Breeding Practice and Correlation of Conformation Traits With Milk Offtake of Camel in Afar Region

Birhane Hailay Gebremariam (Birhane.hailay@gmail.com)
Aksum University
Abrha Hailemicheal
Samara University
Muez Gebru
Mekelle University
Shishay Girmay
Samara Universisy
Fsahatsion Hailemariam Baragabr
Aksum University
Sisay Tilahun
Ethiopian Institute of Agricultural Research

Research

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Abstract

Background: Camel are able to survive and well adapted in harsh environment and reproduce in such environment due to their unique physiology and morphology. It is also serves as source of cash income, milk, meat etc. The study was conducted in four districts of Afar Regional State with the objective of determine the breeding practice and correlation of conformation traits with milk offtake of camel.

Method: Purposive random sampling were employed to select districts and target farmers. Milk offtake, body and udder conformation traits were taken from 320 she-camels. All the collected data were analyzed using Statistical Package for Social Sciences version 20.0 (SPSS, 2017) and index was computed using weight average.

Result: The breeding objective of the farmers in the study area were milk, meat, wealth and social statues. Primordial traits preference for selecting breeding she-camel was based on milk yield, body size and conformation, disease resistance, fast growth and adaptation with an index value of 0.119, 0.105, 0.10, 0.096 and 0.094, respectively. Feed and recurrent drought, disease incidence, poor veterinary service, lack of modern breeding program hinders the productive performance whereas, poor feed quality, long age at first service, calving interval, calve mortality and abortion were the major challenges for reproductive performance of she-camels. District had a significant variation on udder and body conformation traits. The mean value of naval height, naval length, body length, foreleg length, hind leg length, pelvic length, height girth and hump circumference were 2.04±0.06, 2.46±0.06, 145±1.39, 149.24±1.30, 163.78±1.19, 25.33±0.31, 236.05±1.47and 78.51±1.06cm, respectively. The average value of milk yield, distance between fore teat, distance between rear teat, fore teat circumference, fore teat height, udder size circumference, udder size height and udder size length were 837.46±7.66, 7.92±0.36, 7.06±0.06, 6.71±0.11, 5.09±0.08, 45.13±1.34, 6.80±0.27 and 14.30±0.33cm, respectively. The correlation coefficient between body conformation trait and milk offtake were significant positively correlated with height at girth and chest length. Highest correlation coefficient was obtained between milk offtake and hind teat circumference, udder size circumference and udder size length.

Conclusion: It was concluded that camel had a conceivable for the multiuse role to produce income for pastoral and agro-pastoral livestock keepers.

1. Introduction

In the arid and semi-arid zones of the world, it is inevitable for livestock to be well adapted to the harsh environment [1]. Camels are able to survive and reproduce in such environments due to their unique morphology, physiology and serve as source of cash income, draft power, meat, milk [2] and wool since their domestication [3]. Camels are important livestock population for harsh environment in Asia and Africa and highly contribute to the pastoralists and agro-pastoralists living in the insubstantial environments [4].

Camel population in Ethiopia is estimated around 1.42 million. Out of the total camel population in Ethiopia, 33.85 percent are male and the remaining 66.15 percent is female [5]. The estimated lactation length and daily milk yield per camel is 11.51 month and ranges from 1.68 to 4.40 kg per camel, respectively in eastern part of Ethiopia [6, 7]. However, the milk production of she-camel in Ethiopia is generally low [8]. In addition, the little focus given on the improvement of milk or meat type camels contributes to the low reproduction like abortion [6], production potential in addition to traditional management system and related constraints [8, 9].

The contribution of camels to the human welfare of developing countries is generally influenced by several factors, which tends to underrate their true value [10]. Subsequently, less attention has been given to camel health care, management practice and subsequent enhancements of production performance for several years in the national development plans [10, 11]. However, camels are essential for economical contribution to pastoralism and agro-pastoralism and economic development [12].

