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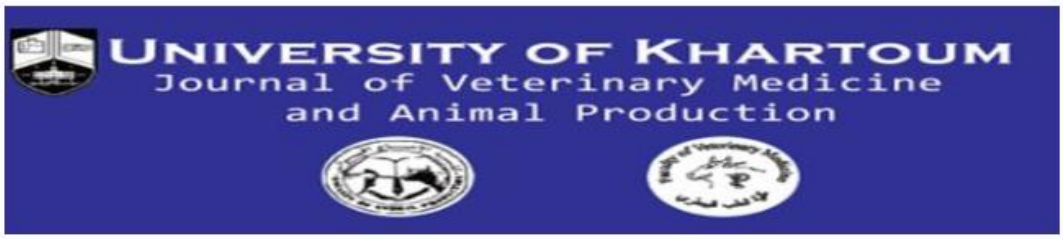

Phenotypic and Production System Characterization of Sudanese Watish Desert Sheep in Sinnar State, Sudan

Sara E. Ibrahim Mohamed[1], Romaz M. A. Omer [2]*, L. M. A. Musa[3,5], Khaleel I. Z. Jawasreh[4] and Mohammed-Khair A. Ahmed[3].

[1]Animal Production Research Centre, Animal Resources Research Corporation, Ministry of Animal Resources, Khartoum,1355, Sudan
[2]Institute for Studies and Promotion of Animal Exports, University of Khartoum,13314, Shambat, Sudan
[3]Department of Genetics and Animal Breeding, Faculty of Animal Production, University of Khartoum, 13314, Shambat, Sudan.
[4]Department of Animal Production, Faculty of Agriculture, Jordan University of Science and Technology, Irbid, Jordan
[5]The Arab Center for Studies of Arid Zones and Dry Lands (ACSAD), P.O.BOX: 2440, Syrian Arab Republic – Damascus
**Corresponding author: romazmo@hotmail.com*

Abstract

This research was conducted to contribute to establishing base line data for the phenotypic characterization of Watish sheep and their production system for future conservation and improvements efforts. A semi-structured questionnaire, field observations and linear body measurements were used to gather information from 59 Watish sheep owners in 7 villages. Body measurements were collected on 156 individuals and the data were classified according to sex and age. Gathered data were summarized and analyzed mainly in the form of descriptive statistics. Watish sheep were found to be produced under a nomadic system (81.4%), a sedentary system (8.5%) or a semi nomadic system (10.2%). Supplementary feeding was adopted by 67.2% of owners and of those, 26.3% fed concentrates supplements. Most owners (81.0%) raised breeding rams from own flock while 17.3% borrowed rams from neighbouring flocks. The main production constraints were water (25.0%), feed (20.6%), disease (19.6%), capital (18.1%), and security (16.7%). The highest mortality rate among all classes of animals, particularly, new born lambs and nursing ewes occurred in dry summer. The overall mean of body length, heart girth, barrel circumference, height at withers and tail length were 63.87±0.48, 81.25±0.66, 93.61±0.87, 76.51±0.42 and 62.37±0.6, respectively. All correlations were positive and significant between different morphometric measurements. No association were observed between the sharing of management by family members (χ^2 = 3.333), breeding system(χ^2=1.262), concentrate provision(χ^2=5.276), vaccination (χ^2=1.280) and record keeping (χ^2 = 0.811) and education level of owners. However, there was a significant association between purpose of rearing sheep (χ^2=17.524) and disease occurrence (χ^2=11.058) and level of education of owners. A highly significant association was observed between identification method and education level (χ^2=18.133). This study highlights the need for greater control of environmental factors in order to improve Watish sheep production.

Key words: Desert Sheep, Phenotypic Characterization, Production system Sudan, Watish.

