



Characteristics and Constraints of Dromedary Camel Production in South Kordofan State, Sudan

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ABSTRACT

This study was conducted to characterize the production systems, evaluate the reproductive performances and management systems, identify the breeding goals, husbandry practices and production constraints of dromedary camels in three localities in South Kordofan State; namely; Algoz, Alkwiek and Aldalang. Through a set of detailed questionnaire, one hundred camel owners were interviewed during March and April, 2014. The study showed that 68% of the camel owners were illiterate. The respondents adopted traditional nomadic system of camel husbandry, and 53% of them preferred camels breeding compared to other livestock species. The mean age at first calving was 4.76 years, the calving interval was 23.61 months, the number of services per conception was 1.08, the age of keeping she camels was 16.87 years, the average milk yield per lactation was 1088.20 kg and the lactation length was 11.70 months. The age at first calving, milk yield and lactation length were significantly ($P \leq 0.01$) influenced by locality. Aldalang Locality attained the highest values whereas the lowest values were recorded in Alkwiek Locality. However, the calving interval, number of services per conception and age for keeping she camels were not affected. The important production constraints, as defined by the respondents, were deficiency of feed, lack of security, high disease prevalence and shortage of water. It is concluded that adoption of proper husbandry practices and provision of adequate health services can play significant roles in the improvement of camel production and productivity in the State.

Keywords: South Kordofan, Camels, Production system

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INTRODUCTION

The one-humped camel (*Camelus dromedarius*) plays an important role as a primary source of subsistence in the desert and semi desert land in Sudan. It lives in areas which are not suitable for crop production and where other livestock species hardly thrive. Because of its outstanding performance in the arid and semi-arid areas of Sudan where browse and water are limited, pastoralists rely mainly on camels for their livelihood.

In these areas, camels are mainly kept for milk production and produce milk for a longer period of time even during the dry season when milk from cattle is scarce (Bekele *et al.*, 2002). In Sudan, camels are concentrated in two main regions; the Eastern states (Butana plains and Red Sea mountains) and Western regions (Darfour and Kordofan) (Agab, 1993). The percentage of livestock in South Kordofan State is 17.60% for cattle, 5.95% for sheep, 7.75% for goat and

11.23% for camels (Ministry of Animal Resources and Fisheries, 2010). Sudanese, camels are kept mainly under the traditional nomadic production system, semi nomadic and transhumant production system, as well as the newly adopted intensive and semi intensive production system (Shuiep and El-Zubeir, 2012). This study was carried out in three localities of camel breeding in South Kordofan namely; Algoz, Alkweik and Aldalang, with the objective of clarifying the conditions of production systems and to identify breeding goals, husbandry practices and production constraints, as an essential step towards the development of a sustainable breed improvement program.

MATERIALS AND METHODS

Sampling and questionnaire methodology:

The study was conducted through a questionnaire and guided interviews with camel owners of varying herd sizes, adopting different management systems. Three localities were selected, namely; Aldalang, Algoz, Alkweik. Within these three localities, the areas selected for the study were Kormali, Altokma, in Aldalang Locality, Manago, Alhajez and Alsongokaya in Algoz locality and Damik, Albrdab, and Alkweik in Alkweik locality. The data was collected through an extensive and detailed structured questionnaire. The

questionnaires were used to collect information from a total of 100 camel owners in the three localities through personal contact and field visits. The information were taken directly during interviews and supported by observation. The data collected include information on general household and livestock herd structure, breeding practices, herd management, production objectives, feeding and watering management, disease prevalence and production constraints.

Data analysis: The collected data was statistically analyzed by Statistical package for Social Science (SPSS) computer program. The analysis was implemented separately for camel owners of each locality. The results are represented mainly in the form of descriptive tabular summaries. The mean and the standard error were calculated (analysis of variance) for milk production, reproduction herd composition and herd size. Chi-square, contingency table for independence correlation was also conducted for comparison between localities.

RESULTS

General household information:

68% camel owners were illiterate followed by those who completed primary school, while secondary school were fewer, less than 14% (Table 1).