In Ethiopia, camel production is predominantly limited to the pastoralists and agro-pastoralists as the case in other parts of the world. For this reason, pastoralists and agro-pastoralists are beneficiaries directly or indirectly from those animals kept under the traditional management system. However; due attention for modernized camel reproduction, production and management as well as appropriate breed improvement strategies is not well designed future success as is in dairy cattle [8].

Breed improvement requires selection of individuals within and between breeds allowing for mating either milk or meat type camels. Therefore, Information about camels in terms of reproductive potentials, breeding practice and correlation of conformation traits with milk offtake in Ethiopia is very sparse and breed improvement practices have been given little focus in selection of the dairy and meat types. Therefore, to fill some gaps the objective was to determine the breeding practice and correlation of conformation traits with milk offtake of camel in Afar region.

2. Materials And Methmods

2.1. Description of the Study Area

The Afar national regional state is located in the northeastern part of Ethiopia. It is 588kms far from the capital. It is geographically located between 39°34’ and 42°28’ East Longitude and 8°49’and 14°30’North Latitude (CSA, 2008). The present study was conducted in Dubti, Abeala, Chifra and Gewane districts of the Afar region. It is characterized by an arid and semi-arid climate with low and erratic rainfall. The annual temperature and rainfall is 30–50 °C and 200–600 mm, respectively. The altitude in the region ranges from 100–1000 meters above sea level (Berhanu, 2008).

The total population of the region is estimated at 1.2 million of which 90% are pastoralists and 10% is agro-pastoralism following some permanent and temporary rivers on which small-scale irrigation is developed (Afar region public relation office, 2006). Animal husbandry in Afar region is characterized by seasonal mobility due to the shortage of rainfall, in the dry season; the pastoralists are forced to move their animals to far distance for water and grazing land. Camel herd movement may move the whole herd to water points and to relatively better areas where green fodder is available.

2.2. Sampling Procedure and Sample Size

Three zones (zone one, two and three) and four districts were selected purposively based on camel populations and access to transportation. From each districts, three *kebeles* were considered to take lactating she-camel samples for this study. In each district, 80 she-camels were also encountered to take body measurements and daily milk production. Semi- structured questionnaire was used to collect information on indigenous knowledge of pastoralists and agro pastoralists about common conformation traits used by camel holders as criterions for choosing good milk yielders of she-camels. This followed by a purposive-random sampling for data collection and on a total 160 households considered to assess current milk off-take of lactating she-camels. These she-camels were monitored and register the name of owners and camel for data collection on reproductive performance, body conformation traits and milk yielding potential. The sample household was selected based on the principle proportional to size sampling technique. The sample size required for this study was determined by the formula recommended by Arsham (2007) for survey studies as illustrated below:

$N = 0.25/SE^2$

Where: N = Sample size SE = Standard error

Hence, at 5% standard error, the total numbers of households to be selected was 100. However, to increase the precision of data collection and analysis it is scaled to 160 households.

2.3. Data Collection

Formal survey

Forty households in each district was selected purposively to administer a questionnaire. The structure and semi-structured questionnaire was designed to explore general information about conformational traits used by pastoralists and agro pastoralists as indicators for milk production potential of she-camels as well as reproductive performance of camels, trait preference, breeding practices and indigenous knowledge. Group discussion was also be used to fill any emerging information gap. Four open group discussions (4–9 members) were carried out at selected sites of each district.

Collection of milk off-take data

Milk off-take data was collected from each registered and identified she-camel on specific investigation days. The following procedure was followed throughout:

- Camels that only calved at short rainy season was involved;
- Milk sample collection and recording was started two weeks after calving as camel first milk (colostrums) is not palatable
- Calf suckling was also be allowed for 15 seconds to stimulate milk let down
- To the degree that possible milking continued until the udder was considered empty to ensure complete milking;
- Volume of milk off-take from every milking session was measured by a given graduated cylinder and recorded in a given format
- Milk off-take was recorded every three days for twelve consecutive weeks in case of Agro pastoralists and for every another day for two weeks duration in pastoralist camel owners because of their mobility
- Trained enumerators from the villages were used to milking, record data under supervision, and follow up.

