Review Articles

On Farm and On Station Comparative Performances Evaluation of Indigenous Sheep with Their Exotic Crosses: The Case in Dorper and Awassi Crosses In Ethiopia

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Abstract

The objective of this review paper was to evaluate the performance of indigenous sheep and compare with their crosses of Dorper and Awassi under on farm and on station management conditions. The performance of indigenous sheep and their crosses with Dorper and Awassi varied as per the location, management, farming conditions and percentage of exotic blood level inheritance. On-farm and on-station performance evaluation (mainly Dorper and Awassi pilot crossbreeding) indicated that crossbreds often outperformed their local contemporaries. The evidence indicated that under station management condition local Horro breeds are well in birth, weaning and yearling weight than other local sheep breeds. Under on farm condition, body weight at different ages was significantly higher in 50% Dorper crosses as compared to their 25% and 75% counter parts. While, the growth rate of Awassi lambs were increased as the exotic blood level increased under on farm management conditions, combined with most reports in the tropics, greater than 37.5% Awassi blood level performed better in terms of on farm condition. On station birth weight of Dorper (3.39-3.8 kg) better than crossbreed (3.0-3.24 ± 0.04 kg) and local sheep (2.36-2.77 kg), respectively. While the mean weaning weight (14-16 kg) and yearling weight (26.95-32.43 ± 0.46 kg) of 50% Dorper crossbreed was better than indigenous sheep breeds. However, under on station condition, Awassi crossbred lambs, 50% Awassi menz, had heavier birth weight than that of local, 25 and 75%. In all aspects Dorper and Awassi crossbred ewes were poor to attain the age at first lambing and have shorter lambing interval than local sheep breeds, however crossbred ewes and local sheep breeds did not differ in litter size. Dorper crosses with Afar under on-station is note economically important due to lower weight in all aspects.

Keywords: Awassi, crossbred, Dorper, indigenous sheep, on farm, on station

Introduction

Small ruminants are integral part of livestock keeping in Sub-Saharan Africa, Ethiopia (Kosgey et al., 2008) and has a substantial contribution to smallholder farmers in generating income and securing food in developing countries (Kosgey et al., 2006).The total sheep population in Ethiopia has estimated to be about 28.89 million, out of which about 72.84 percent are females, and about 27.16 percent are males (CSA 2016).

Indigenous sheep breeds have great potential to contributing more to the livelihoods of the people in low-input, small-holder crop livestock and pastoral production systems (Kosgey and Okeyo 2007).They considered as a living bank against the various environmental calamities (crop failure, drought and flooding) and have socio-cultural values for diverse traditional communities (Edea et al., 2010). Moreover indigenous sheep in Ethiopia have a multipurpose role for smallholder farmers as sources of income, meat, skin, manure and coarse wool or long hairy fleece. They are also a means of risk avoidance during crop failure. However, the current off-take rate is very low. Thus, in-creasing the current level of productivity of sheep is essential to meet the ever-increasing demands of human population.

Sheep production in Ethiopia is based on indigenous breeds except for less than 1% exotic sheep group of mainly Awassi-Menz and Dorper crossbreds. However, comparing the presence of large sheep population similar to other tropical countries, present production levels are far below their potential and productivity per sheep is very low. This is mainly due to low genetic potential for functional traits as compared to improved tropical and temperate breeds (Tsegaye et al., 2013). Increasing the current level of productivity is essential to provide meat to the ever-increasing human population, to increase export earnings and household income thereby improving the living standard of smallholders (Solomon 2002; Tibbo 2006).

The importance of sheep production as a source of meat in Ethiopia has been increasing during recent years. This sheep production has experienced changes regarding the use of introduced exotic breeds, in order to increase the growth rate of lambs. Thus, there is a great demand for Dorper and Awassi sheep to improve the growth performance of lambs, which is an important trait that determines the overall productivity of the flock. Due to these reasons tropical countries have been implementing crossbreed of indigenous animals with improved exotic genotypes to improve the genetic potential of indigenous animals. Within the aim of improving indigenous sheep productivity, in Ethiopia crossbreeding has been undertaken employing several exotic breed such as the Awassi breed and was imported from Israel, to cross with the indigenous Menz (Rummel et al., 2005). Recently the Dorper sheep was also imported from South Africa to evaluate the breed as a potential performance (AARC 2012). Crossbreeding with the aim of combining the desirable attributes in the two breeds are necessary to increase and sustain the productivity of sheep in the areas so as to meet the demands of the human population on them and a breeding program was set up that was supported with a good recording scheme (Rewe et al., 2002).