Table 1: Education level of camel owners

Localities	Level of education							
	Algoz		Alkweik		Aldalang		Overall	
	N	%	N	%	N	%	N	%
Illiterate	14	60.9	32	64.0	22	81.0	68	68.0
Primary	5	21.7	8	16.0	5	18.5	18	18.0
Secondary	4	17.4	10	20.0	0	0	14	14.0

Table 2 shows the numbers and percentages of different livestock species in the studied area. 53% owned only camels of those who bred camel and sheep were 32.0% and then 8% for

who owned camel, sheep, and goat finally percentages of those who owned camel and goat were 7% where non-significant correlation were found between localities ($\chi^2=7.159$, $p>0.05$).

Table 2: Livestock species in the studied areas

Localities	Livestock species							
	Algoz		Alkweik		Aldalang		Overall	
	N	%	N	%	N	%	N	%
Camel	11	47.8	28	56.0	14	51.9	53	53.0
Camel , sheep	8	34.8	18	36.0	6	22.2	32	32.0
Camel, goat	3	13.0	1	2.0	3	11.1	7	7.0
Camel, sheep, goat	1	3.4	3	6.0	4	14.8	8	8.0

Table 3 illustrates the importance of livestock and crop farming in the surveyed areas. The main activity of

the camel owners in different localities is livestock breeding.

Table 3: The main activities and crop growing in the surveyed areas

Region	Main activities						Crop growing			
	Farming		Livestock		Livestock and farming		Yes		NO	
	N	%	N	%	N	%	N	%	N	%
Algoz	-	-	23	100	-	-	-	-	23	100
Alkweik	-	-	50	100	-	-	-	-	50	100
Aldalang	-	-	27	100	-	-	-	-	27	100
Overall	-	-	100	100	-	-	--	-	100	100

All the camel owners have adopted a nomadic management system and all of them had practiced a migratory

mode of camel husbandry during the last 12 months (Table 4).

Table 4: Camel management system and migration in the surveyed regions

Region	Management system						Migration			
	Sedentary		Nomadic		Transhumant		Migrated		Not migrated	
	N	%	N	%	N	%	N	%	N	%
Algoz	-	-	23	100.0	-	-	23	100.0	-	-
Alkweik	-	-	50	100.0	-	-	50	100.0	-	-
Aldalang	-	-	27	100.0	-	-	27	100.0	-	-
Overall	-	-	100	100.0	-	-	100	100.0	-	-

Livestock herd size and camel herd composition

The results (analysis of variance) illustrated that the regions have insignificant ($P>0.05$) effect on the herd size of each species. The average

camel herd size in the surveyed regions was 139.85 heads, the highest camel herd size was recorded in Aldalang (150, 34) followed by Alkweik (142.40) while Algoz had the smallest camel herd size (121.52) (Table 5).

Table 5: livestock herd size in studied areas.

State	Algoz		Alkweik		Aldalang		Overall	
	N	Mean	N	Mean	N	Mean	N	Mean
Camel	23	121.52	50	142.40	27	150.34	100	139.85
Goat	4	47.50	6	46.67	6	33.50	16	41.94
Sheep	11	200.00	20	149.50	9	150.00	40	163.50
Cattle	0	.00	.00	.00	.00	.00	.00	.00

Table 6 reflected that the means of she camels in this study were ranged between 100.35 in Algoz Locality to 124.30 in Alkwiik Locality and 139.85 in Aldalang Locality. The overall mean of she camels was 122.99. The means

of mature males were reported between 1.70 in Algoz to 1.84 in Alkwiik, and 1.63 in Aldalang Locality. The analysis of variance showed that the region had significant effect in young and growing male ($p < 0.01$).

Table 6: Camel herd composition in different regions

State Item	Algoz		Alkwiik		Aldalang		Overall	
	N	Mean	N	Mean	N	Mean	N	Mean
Mature females	23	100.35	50	124.30	27	139.85	100	122.99
Females<4	19	3.79	30	2.77	23	4.30	72	3.53
Female<1	19	3.16	30	3.20	22	2.36	71	3.08
Mature males	23	1.70	50	1.84	27	1.63	100	1.75
Males<4	19	2.05	31	3.71	18	5.94	68	3.84
Males<1	17	1.94	34	4.79	18	2.83	69	3.58

Camels sold, bought and died: Number and percentages of camel owners who sold and bought camels are presented in Table 7. All camel owners in all surveyed regions didn't buy camels within the last 12 months,

while the camel sales were reported by 86% Chi – square test reflected insignificant correlation ($\chi^2 = .641$ $p > 0.05$) between camel owners and different localities who sold camels within the past year.