الخلاصة

تم إجراء هذا البحث للمساهمة في إنشاء قاعدة بيانات أساسية للتوصيف المظهري لأغنام الوتيش ونظام إنتاجها لدعم جهود الحفظ والتحسين المستقبلية. تم استخدام استبيان شبه منظم وملاحظات ميدانية وقياسات الجسم الخطية لجمع المعلومات من 59 من ملاك الوتيش في 7 قرى. وجمعت قياسات الجسم على 156 رأس وتم تصنيف البيانات حسب الجنس والعمر. ولخصت البيانات التي تم جمعها وتحليلها في شكل إحصاءات وصفية، وتحليل التباين والارتباط. وجدت الدراسة أن أغنام الوتيش تنتج في نظام رعوي (81.4٪) ، أو نظام مستقر (8.5٪) أو شبه رعوي (10.2٪). وتعتمد التغذية التكميلية من قبل 67.2٪ من الملاك ومن هؤلاء 26.3٪ يستخدمون مكملات غذائية مركزة. يربي معظم الملاك (81.0٪) الكباش من قطعانهم الخاصة بينما يستعير 17.3٪ ا الكباش من القطعان المجاورة. كانت محددات الإنتاج الرئيسية هي المياه (25.0٪)، والأعلاف (20.6٪)، والأمراض (19.6٪)، ورأس المال (18.1٪)، والأمن (16.7٪). وجد أن أعلى معدل للنفوق بين جميع فئات الحيوانات، ولا سيما الحملان حديثة الولادة والنعاج المرضعة يحدث في الصيف الجاف. كان المتوسط الكلي لطول الجسم ومحيط الصدر ومحيط البطن والارتفاع عند الأكتاف وطول الذيل 63.87 ± 0.48 و 81.25 ± 0.66 و 93.61 ± 0.87 و 76.51 ± 0.42 و 62.37 ± 0.6 على التوالي. كانت جميع الارتباطات إيجابية ومعنوية بين القياسات المظهريةالمختلفة. لم يلاحظ وجود أي ارتباط بين مشاركة أفراد الأسرة في ادارة القطيع ($\chi 2 = 3.333$) ، ونظام التربية ($\chi 2 = 1.262$) ، وتوفير المركزات ($\chi 2 = 5.276$) ، والتطعيم ($\chi 2 = 1.280$) وحفظ السجلات ($\chi 2 = 0.811$) ومستوى تعليم الملاك. ومع ذلك، كان هناك ارتباط معنوي بين الغرض من تربية الأغنام ($\chi 2 = 17.524$) وحدوث الأمراض ($\chi 2 = 11.058$) ومستوى تعليم الملاك. ولوحظ وجود ارتباط معنوي بين طريقة تحديد وسم الأغنام ومستوى تعليم المالكين ($\chi 2 = 18.133$) .تؤكد هذه الدراسة على الحاجة لمزيد من الإرشاد للتحكم في العوامل البيئية لتحسين ظروف إنتاج أغنام الوتيش.

Introduction

The livestock species (especially sheep and goats) play very important economic, social and cultural functions for rural households. They contribute to improved income and wellbeing of the rural family. The Sudan hopes to meet the challenge of the shortage of meat in Arab countries by improving and enhancing its rich agricultural sector. Significant improvements have been achieved in some of the economically important characters in sheep based on phenotypic selection; however, no organized effort was ever made to improve Desert sheep. Desert sheep never had the opportunity to express their real genetic potential in production and reproduction.

The main sheep type in the Sudan is the Desert sheep, which encompasses a number of subtypes. The Sudan Desert Sheep is thought to comprise more than 65% of all Sudanese sheep which are spread north of latitude 12°N, extending into Eritrea and westward into Chad. Sudan Desert sheep suffer from poor nutrition in the dry season (February to June) and this forms the most important constraint to their productivity. The Desert sheep ecotype is the most predominant for marketing purposes. Its meat is in high demand for export because of the size of its carcass, and the quality of its mutton and lamb. However, constraints to Sudanese sheep exports include among others lack of traceability and reliable supply lines.

The Watish sheep is considered the Desert sheep most adapted to living in areas of clay soils and heavy rainfall (Devendra and McLeroy, 1982). The Watish subtype is somewhat smaller and stockier than other Desert sheep ecotypes and it comprises three colour groups, fawn, red, and white with light spotting (McLeroy, 1961). They are predominantly owned by nomadic and semi-nomadic societies including the Rufaa El Hoy, the Kenana, and the Beni Meharib tribes.

In 1992 ILRI (International Livestock Research Institute) organized a workshop as part of the research planning process, to address issues of characterization and conservation of Africa's indigenous AnGR (Rege and Lipner, 1992). Livestock Characterization means the distillation of all knowledge, which contributes to the reliable prediction of genetic performance of an animal genetic resource in a defined environment. Thus, it includes a clear definition of the genetic attributes of an

animal genetic resource and the environments in which it is kept (Rege, 1992).