These two exotic breeds were managed under on farm and on station conditions in Ethiopia. The productive and reproductive performance of the breed varied under on farm and on station conditions. Attempts to improve performance under these prevailing conditions must take into consideration their specific purpose in the production system and their performance potential under varying management levels. As a result, there is a need to quantify the present performance of indigenous sheep breed with their crosses of Dorper and Awassi sheep breed under Ethiopia production systems and decide the significance of importing exotic sheep breeds under the prevailing management conditions. Therefore the objectives of this paper was to quantify the comparative performance of indigenous sheep breed with their crosses Dorper and Awassi under on farm and on station condition.

On-Farm and On-Station Evaluation of Indigenous Sheep

Ethiopia has sizeable sheep genetic diversity (DAGRIS 2004). Sheep breeds are found in all agro ecological zones of Ethiopia and are mostly kept under smallholder subsistence production system where input supplies are low. The indigenous sheep breeds in Ethiopia are highly adapted to low-input systems or are naturally selected for survival under sub-optimal and disease ridden environments.

On-farm performance evaluation provides information in location specific production conditions that could lead to breed improvement options which are appropriate to the system (Getahun 2008). However, unlike on station experiments, on-farm study is influenced by many factors which could not be controlled. On top of that, assessment of the performance of indigenous sheep and their crosses with Dorper and Awassi in nucleus flocks has been a priority research area since livestock research began in Ethiopia. The purpose of nucleus flocks was to provide controlled environments for a more accurate evaluation of performance, measuring several traits that would be difficult under village conditions, and comparative evaluation of more than one breed under similar conditions (Gizaw et al., 2013). Understanding the production environment of indigenous sheep would enable a better comparative understanding of the adaptive fitness and performance of the breed (Helen et al., 2015).

Study from the on station performance evaluation of indigenous sheep breeds and crossbreds in the Central Ethiopian Highlands by Tibbo (2006) confirmed that Horro lambs were heavier than Menz lambs at birth (2.40 vs. 2.06 kg), at weaning (9.48 vs. 8.64 kg) and at yearling (19.0 vs. 17.1 kg) and therefore had faster pre weaning (78.0 vs. 72.6 g per day) and post-weaning (31.0 vs. 29.1 g per day) growth rates. Similarly, comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding conditions by Awgichew et al. (2000) demonstrated that Horro lambs had significantly heavier ($p < 0.001$) birth weight than Menz lambs (2.43±0.03 kg vs 2.17±0.03 kg) at Debre Birhan research station. Another author (Abegaz 2002), however, disclosed that the yearling weight of most indigenous breeds is between 20 and 25 kg although some breeds (e.g. Horro) can weigh up to 34 kg under on-station management. It was indicated that pre-weaning daily gain was as high as 230g, weaning weight up to 23 and yearling weight up to 45 kg for Horro breed. Another study on separate analysis of the data for the two breeds, Menz and Horro by Tibbo et al. (2004) revealed that the overall birth weight was 2.1 kg for Menz in contrast to 2.3 kg for Horro, and they reached 7.2 and 8.7 kg adjusted 3-months weaning weight, 16.2 and 16.1 kg at 12 months and 24.2 and 26.6 kg at 24 months of age, respectively. The birth weight for Menz sheep was similar to the 2.1 kg as reported by Mukasa-Mugerwa et al. (2000) and 2.17 kg as reported by Awgichew (2000) for on-station animals about 1.76 kg reported by Mekoya et al. (2000) for animals under on-farm management conditions. In contrast, Abegaz et al. (2011), However, reported different value regarding the birth weight (2.79±0.03 kg) and weaning weight (12.5±0.23 kg) of Gumz sheep under on farm condition. Similar value was suggested by Mengiste et al. (2009) and Abegaz et al. (2002) for Washera and Horro sheep, respectively.

Under on-farm management system, first lambing and lambing interval of local sheep breeds occurs at 13.8±0.14 and 8.58±0.14 months (Helen et al., 2015), respectively. This value is comparable with age at first lambing and lambing interval of 12.7 and 7.8 months for local sheep breed (Compiled by Zeleke.M 2014). According to Dibissa (2000) and Taye et al. (2009) in association with the above thought Menz breed had age at first lambing of 14-16 and lambing interval of 7-10 months under traditional management system, similar results (15 and 8.4 months) was reported for on station performance of Menz breed (Compiled by Zeleke, 2014). In contrast, higher value (17.06 and 12.7-13.6 months) was reported for Menz sheep breed under on farm management condition (Niftalem 1990). Age at first lambing and lambing interval of Menz sheep were 470.1 days, 255.1 days, respectively. The corresponding values for Afar sheep were 405.6 days, 270.5 days, respectively (Getachew, 2008). However, Mengiste et al. (2008) found that age at first lambing and lambing interval of 15.4 and 9.16 months for washera breed under traditional management system, in contrast to 13.3±1.7 and 7.8±2.4 months for Horro sheep breed (Zewdu 2008). As reported by Mekuriaw et al. (2013) lambing interval for Washera sheep that ewes under station management had shorter lambing interval than their on-farm managed counterparts (263 vs. 303 days), while lower weight at first lambing was recorded under station management system than their farm managed contemporaries (20.03±1.7 kg vs. 23.79±1.4 kg, $p<0.01$). Whereas, under on-farm management system Gumz had age at first lambing and lambing interval of 13.67 and 6.64±1.13 months (Solomon 2007). Better litter size (1.4) of Horro sheep breed was reported by Zewdu (2008) as compared to 1.11 for Menz and washera (Dibissa 2000; Mengiste