Table 7: Percentages of camel owners who sold or bought camels within the past 12 months

Region	Camels sold				Camels bought			
	Yes		No		Yes		No	
	N	%	N	%	N	%	N	%
Algoz	20	87.0	3	13.0	-	-	23	100
Alkwiik	44	88.0	6	12.0	-	-	50	100
Aldalang	22	81.5	5	18.5	-	-	27	100
Overall	86	86.0	14	14.0	-	-	100	100

66 % of camel owners had incidence of camel deaths within the last 12 months (Table 8). The highest percentage of them was found in Alkwiik (74.0%) followed by Algoz (73.9) while the lowest percentage recorded was in Aldalang (44.4%). Chi-square test

revealed significant correlation ($\chi^2 = 7.658$, $p < 0.05$) between the number of interviewees who had dead camels and the the number of surveyed regions. Trypanosomiasis was the main cause of losses in camel herds in the studied areas.

Table 8: Percentages of camel owners having camel mortality within 12 months and number of dead camels

Region	Incidence of camel deaths				No. of dead camels					
	YES		No		Males		Females		ALL	
	N	%	N	%	N	Mean	N	Mean	N	Mean
Algoz	17	73.9	6	26.1	10	1.00	17	1.59	17	2.24
Alkwiik	37	74.0	13	26.0	26	1.27	30	1.13	37	1.54
Aldalang	12	44.4	15	55.6	11	1.00	12	1.00	12	1.00
Overall	66	66.0	34	34.0	47	1.15	59	1.24	66	1.62

Breeding practices: Table 9 reflected that all camel owners kept breeding camels in different regions. The percentage of owners having breeding camels was 97% for those who kept 1-5 breeding camels and only 3% for those who kept 6-10 breeding camels

in the entire region. Chi-square tests indicated high significant differences between the numbers of camel owners who kept breeding camels in the surveyed areas. One breeding season was identified in the surveyed regions in winter.

Table 9: Percentages of camel owners keeping breeding camels and numbers of breeding camels

Region	Keeping of Breeding camel				No. of Breeding camels			
	Yes		No		1-5		6-10	
	N	%	N	%	N	%	N	%
Algoz	23	100	-	-	20	87.0	3	13.0
Alkwiik	50	100	-	-	50	100	0	0
Aldalang	23	100	-	-	27	100	0	0
Overall	100	100	-	-	97	97.0	3	3.0

Table 10 shows that all camel owners reported that the source of breeding camels was their own herds. the age of selection was one year. The percentage age of keeping breeding camels in the herd was 58% of owner kept from (10

to15) years and 42% of them kept breeding camel until died. Chi square tests revealed significant correlation ($\chi^2=14.574$, $p<0.05$) between number of interviewees in age of keeping camels.

Table 10: Source of breeding camels, age of selection and age at end life of herd

Region	Owen herd		Other herd		Purchased herd		selection Years		Keeping Years			
							One year		10-15		Until death	
	N	%	N	%	N	%	N	%	N	%	N	%
Algoz	23	100	-	-	-	-	23	100.0	16	69.6	7	30.4
Alkwiik	50	100	-	-	-	-	50	100.0	27	54.0	23	46.0
Aldalang	27	100	-	-	-	-	27	100.0	15	55.6	12	44.4
Overall	100	100	-	-	-	-	100	100.0	58	58.0	24	42.0

Table 11, illustrates that 60% of camel owners sold male camel that were not selected for breeding purposes, while 40% of camels were used for various

purposes such as packing, drought and riding. The differences between regions were significant correlation ($\chi^2=13.897$, $p<0.001$).

