1.15 [ae]	±0.05
11	*306*	1.38 [ab]	±0.03	*306*	1.23 [abce]	±0.03
12	*85*	1.34 [ab]	±0.04	*85*	1.26 [abce]	±0.05
13	*117*	1.41 [abd]	±0.04	*117*	1.17 [ae]	±0.04
14	*71*	1.18 [e]	±0.05	*71*	1.18 [abce]	±0.06
Breed[1]						
LA	*2959*	1.18 [a]	±0.01	*2959*	1.08 [a]	±0.02
AS	*77*	1.34 [b]	±0.04	*77*	1.24 [b]	±0.05
AA	*157*	1.74 [c]	±0.03	*157*	1.57 [c]	±0.04
ASLA	*218*	1.27 [b]	±0.03	*218*	1.17 [b]	±0.04
Parity						
1	*378*	1.31 [a]	±0.02	*378*	1.17 [a]	±0.03
2	*114*	1.40 [ab]	±0.04	*114*	1.30 [b]	±0.04
3	*1544*	1.42 [b]	±0.02	*1544*	1.29 [b]	±0.02
4	*1118*	1.37 [a]	±0.02	*1118*	1.27 [b]	±0.02
5	*257*	1.33 [a]	±0.03	*257*	1.25 [ab]	±0.03

LSM in columns followed by the same letter do not differ significantly at $p< 0.05$
1 Breed: LA– local Awassi; AS – Assaf; AA– Afec Awassi(B+); ASLA – Assaf x Awassi cross

4.3 Mortality rate of lambs

An overview on the mortality rates of lambs around birth (48h) is given in Table 5.

Table 5: Lamb mortality[1] at birth by farm, breed and litter size in Bedouin sheep flocks in the Negev

Farm	%	% LA[2]	Farm	%	% LA[2]	Breed[2]	*N*	%	Litter	*N*	%
1	11.9	10.8	**8**	3.5	3.3	**LA**	*2959*	7.6	**1**	2634	6.0
2	13.2	13.2	**9**	5.8	8.6	**AS**	*77*	9.3	**2**	713	4.9
3	8.0	8.4	**10**	11.1	10.3	**AA**	*157*	8.0	**≥3**	64	6.3
4	16.5	8.5	**11**	11.4	11.4	**ASLA**	*218*	10.2			
5	7.4	7.3	**12**	6.8	4.8						
6	5.1	4.4	**13**	17.2	33.3						
7	4.0	4.2	**14**	1.3	1.5						

1 Mortality rate at birth: number of lambs dead / number of lambs born
2 Breed of the ewe: LA– local Awassi; AS – Assaf; AA– Afec Awassi(B+); ASLA – Assaf x Awassi cross

The farm effect is clearly more pronounced than the effect of the breed. Differences between the breeds in lamb mortalities appear minor, compared to those between the farms, ranging from 1.3% to 17.2%. Gootwine et al. (2008) also reported about a low variance between breeds in lamb survival. Mortalities in lambs at birth on station were with 3% for IA, 6% for AS and 7% for AA (B+) generally lower, than our results from the Bedouin farms. It has to be noted, that in the present study genetic effects could not be clearly separated from environmental effects.

Table 6 shows the mortality rates of lambs from birth to weaning. The 12.5% in local Awassi lambs was lower than found by Tabaa et al. (2008) for Awassi lambs in Jordan (23%), by Alkass & Juma (2005) in Iraq (18%), or by Emsen & Yaprak (2006) for Awassi lambs in Turkey (17%). The range of mortality rates from birth to weaning was again higher between

Table 6: Lamb mortality[1] from birth to weaning by farm, breed and litter size in Bedouin sheep flocks in the Negev

Farm	*N*	%	Breed[2]	*N*	%	Litter	*N*	%
1	*65*	9.0	**LA**	256	12.5	**1**	*128*	13.3
3	*60*	16.1	**AA**	60	6.6	**2**	*140*	6.4
4	*39*	23.3				**≥3**	*48*	20.8
6	*60*	6.7						
7	*40*	5.0						
8	*52*	5.8						

1 Mortality rate: number of lambs dead from birth till weaning / number of lambs born alive
2 Breed of the ewe: LA– local Awassi; AA – Afec Awassi (B+)

the farms, than between litters or between the breeds of ewes. For the later comparison it has to be kept in mind that AA ewes were only present in one farm, showing overall good lamb survival rates leading to an underestimation of this effect. Litters of three or more lambs showed the highest mortality rates. The increase in lamb mortality with increasing litter size is confirmed by many authors (e.g. Kleemann & Walker, 2005; Gootwine, 2005). The fact that in the present study singles showed a higher mortality rate than twins could be explained with a high average birth weight of singles (5.2 ± 0.8 kg), causing dystocia. Smith (1977) reported a linear relation between birth weight and dystocia cases and "a quadratic relationship between the birth weight of lambs and mortality". Mortality tended to increase in his study with heavier birth weights of more than 5.5 kg. This was the case for 15% of single born lambs in this survey. The higher birth weights of lambs, being crosses of improved Awassi lines and the local one, can be attributed to the differences in body weight of the two lines, as well as to heterosis effects.