et al., 2008; Taye et al., 2009) and 1.17 for Gumz (Solomon, 2007). Some representative productive and reproductive performance of indigenous sheep of Ethiopia is presented in Table 1.

Table 1 Productive and reproductive performance of indigenous sheep breed in different production systems in Ethiopia

Productive performance					
Breed	**Mgt type**	**BWT(kg)**	**WWT(kg)**	**YWT(kg)**	**Reference**
Menz	On station	2.06	8.64	17.1	Tibbo 2006
	On station	2.20	8.3	16.9	Ewnetu 1999
	On-station	2.07	9.01	15.5	Solomon 2002
	On farm	2.4	8.3	16.4	Niftalem 1990
Horro	On station	2.4	9.48	19.0	Tibbo 2006
	On station	2.6	12	24	Abegaz 2002
	On-station	2.27	12.6	23.7	Solomon 2002
Gumz	On farm	2.79	12.5	N/A	Abegaz et al., 2011
Washera	On farm	2.83	13.3	N/A	DBARC 2006
BHS	On-station	2.60	11.4	23.7	Yebrah 2008
Afar	On-station	2.70	11.5	24.5	Yebrah 2008
Reproductive performance					
		AFL (month)	**LI (month)**	**Litter size**	
Local	Traditional	13.8	8.58	N/A	Helen et al., 2015
Bonga	Traditional	13	8	1.4	Compile. Z.M 2014
Menz	Traditional	14-16	7-10	1.11	Dibissa, 2000 & Taye et al., 2009
	On farm	17.06	12.7-13.6	1.02	Niftalem 1990
	On station	698 days	279	1.02	DBARC 2006
	On-farm	470.1 days	255.1days	N/A	Tesfaye 2008.
Washera	Traditional	15.4	9.16	1.11	Mengiste et al., 2008
Horro	On farm	13.3	7.8±2.4	1.36	Zewdu 2008
	On farm	14.9	8.9±2.4	1.40	Zewdu 2008
BHO	On farm	23.56±3.63	10.5	N/A	Fikrte 2008
Gumz	Traditional	13.67	6.64±1.13	1.17	Solomon 2007
Afar	On-farm	405.6 days	270.5 days	N/A	Tesfaye 2008

Mgt = management type, BWT = birth weight, WWT = weaning weight, YWT = yearling weight, BHS = Blackhead Somali, BHO = Blackhead Ogaden, AFL = age at first lambing, LI = lambing interval, N/A = not attend

Performance Evaluation of Awassi & Dorper Crossbred Sheep

The importance of sheep production as a source of meat in Ethiopia has been increasing from time to time. This sheep production has experienced changes regarding the use of introduced exotic breeds, in order to increase the growth rate of lambs. Thus, there is a great demand for Dorper and Awassi sheep to improve the growth performance of lambs, which is an important trait that determines the overall productivity of the flock. Due to crossbreeding of exotic sheep with indigenous to improve growth and wool of indigenous sheep, was first

launched in 1944 when the Merino breed was introduced from Italy. Then after in late 1960s, sheep breeds were imported from France, Spain, Kenya and UK (Brännäng et al., 1987; Beyene 1989) and mainly crossbred with the indigenous Menz at Debre Berhan ranch. But Farmers in the highlands of Ethiopia, declined to accept the crossbreds due to their phenotypic unlikeness to the indigenous sheep (Tibbo 2006).

Crossbreeding of indigenous sheep breeds with improved exotic or local breeds is a usually quick means of genetic improvement (Marshall 2014). The aim of crossbreeding is to combine high yielding capacity of the exotic breed with the adaptation attributes of the indigenous breed, but not all crossbreds equally combine both. Considering the variable growth patterns and marketing age (at about 20 months) in Ethiopia, the present tradition seems to fit well with the growth pattern of the indigenous Menz, but that a much earlier age for marketing of the crossbreds, and especially the 75% crosses, could be recommended, as it does not pay off to keep these lambs for such old age (Markos et al., 2006). However, crossbred sheep represent negligible proportion of the sheep population and productivity improvements are not generally evidenced at smallholder farm level (Tesfaye et al., 2016).