Table 11: Fate of male camels not selected for breeding

Region	Castrate		Kept in herd		Sold		Other	
	N	%	N	%	N	%	N	%
Algoz	-	-	-	-	21	91.3	2	8.7
Alkwiik	-	-	-	-	28	56.0	22	44.0
Aldalang	-	-	-	-	11	40.7	16	59.0
Overall	-	-	-	-	60	60.0	40	40.0

Table 12 shows that all of camel owners in the studied areas they select replacement breeding camel from own herd. Hundred percentage of them in all region explained that they select the son of former breeding camel. Dam

reproduction and milk production performance, sire performance, body size, grazing behavior health and vigor were the most important characteristics for camel owners when selecting breeding camel.

Table 12: Source of replacement of breeding camels

Region	Source of replacement breeding camel						Son of former breeding camel			
	Own herd		Other herd		Purchased		Yes		No	
	N	%	N	%	N	%	N	%	N	%
Algoz	23	100	-	-	-	-	23	100.0	-	-
Alkwiek	50	100	-	-	-	-	50	100.0	-	-
Aldalang	27	100	-	-	-	-	27	100.0	-	-
Overall	100	100	-	-	-	-	100	100.0	-	-

The study showed that the improvement of camel for milk and meat production ranked first 40%, followed by improvement for milk 37%, while 19% for meat and only 4% ranked for racing. Significant

correlation ($\chi^2=6.574$, $p<0.05$) was found between surveyed areas goals of camel improvement than camel lowers regarding to all camel owners in studied areas don't have plans to improve camel's performance.

Table 13: Goals of improvement and plan

Localities	Goals of improving camels						Plan to improve					
	Milk		Meat		Racing		Milk and Meat		Yes		No	
	N	%	N	%	N	%	N	%	N	%	N	%
Algoz	6	26.1	4	17.4	1	4.0	12	52.2	-	-	23	23.0
Alkwiek	23	46.0	9	18.0	3	6.0	15	30.0	-	-	50	50.0
Aldalang	8	29.6	6	22.2	0	0.0	13	48.1	-	-	27	27.0
Overall	37	37.0	19	19.0	4	4.0	40	40.0	-	-	100	100

Milk production and reproductive performance: Milk production performance is reported in Table14. The average milk yield was 1088.20 ± 16.94 liter lactation, camels of Aldalang produced significantly ($p<0.01$) more milk (1180.81 ± 33.16 liter), followed by Algoz (1097.35 ± 35.83 liter) while Alkwiek she-camels produced a significant lower amount of milk (1033.98 ± 20.6

liter) The camel owners reported that camel produced the highest milk yield in autumn because of abundance of lush pastures and sufficient water .The results of this study showed that the average lactation length was insignificant (11.74 ± 0.094 month) in Algoz followed by 11.74 ± 0.064 month in Alkwiek and finally 11.59 ± 0.096 months in Aldalang.

Table 14: Milk production performance (mean±SE) of camel's breeds

Localitis	Milk production (liter)				Lactation length (month)
	Beginning	Middle	End	Total	
Algoz	$4.39^b \pm .1$	$3.39^b \pm .104$	$1.39^b \pm .1$	$1097.35^b \pm 35.83$	$11.74^a \pm .09$
Alkwiek	$4.18^b \pm .06$	$3.18^b \pm .052$	$1.18^b \pm .05$	$1033.98^b \pm 20.6$	$11.74^a \pm .06$
Aldalang	$4.67^b \pm .09$	$3.67^a \pm .092$	$1.67^a \pm .09$	$1180.81^a \pm 33.16$	$11.59^a \pm .1$
Overall	$4.36 \pm .05$	$3.36 \pm .048$	$1.36 \pm .05$	1088.20 ± 16.94	$11.70 \pm .05$
Sig. level	*	*	*	*	NS

Sig. level = significant level * = Significant difference NS= Non-significant difference. Statistics of reproductive traits of camels are given in Table 15. The results revealed that the age at first calving was significant ($p<0.01$) influenced by regions but the calving interval, number of services per conception and age for keeping she camels in the herd were not affected.