Body measurements are widely used in livestock characterization and for the evaluation of breed performance and as a means of selecting replacement animals (Sowande and Sobola, 2008). Morphometric measurements together with body weight describe more completely an individual or population than the conventional methods of weighing and grading (Ahmed, 2014). A strong correlation was revealed between body measurements and body weights. According to Thiruvenkadan (2005) the correlation for different body measurements varied between 0.506 and 0.968. Moreover, Cam *et al*., (2010) stated that fattening conditions traits namely, heart girth, chest depth and chest width are correlated with body weight. However, body weight was not reflected by height at wither, height at rump and body length.

The objective of thisstudy was to generate baseline information on the phenotypic characteristics of the Watish breed and their production system, which is a prerequisite step toward future conservation and improvements efforts.

Materials and Methods

Data Collection

This study was conducted in the homeland of Watish sheep breed, in Sinnar State. A total of 59 sheep owners were included from the seven localities namely: Wadalneyal, Singha, Abuhugar, Umbinein, Umshoka, Alramash, Sinnar, Wad Elgizoli. A semi-structured questionnaire was designed to obtain information on general household information, herd structure, reproductive-productive practices and management and feeding system.

Body measurements: Body length (BL), Height at withers (HAW), Heart girth (HG), Tail length (TL) and Barrel circumference (BC) were collected on 156 individuals and the data were classified based on sex and age. The linear body measurements were made using a tailor's measuring tape and a graded stick in accordance with the recommendations of FAO (2012).

Statistical analysis

Gathered data were summarized mainly in the form of descriptive statistics, ANOVA and correlation analysis. The statistical package used was SPSS for Windows, Version 16.0. Morphometric data were analyzed using analysis of variance and Chi-square tests, while, means were tested for significance using Duncan's Multiple Range Test.

Results

The household information and management system

Table (1) demonstrates detailed information on household, type of land tenure, farm size, role of family in management of flocks, management system, the importance of sheep species and species ranking. About 9.8% of the Watish owners were illiterate, and 5.9% were university graduates. Family members had different roles and responsibilities in sheep management (Grazing, milking and castration). No association was observed between the sharing of management by family members and education level ($\chi 2$=3.333, P-value=0.766). The majority of respondents owned farms (80.0%), while 12.7% had leased farms and 3.6% were on public land and about19.3% of farms were small, 43.9% were of medium size and 36.8% were large. Most owners used an extensive system of management (93.1%) and 43.0% of owners raised sheep only. The respondents ranked sheep first and camels last as income earners.

Table 1. Household information and management system

Parameter	Percentage%	Parameter	Percentage%			
Education		**Responsibility**				
Illiterate	9.8		**Father**	**Mother**	**Sons**	**Daughters**
Primary	51.0	In herding	35.4	7.3	50.0	7.3
Secondary	33.3	In milking	37.3	2.7	56.0	4.0
Graduates	5.9	In castration	37.1	-	62.9	-
Farm size		**Land tenure**				
Small	19.3	Registered			80.0	
Medium	43.9	ownership			12.8	
Large	36.8	On lease			3.6	
		Public land			3.6	
		Other				
Management system		**Species**	**Sheep**	**Cows**	**Camels**	**Goats**
Intensive	0.0	Percentage (%)	43.0	23.7	2.2	31.1
Semi intensive	6.3	Ranking	0.61	0.24	0.02	0.13
Extensive	93.1					

Source of flock and objectives of rearing

Data describing source of flock, purpose of sheep rearing, level of income, adopted system of management, season of migration, changes in flock size during disease outbreaks and criteria for culling are presented in table (2). About 26.7% of owners obtained their flocks from their parents through inheritance while the remainder (73.3%) bought their stocks from local markets. Regarding the purpose of rearing, 27%, 21.3%, 14.4%, 13.8% and 10.9% ranked first meat, milk, wool, skin and manure production, respectively and about 12.6% stated social status as the main reason for their involvement in sheep business. There was a significant association between purpose of rearing sheep and education (χ^2=17.524, P=0.041). About 56.9% of owners regarded their income from sheep breeding as medium and 39.2% said it was good while a few owners(3.9%)said it wasrewarding. Most owners adopted the nomadic system (81.3%) followed by those who adopted the semi-nomadic system (10.2%) and 8.5% were in a sedentary system. The results showed that most owners migrated in summer (78.3%) compared with a few owners who migrated in the rainy season (19.6%) while 2.2% migrated in both seasons. Furthermore, about 69.5% of flocks shared grazing range with other species (mixed grazing) and 30.5% grazed as single species.Noassociation between breeding system and education level was found (χ^2=1.262, P=0.738).Disease was an important constraint facing Watish owners in the study area. About 50.8% of owners complained of high mortality. The majority of respondents (54.2%) said they had to sell some stock during disease outbreaks in order to purchase treatments. Moreover, the culling criteria mentioned by respondents were fertility problems (8.0%), old age (22.9%), colour (9.1), behaviour (5.7%), shape (15.4%), size (8.6%) body (8.6), performance (5.7), and health problems (16.0%).

