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Abstract

The present study was conducted in the National Sheep Research Station in Elhuda, Sudan where the sheep flocks are kept for scientific research purposes. The aim of the study is to evaluate two systems of sheep productivity namely: the prevailing annual single lamb cropping (sheer-sedentary) and induced three lamb cropping per two years to which feed supplementation is provided (improved – sedentary). Three subtypes: Shugor, Dubasi and Watish in Sudan Desert sheep were used for a three –lamp crops, per two years, in addition to feed supplementation, to represent an improved-sedentary system, (B) against a sheer sedentary (A), that represents an annual single-lamp-crop system. The improved sedentary was associated with reductions in the overall average values of the traits: ewes losses (1.95 vs 3.09%), ewe barrenness (17.30 vs 28.67%) and lambing interval (257.97 vs 353.50 days), whereas it enhanced lambing rate (82.73 vs72.67 %), litter size at weaning measured: as lambs weaned per ewes exposed for breeding (1.01 vs 0.67) and as lambs weaned per ewes that actually lambed (1.12 vs 0.93) improved adjusted lamb weaning weight per ewe at 60 days of lamb age (13.62 vs 10.58 kg) , increased lamb survival rate (93.91 vs 75.63%) and eventually promoted productivity index (18.36 vs 5.25kg) of lambs weaned per ewe per year. These overall average values were calculated out of the mean values of the measured traits shown in tables (1 and 2) of the text. Furthermore, the comparison between the three subtype sheep groups for their performance as affected by the improved sedentary against the sheer - sedentary revealed similar trends of response as above, that culminated in the Shugor subtype having the greatest productivity index mean value (20.82 kg) as subsequently compared with that of either the subtype Dubasi (17.56 kg) or the Watish subtype (16.70 kg). It is concluded that these results do encourage the adoption and projection on the improved-sedentary system, specially, under the surroundings of irrigated agriculture land use to provide extra income to the welfare of the farmer.

Keywords: *Ewe; three-lamb-cropping; lambing-interval; single-lam-cropping; improved-sedentary; lambing rate; survival-rate; productivity index.*

1. Introduction

According to The MARF (2004), the sheep in Sudan contributes a sizeable proportion (about 37%) in the livestock sector (Cattle, Sheep, Goats, and Camels) in the country. A major component of this sheep population is contributed by the Desert type which contains numerous subtypes (Mcleory 1961) of which the Shugor, Dubsi, and Watish are of considerable social and economical role. These subtypes predominate the region extending to the South of the National capital city, Khartoum, lying between the Blue and White Niles and in the Butana plains, under extensive rearing. A group of these sheep, each, is kept in the National Sheep Research Station at EL Huda for scientific research purposes of which the ILCA research report NO 18 (Sulieman et al., 1990) is a leading comprehensive picture. Two main production systems are largely adopted in the country depending on whether migratory (nomadic) or sedentary, Transhumans, rearing activities are the norm of husbandry and feeding in particular (Dahab et al., 2014). Usually only one crop of lambs is harvested through either of these two systems because of the delimiting factor of feed availability as was indicated by Zohara et al. (2014) or feed quality as was noted by Molle et al. (1997), who indicated that when pasture availability and quality become limiting factors to nutrient intake and digestibility, flushing the flock with protein – based supplement can improve the reproductive performance. Similarly, Tibin et al. (2010) reported that the offer of one kilogram of concentrate per head to a grazing flock of Hamari subtype Desert sheep on daily watering regime improved the reproductive performance of that flock over its un-supplemented counterpart group which was allowed access to grazing only and restricted water provision. The objective of the present study is to evaluate the essence of approaching a production system whereby sedentary, Transhumans, sheep are subjected to a three-lamb cropping program per two years while receiving an offer of a concentrate supplement on top of grazing. In a trial to promote flock productivity as extension to the prevailing practice of sheep production and as a way to improve the feasibility of sheep farming and management.