Lamb mortality from birth to weaning was mostly influenced by the farm effect. Farms with low mortality rates were all working with hired labor or with the farmer and his wife working full-time in the farm. An increase in litter size can only be fully exploited, if the survivability of lambs of multiple litters can be increased by intensive care through input of qualified labor. Fogarty (2009) recommended as well an improved nutrition and management at lambing for breeds carrying the FecB gene to increase lamb survival.

4.4 Litter weight per ewe

As expected, the prolific AA (B+) ewes (n=98) showed with 66% of twins and about 15% of triplets or quadruplets a higher percentage of multiple litters than the LA ewes (n=213) with 31% and 8% respectively. The analysis of variance thus revealed significant differences in litter weights at birth (r^2=0.12, F=4.63***) for breed, nested in the farm (F=4.42***), besides parity (F=7.04**). The breed effect was significant again (F=4.93***) in the analysis for litter weaning weights (r^2=0.21, F=6.13***), while parity did not show an impact. Table 7 gives the least square means (LSM) for litter weights at birth (LWB) and at weaning (LWW) per ewe lambing (EL) in the investigated Bedouin flocks.

Table 7: Least square means (LSM) of litter weight at birth (LWB) and at weaning (LWW) by farm, breed within farm and parity in Bedouin flocks in the Negev

	LWB/EL (kg)			LWW/EL (kg)		
Breed[1] / Farm	***N***	**LSM**	**S.E.**	***N***	**LSM**	**S.E.**
LA in 1	*53*	4.8 [a]	±0.44	*27*	14.7 [a]	±2.3
LA in 3	*42*	5.9 [a]	±0.43	*37*	17.7 [ab]	±2.2
LA in 4	*29*	4.8 [a]	±0.51	*20*	17.0 [ab]	±2.7
LA in 5	*9*	4.9 [a]	±0.66		------	
LA in 6	*19*	5.4 [a]	±0.54		------	
LA in 7	*26*	5.1 [a]	±0.51	*25*	19.4 [abc]	±2.4
LA in 8	*35*	5.3 [a]	±0.49	*33*	22.3 [bc]	±2.4
AA in 6	*98*	7.8 [b]	±0.26	*30*	31.3 [c]	±2.5
Parity						
1	*73*	5.6 [a]	±0.30	*35*	21.5	±2.0
2	*37*	6.3[ab]	±0.39		------	
3	*201*	7.6 [b]	±0.32	*138*	28.1	±2.1

LSM in columns followed by the same letter do not differ significantly at p< 0.05
1 Breed of ewe: LA– local Awassi; AA – Afec Awassi (B+)

Average litter weight at birth for LA ewes was 5.3 kg and average litter weight at weaning was 18.2 kg per lambing ewe over all farms. Nearly the same value (18.8 kg) was found by Kridli et al. (2007) for Jordanian Awassi ewes. Metawi et al. (2006) reported lower LWW (16.6 kg) for Awassi ewes, kept in an extensive system in the Sinai in Egypt and Iñiguez & Hilali (2009) gave higher values for Syrian and Turkish Awassi ewes, kept under station conditions (21.6 kg and 20.4 kg respectively). In our study, AA (B+) ewes outperformed LA ewes by 2.5 kg more litter weight at birth ($p<0.05$) and 13.1 kg more litter weight at weaning ($p<0.05$). Comparing LA at farm 1 with AA in farm 6, LWW was more than doubled, pointing to a huge performance potential to be exploited under these semi-extensive farming conditions. Compared to best performing crossbreds (Charollais x Awassi) in Jordan (Kridli et al., 2007) with an average of 22.3 kg LWW/EL, there remains still a difference of + 9kg litter weaned for AA ewes. But as can be seen in Table 7, weaning weights for AA (B+) ewes were only derived from one farm and more observations from other farms are needed to confirm this result. Fogarty (2009) reported a slight advantage in LWW of B+ ewes over other breeds and crosses of + 1.5 kg on average in a comparison of numerous studies, but with a wide range of -9.8 kg to +8.4 kg LWW per mated ewe. This reflects the importance of genotype by environment interactions, given the large differences between the management and the production systems.

5 Conclusions

Wide ranges between the farms in all performance parameters reveal the need for parallel improvements of breeds and management. The full exploitation of the higher genetic potential of prolific breeds is only possible on farms with improved feeding and good lamb care. In case of the investigated Bedouin farms in the Negev considerable higher weights of lambs weaned per ewe could be obtained with the use of Afec Awassi compared to the local Awassi. Due to the restricted number of farms with Afec ewes in this study, further performance testing is recommended under a wide range of production conditions.

The local Awassi ewes showed a uniform performance, irrespective of the farm management. Thus, they are more suitable for extensive systems with poor feeding and management conditions, whereas improvements in management will not be translated into higher performance on a same level by the local Awassi than by improved genotypes.

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