Table 2. Source of flock, adopted system of management, criteria for culling and objectives of rearing

Parameter	Frequency %	Parameter	Frequency %
Source of flock		**Breeding purposes**	
Inherited	26.7	Meat production	27.0
Purchased	73.3	Milk production	21.3
		Wool production	14.4
		Manure	10.9
		Skins	13.8
		Social status	1.0
Level of income		**Adopted system**	
Medium	56.9	Nomadic	81.3
Good	39.2	Semi nomadic	10.2
Rewarding	3.9	Sedentary	8.5
Migration		**Season of migration**	
Yes	93.1	Summer	78.3
No	6.9	Rainy season	19.5
		Both seasons	2.2
Mixed grazing		**Sale of stock**	
Yes	69.5	Yes	54.2
No	36.5	No	45.8

Feeding and watering

Details of feeding including the time of grazing, factors limiting fodder production on the farm, source of water, frequency of watering and cost of water in different seasons are presented in table (3). The results indicate that about 32.8% of owners were dependent on rangeland only to feed their sheep while 67.2%provided supplementary feedingbeside grazing. Furthermore, 60.0% of owners who provided supplementary feeding offered roughages, 26.3%concentrates, while the rest (13.7%) provided both. No significant association was observed between concentrate provision and level of education of owners(χ^2=5.276, P=0.153). The majority of owners practiced grazing twice a day (96.6%). About 98.3% of owners provided salts to animals. About43.3% of respondents attributed the main limitation to feed production on the farm to soil type, 15.8% to availability of machinery and equipment, 18.3% to manure application, and 20.8% to the use of technical packages, while 1.7 % attributed it to other factors and reasons. Water was obtained from wells by 39.8% of owners while 6.0% obtained water from water yards (of the local name donkeys) and 54.2 from earth dug reservoirs (Hafirs). In dry summer, the majority of owners (96.4%) watered their animals daily and 3.6% every other day. In winter the majority of flocks (75.9%) were watered every other day, 22.2 were watered daily and 1.9% weekly. Regarding the cost of water in different seasons about 96.6% and 91.5% of owners had to purchase water during dry summer and winter, respectively. This percentage decreased in the rainy season to 13.8%.

Animal housing, reproduction and lamb mortality

Table (4) shows that only 11.9% owners kept their animals in enclosures. The material used in constructing the enclosure was mostly thorn branches (57.1%). Modern reproductive techniques such as artificial insemination were not available

and were not known to farmers and in 91.2% of flock's reproduction occurred randomly without interference or control by owners. As expected most owners (71.1%) stated that the lowest mortality rate was observed among single born lambs. Of all owners sampled 58.3% indicated that twin lambs involved more work chores. Many owners (55.6%) were willing to select twins for breeding purposes. The study found that 96.9% of owners said that Watish ewes dropped lambs throughout the year and only 3.1% said most lambs were born in the rainy season.

Table 3. Some information on feeding and watering practices:

Parameter	Frequency %	Parameter	Frequency %
Dependence on range		**Type of supplementary feed**	
Grazing only	32.8	Roughages	60.0
Grazing + supplementary feeding	67.2	Concentrates	26.3
		Both	13.7
Factors affected total feed production			
The soil	43.3		
Availability of machinery and equipment	15.8	**Type of roughages**	
Manure application	18.3	Green	19.3
Use of technical packages	20.8	Dry	33.3
Other	1.7	Both	47.4
Do you feed concentrates		**If yes what season**	
Yes	36.8	Rainy season	0
No	63.2	Summer	92.3
		Winter	0
		All seasons	7.7
Time of grazing		**Is salt offered?**	
Morning	3.4	Yes	98.3
Morning + Night	96.6	No	1.7
How is salt offered		**Water source**	
With food	0	Shallow wells	39.8
With water	32.8	Water yard (Donkey)	6.0
With food + water	67.2	Earth dug reservoir	54.2
With food	0		
Watering			
Animals moved to source	31.0		
Water brought to animals	44.8		
Both	24.2		
Number of watering	**In rainy season**	**In dry summer**	
Daily	21.4	96.4	
Every other day	50.0	3.6	
Weekly	28.6	-	
Cost of watering			
Free	3.4	8.5	
Purchased	96.6	91.5	

Table 4. The Animal housing, reproduction and lamb mortality:

Parameter	Frequency %	Parameter	Frequency %
Housing		**Type of enclosure**	
No enclosure	88.1	Thorny branches	57.1
Enclosure	11.9	Wood poles	14.3
		Metal poles	28.6
Type of mating		**Ewes preferred**	
Random	91.2	Single bearing	4.0
Controlled by owner	8.8	Twin bearing	26.0
AI	0	Triplet bearing	70.0
Willingness to select for twinning		**Higher mortality**	
Yes	55.6	In triplets	71.1
No	44.4	In twins	20.0
		In singles	8.9
Work Load		**Method of rearing lambs**	
Singles easier	58.3	Running free with ewes	11.3
No difference	41.7	Separated	73.6
		Running with ewes but no suckling	15.1
Season lambs dropped			
Dry summer	0	**Practicing castration**	
Wet summer	3.1	Yes	82.5
Winter	0	No	17.5
Throughout the year	96.9		
Source of breeding rams		**Fate of surplus males**	
From own flock	81.0	Castrated	43.8
From neighbouring flocks	17.3	left in flock	22.9
Both	1.7	Sold before maturity	33.3
Use of ram sons in breeding		**Having improvement plan**	
Yes	98.3	Yes	89.1
No	1.7	No	10.9
Mating season		**Type of mating**	
Dry summer	1.8	Controlled	17.2
Wet summer	5.5	Random	82.8
Throughout the year	92.7		
		Use of Kunan	
		Yes	11.1
		No	88.9

About 73.6% of owners said that they separated new-borns from their dams. Owners who practiced castration of males made up 82.5% of the sample. Most owners obtained males for breeding from their own flocks (81.0%). The surplus males were castrated by 43.8% of respondents, 22.9% left them in flock and 33.3% sold them

before reaching maturity. Male offspring of the breeding ram were used for breeding by 98.3% of owners. About 89.1% indicated that they have an improvement plan for their flocks. For most flocks (92.7%) mating continued throughout the year and 82.8% of owners did not practice any control over mating.

Income and Constraints

Table (5) shows the income and constraints, advantages and problems of raising sheep, mortality and disease. The main inputs purchased by owners were roughages (45.8%), drugs (44.1%), buildings (9.3%) and other items (0.8%). About 77.8% of respondents got most of their income from the sale of animals.

Table 5. Income and constraints, advantages and problems of raising sheep:

Parameter	Frequency %	Parameter	Frequency %	Parameter	Frequency %
Inputs		**Returns**		**Profits**	
Roughages	45.8	Sale of milk	22.2	Rewarding	91.4
Drugs	44.1	Sale of animals	77.8	Not satisfactory	8.6
Buildings	9.3				
Other	**0.8**				
Constraints		**Outbreak occurrence**		**Practicing vaccination**	
Low production	31.9	Yes	43.1	Yes	91.1
Marketing	39.4	No	56.9	No	8.9
Distance to market	25.5				
Other	3.2				
Which disease		**Source of service**		**Reason for adopting sheep raising**	
PPR	97.5	Public vet. Services	73.4	High fertility	32.9
Sheep Pox	2.5	Private vet services	17.2	Rapid capital Turnover	28.0
		Drug store	7.8	Adaptability	36.3
Constraints		Other	1.6	Others	2.8
Feed	20.6				
Drinking water	25.0				
Disease	19.6				
Capital	18.1				
Security	16.7				