2. Materials and Methods

2.1. Experimental animals and accommodation

The animals used for this study were picked out from within about 200 breeding ewes during their breeding season to represent the Desert sheep subtypes: Shugor (SH), Dubasi (DU) and Watish (WA) flocks available to the Research Station. Accommodation facilities available in the Station included pens partially roofed with bamboo to provide for convenient access to all husbandry activities e.g. kraaling, rearing of due to lamb pregnant animals, fostering sheep, weanlings, Vet. Care and production-oriented activities. These pens are equipped with watering, feeding facilities, salt lick in addition to public health and hygiene, and day –today medical care.

2.2. Experimental treatments

- all sheep were doubly identified with numbered plastic ear tags on both ears, grouped in 20 – 25 ewes/sire groups in breeding pens.
- Sires on the improved sedentary production system were fitted with locally improved sire - signers, to fix sires and dates of mating events.
- Two feeding and hence production systems were adopted (A and B)
  a. Sheer-Sedentary (A), where the female sheep were taken to graze every morning (sires held back) about 4 – 6 hours on natural grasses on fallow lands and banks of canals, leftover of agricultural activities or harvested forages. And this system represents the annual harvest of an annual lamb crop/year. Fodder was offered for the night.
  b. Improved-sedentary production system (B) where the female sheep were taken to graze every day as is shown for (A) but with removal of sires. Fodder and 0.75 kilogram (kg) of supplement (50, 30 and 20% of wheat bran, cotton seed cakes and dura grains + salt and lime) were given.
  c. New born and suckled lambs remaining indoors were given harvested green fodder whereas lambs born in the (B) system were provided, in addition, with concentrate in a rising level to 250 grams a day each. All lambs were weaned when 55 – 65 days of age after taking the actual weaning weight and date for each lamb.

Other treatments included those of disease control (preventative) and health care (medicinal) on a routine day to day follow up.

3. Data Collected and statistical analysis

3.1. Data Collected Comprised

- Breeding records and performance especially for the improved system.
- Birth and weaning parameters.
- Adult and lamb mortalities.
- Lambing rates measured as percentage of ewes actually lambed out of ewe exposed for breeding (EE).

- Litter size at weaning measured as:
  - (i) Number of lambs weaned per ewe exposed for breeding (LW/EE).
  - (ii) Number of lambs weaned per ewes actually lambed (LW/EL).
  - Data processing as to produce those indicators to facilitate estimating, based on Sulieman et al. (1990):

a. The adjusted weaning weight at an age of 60 days (AWW60) as:

$$AWW60 = \frac{actual\ weaning\ weight - birth\ weight}{actual\ weaning\ age} \times 60$$

b. Productivity index (P1) at AWW60 as:

$$P_1 = \frac{litter\ weight\ at\ weaning \times survival\ rate \times 365days}{subsequent\ lambing\ interval} = Kg\ of\ young/weaned/ewe/year$$

3.2. Statistical Analysis

The data obtained on these breeding ewes and their lambs were subjected to statistical analysis using the Texas Instruments Programmable calculator (TI 58C). Means of selected parameters, in the feeding and production systems A and B, were calculated. The Standard errors of the difference between mean (SEM) were also calculated for some of the parameters within each of the systems.

4. Results and Discussion

Earlier studies towards describing the sheep of Sudan were carried out by some authors, for example Bennet et al. (1948) and Mcleroy (1961) but Wilson and Clarke (1975) referred to the sheep of South Darfur where about 7.4% of the national sheep prevails, Sulieman et al. (1990) produced a report on the sheep in the Gezira region to which the present study is a furtherance, seeking to explore other merits which may add more scientific and economical values to these sheep.