The Awassi breed, which has phenotypic similarity to the local Menz sheep was imported in 1980, 1984 and 1994 from Israel, and crossed with the indigenous Menz (Rummel et al., 2005). These crosses of Awassi-Menz have been well accepted by farmers of Ethiopian highlands, subsequently, producing of crosses has been boosted up by establishing of ranch and research centre for improvement of the indigenous Menz sheep (Tibbo, 2006). Awassi x Menz (75% Awassi) crossbred rams are distributed to smallholders for breeding purposes aimed at upgrading of village flocks to same blood level. The research center also produced Awassi-Menz crosses and used them for on-station and on-farm research. The Dorper sheep breed is generally recognized as one of the most popular mutton, hardy composite, an early-maturing breed, and well-managed ewes can lamb at the age of 13 -15 months breeds in South Africa (Fourie et al., 2009). Dorper sheep were first introduced into Ethiopia, Jijiga area (Somali Region) in the late 1980s (Awgichew and Gipson 2009), and again introduced in 2006 and 2011 (Getachew, 2016).

According to Hassen et al. (2002), the performance of 37.5% Awassi x 62.5% Menz was no better than the indigenous Menz sheep in a low-input system under smallholder management in the cool highlands of Ethiopia. He suggests that the superiority of 37.5% Awassi x 62.5% Menz in birth weight was not maintained at weaning due to inability of the indigenous Dam breed to support or provide milk to higher growth rate in the lamb. However, several authors (Lemma et al., 1989; Hassen et al., 2004; Tibbo 2006) investigated that birth weight, growth, carcass and wool were increased as exotic blood level increased. Furthermore, weaning weight of lambs produced per ewe lambed were increased as exotic level increased (Olsson and Beyene, 1990). Several studies in different areas of Ethiopia confirmed that better growth performance and lamb survival of Awassi and Dorper crossbreds were observed (Gizaw and Getachew 2009; Tsegay et al., 2013; Tilahun et al., 2014). Although, in the range of inferior to comparable reproductive performances were reported for crossbred ewes (Getachew et al., 2013; Lemma et al., 2014b). Despite the fact that, the inferiority of Awassi crossbred ewes in age at first lambing and lambing interval are mostly more than compensated by the relative larger size of ewes resulted in better ability of crossbred ewes to raise their lambs to weaning age (Olsson and Beyene 1990; Tibbo 2006; Getachew et al., 2013, 2015). Ayele et al. (2015) explained that birth weight of pure Dorper and its F1 crosses was better than 2.50 and 1.90 kg for Awassi x Menz 50% crosses, respectively, at sheno research center. While it was slightly lower than the reports by Gizaw et al., (2012) for F1 (2.83 kg), Awassi x Menz lambs at Debre Birhan Research center.

On Farm Performance Evaluation of Indigenous Sheep with Dorper Crosses

Production performance

On-farm performance assessment concerned with the whole farm environment provides information in location specific production conditions that could lead to breed improvement options that are appropriate to the system (Getahun 2008). However, unlike on station experiments, on-farm study is influenced by many factors

which could not be controlled. Sisay (2002) identified that under on farm condition variation exists between indigenous and exotic sheep breeds for body weight traits. The trend of varied productivity performances of crossbred sheep across locations implies the importance of G x E interaction due to differences in feed supply and farmers' management capability (Getachew et al., 2016).

The mean birth weight of 3 and 3.5 kg for crossed and pure Dorper sheep (Gavojdaian et al., 2013) concurs well with the birth weight of 3.3-3.9 kg of Dorper lambs that found by Neser et al. (2001) and Hinojosa Cuellar et al. (2013) under pasture conditions. Besides, Snyman and Olivier (2002) reported 4.06, 30.0 and 64.4 kg for birth weight, weaning weight and yearling weight of Dorper sheep breed under extensive management condition. Although Cloete et al. (2000) estimated mean weaning weight of 18.2 kg for Dorper sheep breed. However, Ermias et al. (2015) reported that the means of birth weight (kg), weaning weight (kg),weaning age (month), market age (month) and market weight (kg) of Dorper sheep crosses in Wolita and Silte Zone was 2.25, 17.30, 3.16, 12.66 and 30.66 kg, respectively. The mean market weight (30.68 kg) and market age (12.66 months) of Dorper sheep breed (Ermias 2014) was significantly lower than the report of 36 for female crossed and 70 for male pure Dorper sheep (Fourie et al., 2009). On farm evaluation study carried out in the highlands of Ethiopia confirmed that body weight at different ages was significantly higher in 50% Dorper crosses as compared to their 25% counter parts (Ayele et al., unpublished data). Despite this, Ermias et al. (2015) found that birth weight was higher for 25 % crosses, but weaning and marketing weights were found higher for 50% crosses, while litter size was higher in 25% crosses (1.96) than 50% crosses (1.88). On-farm representative's production performance of Dorper crossbreds are summarized in (Table 2).