Table 15: Reproduction performance (mean ±SE) of camel breeds

Localities	Age at first calving (years)	Calving interval (months)	No. of services per conception	Age of keeping she camels (years)
Algoz	4.52 ^a ±0.11	23.87 ^a ±0.07	1.13 ^a ±.07	17.00 ^a ±.17
Alkwiek	4.32 ^b ±0.07	23.72 ^a ±0.2	1.06 ^a ±.03	16.82 ^a ±.1
Aldalang	4.67 ^a ±0.1	23.19 ^a ±0.08	1.07 ^a ±.05	16.85 ^a ±.13
Overall	4.76±0.1	23.61±0.12	1.08±.03	16.87±.07
Sig level	*	NS	NS	NS

Sig. level = significant level * = Significant difference NS= Non-significant difference

Purposes of keeping camels: Table 16 reported that 29% of camel owners said that the keeping of camels is a way of life; followed by 28% for social parameter; 25% of them reported that they kept camels because they are

drought tolerant; and finally 18% of interviewees said that they kept camel as save of money. Chi square test observed significant correlation ($\chi^2 = 4.307, p < 0.05$).

Table 16: Production objectives of camel keeping

Localities	Social		Way of life		Drought		Save money	
	N	%	N	%	N	%	N	%
Algoz	9	39.1	6	26.1	6	26.1	2	8.7
Alkwiek	14	28.0	13	26.0	13	26.0	10	20.0
Aldalang	5	18.5	10	37.0	6	22.2	6	22.2
Overall	28	28.0	29	29.0	25	25.0	18	18.0

Feeding and watering: The study showed that all camel owners in different region reported that feeding and watering were important constraints to their herd production

(Table 17). The duration between two consecutive watering times is very available and free in wet season and unavailable and with paid money in dry season in all surveyed region.

Table 17: Percentages of camel owners had free charge or paid of water supply.

Localities	Water supply				Free charge or paid of water supply							
	Feeding is a constraint		Watering is a constraint		Wet season				Dry season			
	Yes		Yes		Free		Paid		Free		Paid	
	N	%	n	%	N	%	N	%	N	%	N	%
Algoz	23	100	23	100	23	100	-	-	-	-	23	100
Alkwiek	50	100	50	100	50	100	-	-	-	-	50	100
Aldalang	27	100	27	100	27	100	-	-	-	-	27	100
Overall	100	100	100	100	100	100	-	-	-	-	100	100

Animal health and camel production constraints: Table (18) shows the incidence of diseases during the last 12 months and source of veterinary help available .72% of camel owners in the studied area reported the incidence of diseases within the last year. The highest percentage was reported by respondents of Alkwiek followed by those of Aldalang while the lowest

percentage was reported by respondents of Algoz insignificant correlation ($\chi^2 = 2.342, p > 0.05$) observed between respondents of the studied region and the majority of camel owners 65% in surveyed region found veterinary help from drug suppliers , while 35% found help from governmental services. High significant correlation ($\chi^2 = 17.773,$

p<0.01) were found between respondents of studied regions and found of veterinary help.

Table 18: Reports of diseases during preceding 12 months and sources of veterinary services

Region	Diseases reported during past 12 month				Source of veterinary help							
	Yes		No		Government services		Private services		Drug suppliers		Others	
	N	%	N	%	N	%	N	%	N	%	N	%
Algoz	14	60.9	9	39.1	6	26.1	-	-	17	73.9	-	-
Alkwiik	39	78.0	11	22.0	27	54.0	-	-	23	46.0	-	-
Aldalang	19	70.4	8	29.6	2	7.4	-	-	25	92.6	-	-
Overall	72	72.0	28	28.0	35	35.0	-	-	65	65.0	-	-

Important camel diseases in the surveyed areas were reflected in Table 19. Trypanosomiasis was reported as the most important disease while the lowest disease was calf diarrhea in the

study area Chi square tests showed insignificant correlation ($\chi^2=10, 354, p>0.05$) between camel owners for important diseases reported.