Returns were considered rewarding by 91.4% of respondents. Furthermore, the main constraints were identified as: Marketing problems (39.4%), low productivity (31.9%), distance to market (25.5%) and other problems (3.2%). Owners mentioned many advantages in raising sheep. They pointed out that sheep

are well adapted to the local environment (36.4% of respondents). Others mentioned the high fertility of sheep (32.9%) and the rapid capital turnover in the sheep business (28.0%). The main constraints to sheep production activities were availability of water and feed. Diseases, Security and finance were also mentioned as major constraints (Figure1). About 43.1% of respondents said there were disease outbreaks in their flocks in the last year. Vaccination was practiced by 91.1% and 73.4% obtained vaccines from the public veterinary services, 17.2% from private veterinary services and 7.8% from drug stores. The diseases against which vaccination was done were Small Ruminant Plague (PPR) and sheep pox. Significant association was detected between level of education of owners and disease outbreak occurrence (χ^2=11.058, P=0.011), while no association between vaccination and level of education was found (χ^2=1.280, P=0.734). The highest mortality rate among all classes of animals occurred in dry summer. The highest rate of mortality was among new-born lambs and nursing ewes (Table 6).

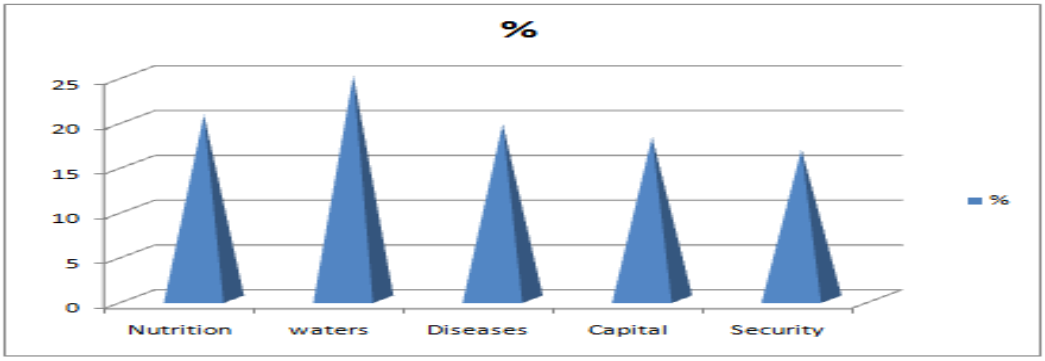

Figure 1. Constraints facing Watish producers

Table 6. Mortality rate among seasons and animal classes:

Seasons	New born	Weaned	Mature	Pregnant	Nursing
Dry summer	25.0	35.7	28.6	30.8	25.0
Wet summer	37.5	21.4	14.3	23.1	16.7
Winter	6.3	7.1	42.9		
More than one season	31.3	35.7	42.9	46.2	58.3

Table (7) presents the structure of Watish sheep flocks in the study area. Females of more than 6 months of age constituted the largest category in the flocks (118.2±65.2), followed by mature nursing females (111.1±160.9) while the number of dry females was 100.0±71.7and that of females less than 6 months of age was 78.8±73.8. The table also, demonstrates some of reproductive traits in Watish sheep in the study area.

Descriptive and morphometric traits

Data describing coat colour, identification method, willingness to use records and morphometric traits of Watish sheep are presented in table (8,9 and 10). The results revealed that the coat colour of the flocks included in the study was predominantly white (88.2%) and 2.9% were white with a black muzzles. About 8.8% were a mixture of white and brown or white and black. Different methods of identification were applied by owners including ear tags (50.0%), names (27.8%) and tattoo (22.2%) (Table 8). A highly significant association was observed between identification method and education level (χ^2=18.133, P=0.006).

Table 7. The flock structure and some of reproductive traits in Watish sheep flocks in the study area

Item	N	Minimum	Maximum	Total	%	Mean ±SE
Flock structure						
Males< than 6 months	15	2	70	539	7.4	35.9 ± 22.2
Males > 6 months	13	0	70	361	5.0	27.7 ± 18.5
Mature males	16	1	50	172	2.3	10.8 ± 12.6
Females <than 6 months	15	7	300	1182	16.2	78.8 ± 73.8
Females > 6 months	14	25	210	1655	22.7	118.2 ± 65.2
Mature nursing females	16	8	500	1778	24.4	111.1 ± 160.9
Dry females	16	10	212	1600	22.0	100.0 ± 71.7
Reproductive traits						
Age at first oestrus (months)	48	5	11			7.1 ± 1.26
Age at first lambing (months)	52	10	16			12.4 ± 1.19
Lambing intervals(months)	45	6	9			6.5 ± 1.01
Weaning age(days)	51	90	121			96.5 ± 13.8
Number of parities	41	5	12			8.4 ± 1.63
Age at first mating(years)	53	1	2			1.1 ± 0.23
Life span of ram in flock	52	3 years	15 years			9.4 ± 3.64