Reproductive performance

According to Helen et al. (2015) the age at first lambing and lambing interval of indigenous sheep in eastern Ethiopia were 13.8±0.14 and 8.58±0.14 months, respectively. In contrast, age at first lambing of local sheep breed of 17.01 months (Samuel 2005), 20.7 in pastoral and agro-pastoral system of Southern Ethiopia (Adugna and Aster 2007), 14.6 for Adilo sheep (Getahun 2008), 470.10 days for Menz sheep (Tesfaye 2008), 12.43 months (Solomon 2007; Zewdu 2008; Deribe 2009) and 12.88 months of Dawuro sheep (Amelmal 2011). However, the least square means of age at first lambing of Dorper sheep of 11.81 (Ermias 2014) and 11.5 months (Fourie et al., 2009) was comparable with the report of 12 months (Tsegaye 2013) in Ethiopia. Dorper sheep crosses had better reproductive performance than indigenous sheep breed of Adilo especially in weaning weight and market weight even though it has similar sexual maturity and litter size (Ermias 2014). On-farm representative's reproductive performance of Dorper crossbreds are summarized in (Table 2)

Table 2 Productive and reproductive performance of Dorper crosses

Breed group	BWT (kg)	WWT (kg)	YWT (kg)	Reference
Dorper	4.06	30.0	64.4	Snyman and Olivier 2002
50% Dorper	2.25	17.3	N/A	Ermias et al., 2015
25% Dorper	2.31	15.05	N/A	Ermias et al., 2015
		Reproductive traits		
	AFL (months)	**LI (months)**	**Litter size**	
50% Dorper	11.07±0.53	N/A	1.88±0.27	Ermias et al., 2015
25% Dorper	12.50±0.65	N/A	1.96±0.26	Ermias et al.,2015

BWT = birth weight, WWT = weaning weight, YWT = yearling weight, AFL = age at first lambing, LI = lambing interval, N/A = not attend

On Farm Performance Evaluation of Indigenous Sheep with Awassi Crosses

Production performance

Over the years, Awassi x Menz crossbred rams having 75% Awassi genotype level were distributed to groups of participating farmers and run together with village flocks all year round along with rams of indigenous local breeds. Lambs with various levels of Awassi genotype ranging between 0 to 56.25 % were born and reared under farmers' management (Tesfaye et al., 2016). According to Sisay et al. (1988) the birth weight and weaning weight of 50% Awassi x Menz and 75% Awassi x Menz was 3.0, 3.8 kg and 17.6 and 21.5 kg, respectively. This increased growth rate as exotic blood level increased was supported by Gizaw and Getachew (2009) who found that yearling weight of local Wollo, 25 to 50% Awassi and above 50% Awassi was about 22, 26, and 35 kg, respectively. The growth rate of lambs were increased as the exotic blood level increased under village management; >50% Awassi were better in birth-yearling than that of local and 25-50% Awassi, respectively. In contrast a study by Gizaw et al. (2014) suggests that 37.5% Awassi was recommended for small holder farmers. However, in a study involving the performance of crossbred and indigenous sheep under village conditions in the cool highlands of central-northern Ethiopia (Hassen et al., 2002) investigated that even though crossbred lambs were heavier in body weight than indigenous lambs at all ages, with the largest difference being 1.46 kg (9.1%) and occurring at 210 days of age, but this difference tended to decrease with age, and the advantage of crossbred lambs in birth weight did not persist later in life. This may indicate that the milk supply of the Dam breed ewes is inadequate to rear crossbred lambs, which is crucial, especially during lambs' early postnatal growth periods. From birth to 4 weeks of age, crossbred lambs increased in live-weight by 3.15 kg (94.03% BWT), and underlines that 37.5% Awassi x indigenous crossbred lambs were heavier than indigenous lambs at birth and at all stages, while crossbred lambs were not significantly better than indigenous lambs in average daily gains. Representatives of on-farm production performances are presented in Table 3.