Table 19: Important camel diseases in the studied areas

Diseases		Localities							
		Algoz		Alkwiik		Aldalang		Overall	
		N	%	N	%	N	%	N	%
Contagious skin necrosis	skin	2	8.7	3	6.0	1	3.7	6	6.0
Pneumonia		4	17.4	5	10.0	5	18.5	14	14.0
Mange		3	13.0	4	8.0	5	18.5	12	12.0
Ticks		1	4.3	5	10.0	2	7.4	8	8.0
Anthrax		1	4.3	3	6.0	2	7.4	6	6.0
Calf Diarrhea		0	0	2	4.0	2	7.4	4	4.0
Trypanosomiasis		4	17.4	12	24.0	3	11.1	19	19.0
Internal parasites		3	13.0	5	10.0	2	7.4	10	10.0
Wry-neck syndrome		4	17.4	7	14.0	5	18.5	16	16.0
Dermatomycosis		1	4.3	4	8.0	0	0.0	5	5.0

Production constraints: Production constraint which were defined by camel owners are presented in Table 20. Lack of pasture was mentioned as the most important constraint. Security was the second most and then diseases prevalence by the most of camel owners in studied localities. Small

portion of camel owners mentioned that water shortage was also consider constraint. Chi square tests showed significant correlation ($\chi^2=5.741, p<0.05$) between camel owners in their choice of serious coinsurance of their camel production and surveyed areas.

Table 20: Serious constraints to camel production

Serious constraints	Localities							
	Algoz		Alkwiik		Aldalang		Overall	
	N	%	N	%	N	%	N	%
Diseases prevalence	3	13.0	14	28.0	3	11.1	20	20.0
Lack of pasture	13	56.5	33	66.0	9	33.3	55	55.0
Security	7	30.4	2	4.0	15	55.6	24	24.0
Water	0	0	1	2.0	0	0	1	1.0

DISCUSSION

The camel is an important species uniquely adapted to hot and arid environments (Schwartz, 1992). This study reported that the interviewees bred mixed species of animals in the studied areas. The majority of camel owners (53%) bred camels only, 32% of them bred camels with sheep while only 7% for bred camels with goat and sheep. The highest percentage of interviewees who bred camels was found in Alkwiek Locality. The environment is more suitable for camel production. *Acacia* species were the dominant plant in the study area. Camel was the best adapted animal because of its ability to resist drought and thirst by their special physiological and anatomical adaptation mechanisms over other domestic livestock species. Sheep and goats thrive in years of good rainfall while camels are the mainstay in years of poor or below average rainfall (Ishag and Ahmed, 2011). The study showed that all camel owners considered livestock raising to be their main activity. On the other hand, all camel owners didn't grow crops during the past 12 months preceding the conduction of the survey because they were migrating in the autumn from their places to other place. The nomadism system was the system adopted by all camel owners in studied regions. The results of this study revealed that all the interviewees in surveyed regions migrated with their camels during the past year, in wet season they migrated to North Kordofan in response to availability of water supplies and grazing pastures and where there is no tick infestation and flies to prevent tick-borne diseases and foot wounds or escaping from biting insects. Similar findings were also reported by Al-khori and Majid (2000); Ishag and Ahmed (2011) and Abbas *et al.* (1992). The average camel herd size in this study is higher than that reported by Ishag and Ahmed

(2011) for Sudanese camels and than that reported by Adam *et al.* (2011) in Butane area, north-eastern Sudan. The average of mature female camels was 122.99 while the average of the mature males was 1.75 of the total herd sizes. This result is similar to that reported for North-Eastern Nigeria herds (Shuaibu *et al.*, 2014). The differences in camel herd size and composition may come from environmental conditions and the differences between the region nature in feeding and watering. It may also reflect the degree of development and importance of camel production and marketing. The results showed that 86% of the respondents did sell camels in contrast to the fact that all of them didn't buy camels during the 12 months preceding the survey time. Shanabla tribe is dominating in Hagiz market and this is mainly because they own one of the best breed of camels in the area. They are followed by Maalia and Maganeen tribes. The camel males are most marketable and the prices range between 5-15 thousand Sudanese pounds. These prices are reasonable for the buyers, while the sellers are not comfortable with these prices as they don't have substitutes or other sources of income other than selling their camel. Under these difficult living conditions it became impossible to sell a camel to replace it. The results also showed that 66% of interviewees reported camel death during the past 12 months. The highest percentage of death reports was in Alkwiek Locality. The main cause of camel mortality in the areas of study was the prevalence of serious diseases such as trypanosomiasis that is in agreement with Ishag and Ahmed (2011) and wry-neck syndrome. The study also observed that there was no recording system followed in all studied areas, that might be due to the most of them are illiterate and they don't know the