2.3.1. Measuring and observing of conformation traits

Quantitative and qualitative data

She-camels selected for milk off-take recording was used to collect data for quantitative traits (body and udder conformation traits). The body conformation traits recorded was navel flap height and length, body length, hind and fore leg length, pelvic height, pelvic length, height at wither, height girth, chest length, hump factor, hump circumference. The udder conformation traits was also recorded like milk yield, difference between fore teat, difference between rear teat, fore teat circumference, fore teat height, hind teat height, hind teat circumference, udder size circumference, udder size height and udder size length as described in detail by [13] in cross breed dairy cows. Quantitative measurements were made on 320 (two she-camel per household) mature she-camels and 80 lactating she camels per each sampled districts.

2.4. Data Management and Analysis

The primary and secondary data collected from each site was recorded in a standard format and feed into the computer using Microsoft Excel (2007) for further analysis. Collected data was entered into Statistical Package for Social Sciences version 20.0 (SPSS, 2017) for analysis.

Questionnaire data

Data collected through questionaries' was described by descriptive statistics using Statistical Package for Social Sciences version 20.0 (SPSS, 2017). Ranking analysis was under taken for data on conformation traits as related to selection of camels like selection criterions of camel, sources of breeding bulls and trait preferences. In the preference ranking method, index was computed using weighed averages and indexes was ranked using auto ranking with MS-Excel 2007.The following formula was used to compute index as employed by Musa *et al*. [14]:

$$\text{Index} = R_n * C_1 + R_{n-1} * C_2 \ldots. + R_1 * C_n / \sum (R_n * C_1 + R_{n-1} * C_2 + \ldots. + R_1 * C_n)$$

Where, R_n = the last rank, C_n = the % of the respondent's in the last rank, C_1 = the % of the respondents in the first rank

Measureable data

Each of the quantitative traits (milk yield and conformation traits) as well as correlations (relationship) between milk off-take and measured conformation traits was described by descriptive statistics using Statistical Package for Social Sciences version 20.0 (SPSS, 2017). The model to analyze milk yield and udder/ body measurements was:

Yi = μ + Ei + ei where

Yi = the observed J (milk yield, udder and body conformation trait) in the i^{th} districts

μ = overall mean

Ei = the effect of i^{th} Districts (i = Chifra, Abeala, Dubti and Gewane)

ei = random residual error

3. Result

3.1. Herd composition

The herd composition of camel in the study area is presented in Table 1. The average herd structure of lactated she-camel was higher in Chifra and Dubti districts when compared to the remaining two districts. Camel herd structure in female calves less than 1.5 to three years were more intended to keep by producers than male calves across all districts. This is due to farmers mostly kept few males for breeding purpose based on their family history performances and body conformation traits. Extra males are served for ritual ceremonies in wedding, special religious holy days, meat sale and as source of income by marketing the live camels. Males were castrated to control undesired breeding when they approach to maturity, for meat purpose and draught power utilization. As stated in Table 1, the herd composition of dry she-camel, pregnant she-camel and young camel heifer's greater than 1.5 to three years was higher in the Dubti than the other three districts.

Table 1
Herd structure of camel in the study area.