Reproductive performance

Reproductive performance of local and their crosses with Awassi (25 to ~50%) and Corriedale based on the data from the three villages, Serity (Chacha), Negasi-Amba (Menz) and Chiro (Wollo) were studied (Getachew et al., 2013). In his study crossbreds showed poor performance for age at first lambing (553.2), lambing interval (286.3), and number of lambs born

Table 3 Productive and reproductive performance of indigenous and its cross with Awassi under on farm condition

Productive performance			
Genotype	**BWT (kg)**	**WWT (kg)**	**Reference**
50%Awassi x Menz	3.0	17.6	Sisay et al., 1988
75%Awassi x Menz	3.8	21.5	Sisay et al., 1988
Indigenous	2.82	——	Hassen et al., 2002
	2.4	15.6	Sisay et al., 1988
Reproductive performance			
	AFL (days)	**LI (days)**	
local	662	228	Gizaw & Getachew, 2009
	472.7	247.6	Tesfaye. G et al., 2013
Awassi crossbred	669	252	Gizaw & Getachew, 2009
	553.2	286.3	Tesfaye. G et al., 2013

BWT = birth weight, WWT = weaning weight, AFL = age at first lambing, LI = lambing interval

per ewe per year (1.62) than local breeds with a value of 472.7 days, 247.6 days and 1.74 in all locations. Interestingly, depending on lambing interval, local ewes ranged from 227.1 days in Wollo to 260 days in Menz and of Awassi cross ewes ranged from 249.7 in Wollo to 329.4 days in Menz. This is in good agreement that under village management age at first lambing, lambing interval and ewe postpartum weight of local sheep was better than that of Awassi crossbred with a value of 228 and 252 days; 662 and 669 days; 26 and 32 kg (Gizaw and Getachew 2009), respectively. On the other hand age at first lambing of 434.1 to 630.7 days for local and their crosses with Awassi (Getachew et al., 2013) seemed to be comparable with that reported in tropical systems between 431 and 572 days (Asare and Wilson 1985; Armbruster et al., 1991; Galina et al., 1996); lambing interval for local ewes ranged from 226.9 to 257.8 days and fairly comparable with that of reported for Ethiopian and Mexican sheep (Mukasa-Mugerwa et al., 1994; Galina et al., 1996). It has been also reported that a trend of delayed age at first conception in Awassi crossbred ewes compared to the indigenous Menz sheep in the Ethiopian highlands (Demeke et al., 2004). Purebred local and Awassi x local crossbred ewes did not differ in litter size and lamb mortality rates, however, crossbred ewes apparently had longer interval between parturitions but produced heavier lambs and were heavier themselves at post-partum (Tesfaye et al., 2016). On-farm representative's of reproductive performance of Awassi crossbred sheep are indicated in Table 3.

On Station Performance Evaluation of Indigenous Sheep with Dorper Crosses

Production performance

Attempts have been made (Ayele et al., 2015) in order to evaluate the growth performance of Dorper and its F1 crossbreds at Debre Birhan Agricultural Research Center (DBARC). In his study the overall birth weight, weaning weight and yearling weight of pure Dorper and Dorper x Local 50% cross breed lambs were 3.04±0.04kg, 14.32±0.23 kg and 32.43±0.46 kg, respectively. The author investigated that pure Dorper lambs were heavier at birth than the F1 crosses with Afar and Menz breeds with the mean birth weight of 3.39 vs 2.57 and 2.77 kg, respectively. Furthermore, he found that pure Durper lambs were significantly heavier at 90 days compared to the Dorper x Afar50% and Dorper x Menz 50% lambs and they were 71 and 31 % heavier at the age, respectively. Similar to this, heavier birth weight of pure Dorper (3.5 kg) as compared to crossed (3kg) was reported by Gavojdian et al. (2013). Lakew et al. (2014) mentioned that weaning, six months and yearling weights of 50% Dorper crossbreds were much higher with values of 14.95, 20.43 and 31.37 kg, respectively; as compared to the corresponding values for local breed in North Wollo lowland areas of Ethiopia with values of 8.53, 11.92 and 22.38 kg, respectively. In contrast, a study on response to feeding trial (Tilahu et al., 2014) identified that initial weight for local, 25% Dorper and 50 % Dorper at about 7 months were 14.8, 20.3 and 17.9, respectively; Final weight after 90 days were 22.8, 32.2 and 29.3 kg, respectively. He underlines that 25% Dorper performed well with final body weight under on station condition. On the other hand, a recent study carried out by Ayele et al. (2015) found that the adjusted yearling weight of lambs in Debre Birhan research center was 32.43±0.46 kg; as yearling weight for 50% Dorper x Menz sheep (31.33 kg) was superior to the 50 (26.95 kg) and 75% Dorper x Local sheep (29.13 kg) (Mekonnen et al., 2012). However, the estimated birth weight of Dorper lambs under intensive condition was 3.8±0.8 kg (Jesús Mellado et al., 2016) and yearling weight reached an average weight of 55.0 kg at 18 months of age (Gavojdian et al., 2013). In other cases Lakew et al. (2014) at Sirinka Agricultural Research Center found that the local sheep and their Dorper crosses mean birth weight and weight at weaning was 2.36±0.05 kg, 3.24±0.04 kg; 8.53±0.14 and 14.95±0.21kg, respectively. On-station representative's of productive performance of indigenous and their cross with Dorper sheep are summarized in Table 4.