The variations observed on fertilization rates for these subtypes (SH, DU, WA) during the six-week breeding season (figure 1) could be explained in the light of the initial status of these sheep and their preparedness to respond to concentrate offering and/or, probably, the first-time presence of the sire, to promote their breeding attitudes. Mukasa – Mugerwa et al. (1994) inferred that when rams were introduced to ewes that have been previously isolated or kept exposed to vasectomzied rams for a year, oestrus behavior was synchronized in the isolated ewes. Although the introduction of ram will not increase ovulation rate, however, they added, it is used as natural tool to match reproductive cycle events with feed resources. Also, Tibin et al. (2010) noted that the fertility rates in Hamari female sheep were highest when these sheep were offered one kilogram concentrate in addition to grazing while being daily watered in contrast to other treatments which received no concentrate supplement and allowed only grazing and intermittent watering. The variation in breeding performance as it may appear here needs to be established on more solid grounds with larger groups of sheep and for more extended trials, bearing in mind that the occurrence and distribution of heat and mating during a breeding season plays a major role in the overall productivity and economy of a flock. The shorter the breeding season, the lesser will the efforts (physical and/or monetary) be needed to execute any task feasibly.

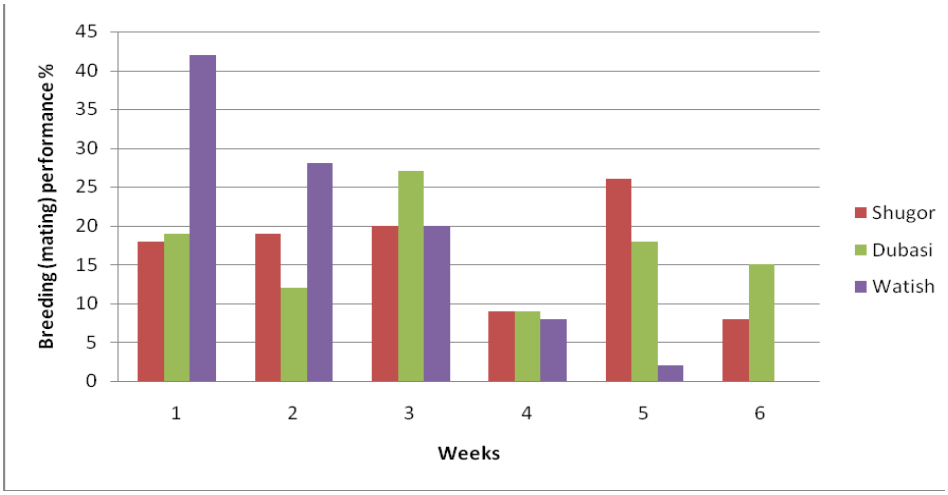

Figure (1): Breeding patterns of Female SH, DU and WA Sheep during breeding season of Six Weeks

An overall within subtype female sheep losses trend (Table 1), of about 3.8, 2.05 and 2.15% for the WA, SH and DU, respectively, could be explained to be due to the, perhaps, lesser adaptability of the WA to the region, and also probably due to their being initially more widely nomadic in prevalence than the other two subtypes, moving in a wider scope extending to the southern quarters of the region. But between sheer-sedentary and improved sedentary production systems, on an overall average comparison, inclines to favour the latter system with reduced ewe losses as (1.95 vs 0.93.42%) that is, more likely to be due to the increased availability and improved quality of feed. The latter condition has also been seen (Table 1) in the case of fertility as being reflected in the level of ewe barrenness. For it can be evaluated from (Table 1) that ewe barrenness varied with ewe subtype at average

levels of 16.0, 26.3 and 28.8% for the SH, DU and WA, respectively. Since mortality and fertility are known to be sensitive to management, especially feeding management, a reduction of about 40%, on average, in the barrenness was associated with the concentrate, offer in the B system (17.3 vs 28.67). This was most noticeable in the subtype SH subgroup on B system which attained an improvement of about 45% over its counterpart sheer-sedentary (A). In the previous study of Sulieman et al. (1990), the least death or ewe losses were experienced at about 10.0% for records compiled over 9 years (1975 - 1984) which was thence complicated by a critical nutritional crisis. In this respect, Tibin et al. (2010) noted that the group of the grazing Hamari Desert sheep subtype on offer of one-kilogram supplement and daily watering regime had the highest fertility but the least losses as abortions in contrast to those solely grazing Hamari groups with intermittent watering regime. On the other hand, Mukasa – Mugerwa and Lahlu – Kassi (1995) obtained a fertilization rate of more than 90% in a flock of sheep producing three lamb crops per two years as an improved production system compared to one annual lamb cropping. Similarly, Molle et al. (1997) obtained an improvement in the prolificacy (1.54 vs 1.33) and fecundity (1.29 vs 1.14) of sarda ewes following an offer of concentrate supplementation.