Table 8. Coat colour, identification method and willingness to use records

Colour	%	Identification	%	Keeping records	%	Willingness to keep records	%
White+ black muzzle	2.9	Names	27.8	Yes	5.9	Yes	50.0
White+ brown or white+ black	8.8	Ear tags	50.0	No	94.1	No	50.0
White	88.2	Tattoo	22.2				

A few owners kept records for their flocks (5.9%) and 50%were willing to use records in the future. No association was detected between record keeping and education level (χ^2=0.811, P=0.847). Detailed description almost covering all animal body parts was conducted in this study in (Table 9). The means squares of body length, heart girth, barrel circumference, height at withers and tail length were 63.87±0.48, 81.25±0.66, 93.61±0.87, 76.51±0.42 and 62.37±0.6, respectively. The correlation matrix between different morphometric measurements of studied sheep (n=156) are presented in table (10). All correlations were positive and significant (P≤0.005).

Table 9. The least square means and standard errors of some morphometric traits of Watish sheep

Sex	Age (years)	N	Body length	Heart girth	Barrel circumference	N	Height at withers	Tail length
Males	1	26	59.62±0.96[a]	73.62±1.20[a]	87.08±1.62 [a]	26	72.69±0.8 [a]	58.54±1.6 [a]
Males	2	43	68.56±0.95[c]	88.26±1.15[c]	101.49±1.62 [c]	42	81.36±0.7 [c]	67.07±1.1[bc]
Males	3	6	73.83±1.82[d]	91.50±3.65[c]	108.33±4.28 [d]	6	82.00±1.0[c]	69.00±1.7[c]
Females	2	56	61.48±0.52[ab]	78.21±0.71[b]	88.91±1.12[ab]	56	74.29±0.6[ab]	59.34±0.9[a]
Females	3	25	63.16±0.55[b]	81.48±0.96[b]	93.84±1.31[b]	25	76.00±0.6[b]	63.48±1.6[ab]
Overall		156	63.87±0.48	81.25±0.66	93.61±0.87	155	76.51±0.42	62.37±0.6

a, b, c: different superscript letters within the same column indicate significant difference at P<0.05SEM= Standard error of mean

Table 10. Correlations among morphometric traits:

Trait	Body length	Height at Withers	Barrel circumference	Tail length	Heart girth
Body length	1	.673**	.672**	.543**	.712**
Height at withers		1	.702**	.657**	.790**
Barrel circumference			1	.524**	.819**
Tail length				1	.608**
Heart girth					1

**correlation is significant at P<0.01

Discussion

The current study revealed that the practice of raising sheep is a predominant occupation for most rural inhabitants of Sinnar State. The duties of sheep management are mostly shared by male and female members of the family with no hired labour. These results may be subject to change under different conditions (FAO, 2015). The level of education of most Watish owners interviewed was rather low with about 51.0% of them having primary education only. This is close to the findings of Ishaq and Ahmed (2011).

Our results show that 96.5% of owners practiced additional activities besides sheep breeding. Apparently, revenues reaped from the sheep business are reinvested in other agricultural activities. The short generation interval of sheep coupled with high frequency of multiple births allow for rapid increases in numbers, sale of surplus animals and fast capital turnover.

About 43% of respondents in this investigation reared Watish sheep while 31% of them reared goats beside Watish. This allows for optimum utilization of available range resources as sheep feed close to the ground while goats feed at a higher level and browse shrubs and trees.

Sheep husbandry systems in Watish sheep homeland vary between nomadic and semi nomadic. In the semi nomadic systems, the flocks are kept close to villages, with minimal movement. Nomadic tribes have no permanent residence place and move along defined routes throughout the year. This result is in agreement with the findings of El Tahir *et al*. (1999). Systems of production are mostly extensive and

seasonality of production reduces the economic efficiency of the system. However, some degree of intensification can be seen in some flocks. The success of such systems will depend on some degree of good reproductive management and State support. More than half of the sheep owners complained of high mortality. This may be caused by the stresses of the management system and lack of access to veterinary services.