Reproductive performance

According to Fourie et al. (2009), Dorper ewes in South Africa had age at first lambing of 346 days (11.5months), in contrast to, a well-managed ewes can lamb at the age of 13-15 months (Gavojdian et al., 2013). Age at first lambing and lambing interval of 12 and 8 months was reported for pure Dorper sheep breed

Table 4 Production and reproduction performance of local and Dorper crosses in Ethiopia

Productive traits						
Genotype	**BWT (kg)**		**WWT (kg)**		**YWT (kg)**	**Reference**
local	2.36 ± 0.05		8.53		22.38	Lakew et al., 2014
Dorper x local	3.24 ± 0.04		14.95		31.37	Lakew et al., 2014
BHO x Dorper	M	F	M	F	N/A	Tsegaye et al., 2014
	2.67	2.67	14.67	13.9	N/A	
HH x Dorper	2.82	2.61	15.57	13.75	N/A	Tsegaye et al., 2014
Pure Dorper	3.39 ± 0.08		16.18 ± 0.35		34.43 ± 0.79	Ayele et al., 2015
Dorper x Afar (50%)	2.57 ± 0.06		9.45 ± 0.87		24.96 ± 3.77	Ayele et al., 2015
Dorper x Menz (50%)	2.77 ± 0.04		12.34 ± 0.25		31.33 ± 0.56	Ayele et al., 2015
Reproductive traits						
	AFL		**WFL**		**LI**	
local	469 ± 8.45 days		22.8 ± 0.43		287 ± 2.38	Lakew et al., 2014
local x Dorper	556 ± 6.25days		32.7 ± 0.63		306 ± 4.62	Lakew et al., 2014
Pure Dorper	12 months		N/A		N/A	Fourie et al., 2009
	12 months		N/A		8 months	Budaie et al., 2013

BWT = birth weight, WWT = weaning weight, YWT = yearling weight, BHO = Blackhead Ogaden, HH = Hararghe Highland.

(Budai et al., 2013), while age at first lambing of 12 and 13 months for pure Dorper and Dorper crossbred in South Africa (Fourie et al., 2009). Besides, Lakew et al. (2014) addressed that the local sheep attained faster age at first lambing than the crossbred ewe lambs (469±8.45 vs 555±6.25 days), while the crossbred ewes weighed more than the local sheep ewes at the age of first lambing (32.7±0.63 vs. 22.8±0.43 kg) in Sirinka Agricultural Research Center, Ethiopia. He confirmed that the crossbred and local ewes were comparable in their litter size for local (1.18±0.02) and for Dorper crosses (1.17±0.00), despite the fact that the lambing interval of crossbred ewes was longer than the local ewes (306±4.62 vs. 287±2.38 days). Furthermore, the local ewes had higher annual reproductive rate than that of the crossbred sheep ewes (1.49±0.02 vs. 1.37±0.01 lambs) under the same environmental conditions (Lakew et al., 2014). As a result he outlined that the local sheep were faster to attain the age at first lambing and have shorter lambing interval than the crossbred ewes, whereas the crossbreds were heavier at first lambing than the local sheep. Moreover, the local sheep had higher reproductive rate, while litter size and mortality rate were comparable for both breeds. In contrast to (Budai et al., 2013) there was no significant difference between lambing interval of pure Dorper (8 months) and Dorper crosses (8months), respectively. The average litter size of Dorper sheep under on station condition is 1.19 to 1.5 (Snyman and Herselman 2005). On-station representative's of reproductive performance of indigenous and their cross with Dorper sheep are summarized in Table 4.

On Station Performance Evaluation of Indigenous Sheep with Awassi Crosses

Production performance

According to Seid et al. (2000) least square means of birth and weaning weight of Awassi lambs was 4.4±0.04 and 19.7±0.2 kg. However, birth weight of 2.50 kg for 50% Awassi x Menz crosses, at Sheno Research Center (Demeke et al., 1995) was slightly lower