Table (1): Reproduction traits of Shugor (SH),Dubasi (DU) and Watish (WA) Female Desert sheep Sub-types Under Sheer-sedentary (A) and Improved –sedentary (B) Production Systems.

Sub-type Sheep groups / Parameters		SH Mean value	DU Mean value	WA Mean value	±*SEM
Ewe Losses, % :					
	A	2.13	2.87	5.22	
	B	2.00	1.40	2.40	
Barrenness, % :					
	A	2.69	29.56	34.65	
	B	10.96	17.95	22.89	
Lambing Rate, % :					
	A	82.17	70.44	65.35	
	B	89.04	82.05	77.11	
Lambing Interval, days:					
	A	335.83	362.80	361.85	± 15.61
	B	258.75	257.98	267.14	± 11.29
Litter size at weaning as Lambs weaned per:					
EE**	A	0.809	0.616	0.591	
	B	1.027	0.827	0.928	
EL**					
	A	0.984	0.874	0.904	
	B	1.154	1.009	1.203	

±SEM*= Standard error of subtypes compared on the A system and similarly for comparison on the B system.
EE**= Ewes Exposed to breed.
EL** = Ewes actually lambed.

For sheep subtype effect on lambing rate on average as is estimated from Table 1, it indicates, a superiority of the SH (85.6%) over either of the DU (76.25%) or WA (71%). Many authors e.g. ELMubark (2001), Ali (2003), ELhag et al. (2007) and Idris et al. (2010 ab) noted on the positive effect of supplemental offer on the reproductive performance of grazing sheep. Thus ELMubark (2001) obtained, in Kabashi and Hamari; Sudan Desert subtypes, an overall average lambing rate of 90.68% for all types of supplementations offered while that in the control ewes was only 66.96%. Similarly, Ali (2003) reported 92.9 and 85.0%, respectively as lambing rates, on average, for Sudan Nilotic sheep ewe parents and first- time lambing ewe lambs. Other studies on this line include those of Mukasa – Mugerwa and Lahlu – Kassi (1995), Hassan and Talukder (2011), Mohamadabadi and Sattayimokhtari (2013) Zohara et al. (2014), who investigated the effect of concentrate offer and genetic influence on the lambing rate, confirming the role of the former factor and impressing the necessity of including the latter in breeding programs for future genetic improvement, whereas Mukasa – Mugerwa and Lahlu – Kassi (1995) ventured the possibility of getting three lamb crops per two years, displaying a lambing rate of 72% in the Menz ewe sheep which they investigated.

The overall average lambing interval obtained for the present study observed, estimated from (Table 1), on average, is clearly reduced for the improved sedentary production system (257.97 days) as compared to that in the sheer-sedentary system (353.5 days), and this is quite compatible with the objectives of this study, even though it does not fit precisely with the picture set up by the argument of Tempest (1983) for the management of the frequent lambing flock, which allows 8 months for lambing interval spread over a sequence of events of one month for preparation, 5 months for gestation and 2 months for lactation and drying up. The evident noticeable difference in the two intervals should be permissible for circumstantially