Profits from the sheep business were rewarding to more than 90% of Watish owners. A significant percentage of respondents (56.9%) reported the occurrence of disease outbreaks during the last year. Most of those who reported outbreaks had to sell stock in order to purchase vaccines and drugs.

According to most respondents (92.7%), no controlled breeding measures had been imposed in their flocks, with ewes and rams kept together all the time. This means that parentage cannot be verified and reproductive records cannot be kept.

This system of uncontrolled breeding is usually practiced in areas where there is an abundance of feed and water. In drier areas kunan is used to control breeding. It is used as a means of mating control in north and west Africa and in Sudan (Wilson, 1991), Kunan is timed in such a way that lambs are dropped during the rainy season (Mc Leroy, 1961). The same method is applied in India (Mittal, 1980).

There was a clear effect of season on all aspects of Watish sheep production. Season is a complex factor that encompasses a number of environmental effects. The most obvious of these is the effect of rainfall on pasture growth. Season also causes variation in the incidence of disease and mortality. Heat stress also affects feed intake and reproductive performance (Maraiet *al*, 2006). The majority of owners in this study reported that they provide supplementary feeding at the beginning of the dry season because in this period pasture on the range becomes dry and feed intake on the range decreases. This coincides with the time ewes are joined and acts as steaming up. The majority of respondents indicated that they do not provide any type of housing. In a hot climate like that of the study area animal housing is important to provide optimal conditions for thermo regulation. Simple structures that allow for air movement during the critical diurnal heat stress hours will be sufficient for sheep (Naas and Moura, 2004). Salt was offered to sheep in drinkingwater and in feed and animals are given water daily in summer (96.4%) and every two days in the rainy season. This is in agreement with the results of El-Hag *et al*. (2001). In summer the temperature may exceed 40 ºC during the day and animals need more drinking water. The highest mortality rates in the present study were in summer and occurred among recently weaned animals followed by pregnant ewes, mainly due to insufficient feeds and water in dry summer. Newborns recorded the highest mortality rate in wet summer among all animal classes. Ahmed *et al*, (2000) and Otesile and Oduye (1991) found that lambs that were of low weight at birth were unable to suckle enough colostrums and died of starvation. Pregnant ewes were second to newborns in mortality rate mainly due to disease outbreaks in the rainy season. In winter the highest mortality rate occurred in mature animals followed by recently weaned lambs and finally newborns. This is probably a reflection of the constitution of the flock since the majority of animals in the flocks in winter consisted of mature animals.Our study showed that the predominant class of animals among flocks was females more than 6 months of age, followed by mature nursing females and least were dry females and females less than 6 months.

The respondents explained that the main constraints facing Watish sheep production were lack of water and disease prevalence. Similar results were reported by Elrasheed *et al*. (2010). In addition, Tirab and Chimonyo (2016) found that in Darfur and Kordofan. Feed shortages, prevalence of

diseases and parasites and water shortage were major constraints to production.

Factors that have a clear influence on morphometric body measurements of animals include sex, age, breed, season of birth, nutrition and management system. In our study the variation in body measurements was significantly affected by gender and age in both males and females. This result is due to the fact that males are normally heavier in live body measurements than females due to differences in skeletal dimensions and hormonal system (Cloete *et al*., 2012) in addition to efficiency in feed utilization (Seideman *et al.,* 1982). A positive correlation was recorded between all body measurements of Watish sampled in this study. Similar results of strong correlations were observed between body weight and some body measurements in Sudanese sheep (Sulieman *et al*., 1990; Khalifa, 2002 and Ahmed, 2014).

Conclusions

This study highlights the need for greater control of environmental factors such as housing and feeding in order to improve Watish sheep production. Misconceptions and incorrect management practices uncovered in the sample responses call for better and more inclusive extension work. It is necessary to improve birth weight of newborns by providing supplementary feeding for pregnant ewes during the third trimester of pregnancy. It is also necessary to follow proper hygienic practices to prevent/reduce incidence of diseases in lambs. Major constraints to sheep production such as parasites and diseases, availability of water and feed in the dry season should be addressed and appropriate interventions designed to ameliorate the situation. Further studies involving larger samples are needed for the characterization of the Watish ecotype and its production system.

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