than the report of Gizaw et al. (2012) for F1 (2.83kg), Awassi x Menz lambs at Debre Birhan Research Center. Other observations by Demeke et al. (2004) reported that Awassi x Menz crossbred lambs (2.9±0.05kg) were heavier at birth compared to pure Menz lambs (2.5± 0.05 kg). In contrast to this, birth weight of pure Menz (2.49±0.03 kg), 25% Awassi x 75% Menz (2.37±0.04 kg) and 37.5% Awassi x 62.5% Menz (2.36±0.04 kg) had no significant difference, while Menz sheep breed (9.29±0.15 kg) had lower weaning weight than that of 25% Awassi x Menz (10.35±0.21 kg) and 37.5% Awassi x Menz (10.22±0.21 kg), respectively (Demeke 2013). The study conducted by Tibbo (2006) on profitability, different growth patterns between the genotypes were observed and ranking of genotypes in weight gain changed with age, at the start of his experiment, the indigenous Menz sheep were inferior to the 75% Awassi-Menz in live body weight (16.6 vs 23.5 kg). During the 10 months experiment, however, the indigenous Menz had about the same (or slightly higher) growth rate as the 75% Awassi-Menz, but both genotypes had lower growth rate than the 50% Awassi-Menz. This variation is important for economic reasons because the 75% Awassi-Menz had already attained the marketing weight of Menz sheep at the start of the experiment. The author suggests that keeping 75% Awassi-Menz longer than a year can be costly compared to other genotypes, reducing profit. Instead this cross could have been marketed much earlier than indigenous Menz. Information on costs of production from birth to one year, including figures on possible differences between the genotypes in fertility and mortality rate, however, is needed to draw clear conclusions on the final value of the different genotypes. The higher weight gain of 50% Awassi x Menz over indigenous Menz and 75% Awassi x Menz genotypes (Tibbo 2006) is different from the study by Gizaw and Getachew (2009) who mentioned that yearling weight were increased as the exotic inheritance level increased (local; 22kg, 25-50%Awassi; 26kg and >50%Awassi; 35kg). On the other hand Hassen et al. (2002) found that the superiority of 37.5% Awassi x 62.5% Menz in birth weight was not maintained at weaning due to inability of the indigenous Dam breed to support or provide milk to higher growth rate in the lamb.

Reproductive performance

According to the report of Lakew et al. (2014) and Gizaw (2002) the local sheep were faster than Awassi crossbred sheep ewes to attain the age at first lambing. Several studies have found that longer lambing interval was attained for Awassi crossbred sheep than the local sheep breeds (Lakew et al., 2014; Gizaw and Getachew 2009). As stated by Lakew et al. (2014) the crossbred ewes were found weighed more than the local sheep ewes at the age of first lambing (32.7±0.63 vs 22.8±0.43 kg).

Conclusions and Recommendations

Ethiopia has a diverse indigenous sheep population, estimated about 28.89 million, out of which about 72.84 percent are females, and about 27.16 percent are males. Sheep production in Ethiopia is based on indigenous breeds except for less than 1% exotic sheep group of mainly Dorper crossbred and Awassi-Menz crossbreds. However, comparing the presence of large sheep population similar to other tropical countries, present production levels are far below their potential and productivity per sheep is very low mainly due to low genetic potential as compared to improved tropical breeds. The productive and reproductive performance of sheep in Ethiopia showed variation among breeds / types, locations and differences. Besides, under farm and station condition variation exists between indigenous and exotic sheep breeds for productive and reproductive traits. The evidence from this review paper points towards the idea that productive and reproductive performance of indigenous and its crossbred with Dorper and Awassi found to vary under on farm and on station conditions. It was revealed that on station performance of Horro out performed well in birth, weaning and yearling weight than other local breeds of Ethiopia, with minimum birth weight of 2.3 and maximum of 2.6 kg, respectively. With consideration of crossbreed, under on farm conditions body weight at different ages was significantly higher in 50% Dorper crosses as compared to their 25% and 75% counter parts. While, the growth rate of Awassi lambs were increased as the exotic blood level increased, combined with most reports in the tropics greater than 37.5% Awassi blood level performed better in terms of on farm condition. On station birth weight of pure Dorper out performed well than that of cross and local contemporaries, while Dorper

crossbreed (50%) is better than local breeds in terms of mean birth weight; ranges from 2.6-3.8 kg, weaning weight; ranges from 13-16 kg and yearling weight; ranges from 24-35 kg. Dorper crosses with Afar under station condition is not economically important due to lower body weights in all aspects. However, the on station productive performance of Awassi crossbred showed that the 50% Awassi x Menz had higher weight gain than the indigenous Menz and 75% Awassi x Menz genotypes, respectively. In all aspects, on farm and on station management condition, Dorper and Awassi crossbred worse in reproductive performance than local sheep breeds of Ethiopia. Surprisingly, results obtained from the on farm productive and reproductive performance of Washera and Gumz sheep breeds are very promising and encouraging. Despite this interest, previous work has failed to address the on station performance of Washera and Gumz sheep breeds. Therefore, future work should focus on the on station performance of these two sheep breeds. However, researches regarding on farm performance of indigenous and their crosses with Dorper and Awassi sheep breeds are not well grounded due to the reason that many researchers has tended to focus on on-station performance evaluation rather than on farm condition.

Indeed future research on On-farm performance evaluation of indigenous and their crosses with Dorper and Awassi sheep breeds with different blood level inheritance should be encouraged.

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