transient necessities. A similar lambing interval, to our results on the B system, of 8.4 months was obtained by Mukasa – Mugerwa and Lahlu – Kassi (1995) for Menz sheep set on a three lamb crops per two years. On the other hand, our present results are better, on either of the two systems (A or B), than those intervals reported by Sulieman et al. (1990) as 426.0±20.0 days as an overall average lambing interval for the SH, DU and WA. But otherwise more lesser intervals than ours were shown by Ali (2003) for the Sudan Nilotic sheep type, as 201.1 vs 204.0 days for parent ewes and 215.8 vs 204.2 days for ewe lambs, fed on two types of concentrate. However, breed or type of sheep seemed to have but little effect on lambing interval since Hassan and Talukder (2011) reported that it differed as 188.6±6.0, 189.5±5.5 and 204.3±7.7 days, in different regional native sheep in Bangladesh. On the other hand, Lakew et al. (2014) reported a lambing interval of 287.0±2.3 and 306.0±4.62 days in Local, and Dorper×Local crossbreds, respectively. Furthermore, the lambing intervals observed in this study per subtype (A+B) for the SH (297.3 days), DU (310.4 days) and WA (309.5 days) are shorter in contrast to those (449, 425 and 403 days) which were shown earlier by Sulieman et al. (1990) for the these subtypes, probably due to an over years cumulative residual improvement in the present flocks management in general,especially on the part of nutritional improvement, which is more directly related towards the improved flock productivity by, among other things, shortening the reproductive cycle in the flock, aided by nutritional augmentation since the genetic influence on the latter is known to be poor.

Overall subtypes average values for litter size at weaning estimated from the relevant mean values shown in (Table 1) compare as 1.04, 0.72 and 0.76%, and as 1.07, 0.94 and 1.06%, are measured as lambs weaned per ewe exposed (EE) and lambs weaned per ewe actually lambed (EL), respectively, for the SH,DU and WA subtypes. However, as concerns production system, it is clear that the B system is more favorable and was associated with the greater positive response in litter size in both terms (1.01 vs 0.67 %, for EE and 1.12 vs 0.93% for EL as comparing on average, B and A. That confirms the strong relation of nutritional influence on fertility, multiple birth and survival of youngs to weaning age and hence improved litter size and/or weight at that age. A number of investigations carried out by, for example, Mukasa – Mugerwa and Lahlu – Kassi (1995), EL Hag et al. (2007), Idris et al. (2010 ab), EL Mubark (2001), Mohamadabadi and SattayimoKhtari (2013) and Zohara et al. (2014) indicated that the offer of concentrate supplement to the flock during breeding, pregnancy and lactation, improved litter size and weight at weaning. For instance, Mohamadabadi and SattayimoKhtari (2013) obtained 0.94 and 0.87 for litter size at birth and at weaning, respectively, and 2.9 Kg and 18.26 Kg, for these parameters, respectively, as weights. Hence it is well understood that good management of litter weight at weaning contributes to a moderately great extent to the genetics of flock improvement. Previously Sulieman et al. (1990) indicated that these three subtypes were significantly different only for the SH, having greater litter size (1.30) at birth compared to that ,1.18 and 1.17, in the DU and WA,respectly. But Hassan and Talukder (2011) found no significant difference in litter size in three native sheep groups (Bangladesh) with mean values of 1.18, 1.17 and 1.16. Similarly, Lakew et al. (2014) reported a litter size of 1.18 and 1.17 for Local and Dorper×Local. Crossbreeds respect in Ethiopia.

In Table (2), body weights at birth and as adjusted weaning weight at 60 days of age tended to be consistently lower for the Watish subtype but similar for the Shugor and Dubasi subtypes, with but little difference between A and B feeding systems, for birth weight while these weights are clearly bigger,about28.73% more weaning weight for the improved-sedentary (B) lambs over their counterparts which were fed on the sheer-sedentary system only. Lambs within subtypes but on different feeding systems (A or B) responded by an increase of about 31.29 and 28.73% and 26% more weaning weights in favour of those lambs fed on the B-feeding system within the Shugor, Dubasi and Watish subtypes respectively.

The earlier observations of Sulieman and Wilson (1990) indicated that the Shugor and Dubasi subtypes studied were of greater body weight from birth to one year of age as compared to the Watish subtype. Other authors, for example, EL Hag et al. (2007) and Idris et al. (2010 ab) confirmed that concentrate offer to grazing Desert sheep subtypes for flushing, steaming or both resulted in an improvement in birth and the subsequent body weights measured. A similar finding was shown by Tibin et al. (2010) in Hamari Desert sheep subtype when grazing ewes were supplemented with one Kg of concentrate per day within the daily watering regime which allowed them to produce the best birth and 120 days weights in contrast to their control of other sheep groups which were compared as for birth and for 120 days of age : (4.0±0.19 vs 2.30±0.29 Kg) for birth weight and (28.0±0.79 vs 19.5±1.17 Kg) for weaning weight. On the other hand, Hassan and Talukder (2011) obtained significantly different effect, irrespective of locality, on birth weight amongst the Jamuna, Brind and coastal types of Bangladeshi sheep.