importance of it . All camel owners in the study areas were found practicing selection of the replacement male breeding camels from their own herd and they also select the off-springs of former breeding camels. This is also reported by Ishag and Ahmed (2011) in Sudanese camels. The lactation length in this study is in close agreement with the previous findings of Mehari *et al.* (2007) and that of Bakht and Arshad (2011), and is similar to that reported by Abdussamad *et al.* (2011) and Simenew *et al.* (2013) in Somali region in eastern Ethiopia. The milking frequency in the present study is twice a day; this in agreement with the finding of Ishag and Ahmed (2011). The estimated mean daily milk production during the early stage of lactation in this study was lower than that reported by Ishag and Ahmed (2011) in Sudanese camels. Also the estimated average total milk production in this study was found to be lower than that reported by in Kordofan camels, and Adam *et al.* (2011) in milk yield per lactation for migratory system in Butana area and Simenew *et al.* (2013) in North East Ethiopia camels. The great variation in camel milk production might be attributed to the methods employed to determine the yield, the high genetic variation between individuals, breed, feeding and management conditions, type of work, milking frequency, age of the animal, persistency of lactation, lactation number and stage of lactation. The average age at first calving in the present study was in agreement with Abdussamad (2011) in Nigeria and Ishag and Ahmed (2011) in Sudanese camels. However, the average calving interval estimated in this study was not in agreement with Babiker *et al.* (2011) who reported 30.5 months for she camels in Butana. The average age of keeping she-camels was found to be 16.87 years in the present study. This

is similar to the finding reported by Algayli *et al.* (1998) who stated that 75% of camel owners in Saudi Arabia have mentioned that the productive age of she-camels ranged between 16 to 20 years. This study reported that the majority of respondents improved their camels for both meat and milk production. This is not different from the finding of Ishag and Ahmed (2011) of camel owners in North Kordofan and Sinnar were improved their camels for meat and milk production. Also agrees with Algayli *et al.* (1998) who reported that 85% of the camel owners in Suadia Arabia kept camels for milk and meat production. In this study, all camel owners did not have plans to improve their camels production. The study showed that the production objective of camel keeping is similar to that finding of Ishag and Ahmed (2011). Feed and water supply were considered as constraints in all study regions but water considered to be most serious in summer seasons; probably due to the decrease in available water resources and the high costs of water drilling. The majority of camel owners mentioned that they fed their camels through natural grazing as well as providing hay, crop residues, concentrates and minerals. However, they use hay and concentrates only for weak and breeding males in mating seasons. The balanced nutritional feed containing all the requirements of vitamins, elements, metal energy and protein of breeding camel is one of the most important bases for maintaining the vitality and activity of these breeding camel and maintain their ability to produce enough sperm fluid and give good quality sperms in terms of numbers, ability of movement and low distorted numbers and dead ones. Most respondents in all study areas reported disease incidence during the last year. In this study, trypanosomiasis was the most important disease. This

finding is in agreement with the finding of Ishag and Ahmed (2011) in Sinnar, Gedaref and North Kordofan States. On the other hand, the study revealed a deficiency in governmental and private veterinary services in comparison with the haphazard drug suppliers and other drug and vaccine dealers who do not have monitoring and control measures on the way of keeping and using these products. Such malpractices in drugs and vaccines handling and marketing may lead to severe negative impacts on disease incidence and disease prevalence. As a result of these shortages and limitations, the high cost of drugs and veterinary services might put these services beyond the reach of poor herders in rural areas (Musa, 2007).

Conclusions and recommendations:

- Further studies and researches are needed to identify the genetic improvement potentials of camels for milk and meat production.
- The traditional camel owners must be educated to know the enormous risks that may occur as a result of the non-scientific use of antibiotics, drugs and vaccines and their serious consequences on human, animal and the environment.
- Uses of all the media outlets, newspapers, radio; television and videos as well as mobile cinema should be employed to disseminate the culture of scientific and proper dealing with such materials.
- Mobile herder schools to decrease illiteracy, mobile health care clinics, mobile security service and mobile markets; that could move wherever the pastoralists move; are highly needed.
- Water harvesting projects during rainy seasons and digging of

deep-bore wells should be implemented to solve problems of pasture and water scarcity.

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