Amongst the strong determinant factors for level of flock productivity is survival rate at specific targeted age for production objectives. Pre-weaning lambs survival rates to weaning age vary with flock management beside other factors like breed, season ,..ect(Sulieman et al,1990) .The mean values for survival rates in the lambs of the present study (Table 2) are estimated on average to read for mean subtype values which are compared as : 84.72 ,85.56 and 84.07% representing the within subtype SH ,DU and WA performance disregarding feeding system effect. But measured for feeding system effects

within the subtype, between the mproves subtype group and at the overall between feeding effects variations,indicated a greater advantages in survival rate records for the within subtype(A vs B) and between feeding subgroups B systems and on the overall (B) as per its overall (A). The responses being about: 25.62 20.40 and 26.50% and extra for the Shug, Dub and Wat within subtype comparison respectively while the overall average improved - sedentary was greater by about 24.17% than that observed for the sheer-sedentary, being of 93.91 vs 75.63 % of average values for B and A. In general this performance is more favorable than that which was shown by Sulieman and Wilson (1990) that reported an overall average survival (mortality) rate of 43.70% for lambs of the Shugor,Dubasi and Watish subtypes brought to 150 days of age having individual survival rate mean values of 48.5 , 46.5 and 34.70%, respectively. A similar survival rate of (85%), to the present subtypes performance was shown by Mukasa –Mugerwa and Lahh-Kassi (1995) for the Ethiopian Menz sheep. However, the average survival rates of 93.69% for Local and Dorper X local crossbred (Lakew et al. 2014), and those of 100 and 75% as reported by Zohra et al. (2014) for unflushed Bangladeshi sheep reflect the importance of feed supplementation on this vital trait.

Productivity index measured on a compilation of production characteristics is good and sound measure as a production, on its own parameter that facilitates workable and feasible comparison in flocks of sheep or other livestock for economic and promotion evaluation. The present index, thus described in this study and its relevant mean values in (Table 2) reveals an advantage of over two to three folds of an index value for the improved sedentary (B) in contrast to the sheer-sedentary system (A).This trend holds true for the within subtype comparison Table (2) as well as for between the two feeding systems (A and B) at large observing that the response to the improved sedentary is at its highest index value for the Shugor followed by Dubasi and Watish (Table 2).

Table (2): Some Characteristics of lamb production and ewe productivity in three desert sheep subtypes under sheer-sedentary (A) and improved sedentary (B) systems

Parameters \ Sheep groups and Production Systems	SH Mean values	DU Mean values	WA Mean values	±SEM *
Birth Weight, Kg:				
A	3.97	4.05	3.24	0.14
B	4.03	4.48	3.47	0.12
Adjusted Weaning Weight at 60 days, Kg:				
A	10.88	11.42	9.45	1.08
B	14.27	14.67	11.92	0.53
Lamb Survival Rate, %:				
A	75.10	77.74	74.23	
B	94.34	93.48	93.90	
Productivity Index (PI), Kg of Weaned lambs/ per ewe/ peryear:				
A	5.19	5.24	5.31	0.97
B	20.82	17.56	16.70	2.27

±SEM * = Standard error of treatments means.

5. Conclusion

It is concluded from this study that the results obtained in the subject matter of the study are quite an encouraging and therefore quite conclusive to a promising sheep farming shortly or in the intermediate long run. The successfulness of such study and its projection in the surroundings of irrigated agriculture land use is strongly inductive to new era in sheep production in the country, bringing forth the stratification production into the shade of systemization.

5.1. Recommendations

It is strongly recommended that this then should be adopted stately to initiate a policy on integrated farming to improve multidisciplinary sources of income generation for the farmer's(crop/animal) well-being and animation as well as enriching the animal agricultural role in the economic sector.

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