Herd structure	Chifra	Dubti	Abeala	Gewane	Overall
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	
Male calves ≤ 1.5 year	1.95 ± 0.21^{a}	1.18 ± 0.19^{b}	0.98 ± 0.16^{bc}	0.48 ± 0.11^{c}	1.14 ± 0.10
Young bulls > 1.5 to 3 year	1.30 ± 0.16^{a}	1.13 ± 0.17^{ab}	0.60 ± 0.16^{ab}	0.90 ± 0.17^{b}	0.98 ± 0.08
Young castrated	0.50 ± 0.13^{a}	0.35 ± 0.12^{a}	0.31 ± 0.10^{a}	0.11 ± 0.06^{a}	0.32 ± 0.05
Breeding bull	0.85 ± 0.14^{a}	0.88 ± 0.10^{a}	0.78 ± 0.07^{a}	0.75 ± 0.09^{a}	0.81 ± 0.05
Female calves ≤ 1.5 year	2.57 ± 0.23^{a}	2.87 ± 0.23^{a}	2.72 ± 0.19^{a}	2.75 ± 0.21^{a}	2.73 ± 0.12
Young heifer > 1.5 to 3 years	2.93 ± 0.30^{a}	3.28 ± 0.31^{a}	2.95 ± 0.2^{a}	3.07 ± 0.28^{a}	3.06 ± 0.14
Lactation she-camel	4.43 ± 0.28^{a}	4.15 ± 0.30^{ab}	3.48 ± 0.23^{ab}	3.18 ± 0.25^{b}	3.81 ± 0.12
Pregnant she-camel	3.08 ± 0.25^{b}	4.55 ± 0.44^{a}	2.80 ± 0.25^{b}	3.48 ± 0.34^{ab}	3.48 ± 0.17
Dry she-camels	2.88 ± 0.36^{a}	3.03 ± 0.39^{a}	2.21 ± 0.31^{b}	2.95 ± 0.40^{a}	2.77 ± 0.18

a, b, c, means with the different superscripts across rows are significantly different at ($P < 0.05$), SE – Standard error of mean

3.2. Reproductive performance of camel

According to the respondents of camel producer's she- camels can kept in the presence of abundant pasture feeds for about 40 years for the sake of milk harvesting in its lifespan for home consumption and surrounding communities during deficit. Those long years are considered if animals are no longer constrained with poor reproduction and milk production performances. Availability of feed for animals in the area is another factor to be kept she camels in its herd for several years. However, during the milk collection, the maximum year of she-camels in the production system was 36 years (Table 2).

The average reproductive performance of camel in the study area is presented in Table 2. The average age at maturity, age at calving, number of calves per she-camel and age of she-camel was higher in Chifra districts when compared to Abeala, Dubti and Gewane. Age at first service and age at calving results as assessed in the study was different across Chifra with the other three district; it may be attributed to the fact that the she-camels attain maturity later in the Chifra areas when compared to those reared in the three districts, which may be effect of both genetic and non- genetic factors.

According to the respondents, she-camels remains productive for about 40 years in the presence of abundant pasture feeds for the sake of milk production to home consumption and surrounding communities during deficit. Availability of feed for animals in the area is another factor to be kept she camels in its herd for several years. However, during the milk collection the maximum year of she camels in the production system was 36 years.

The calving intervals of she-camel is one of the most important factors affecting the lifetime productivity of camel. The average calving intervals of she-camel was greater in Gewane and Dubti when compared Chifra and Abeala districts. This may be due to better accessibility in feed and water than the two districts. Based on the respondents, the calving interval of she-camels is increasing over time due to various constraints prevailing in several years because of climate change and weather variability's in the lowland areas.

Table 2
Reproductive performance of camel in the study area

	Abeala			**Chifra**			**Dubti**			**Gewane**		
	Mean + SD	Min	Max	Mean + SD	Min	Max	Mean + SD	Min	Max	Mean + SD	Min	Max
AFM	4.79 + 1.05	2.5	6.70	5.81 + 1.01	3.9	8.0	5.53 + 1.07	3.70	8.30	5.40 + 1.28	2.9	8.0
AFS	5.26 + 1.0	3	7.0	6.19 + 0.99	4.1	8.3	5.88 + 0.97	4.30	8.40	5.80 + 1.24	3.7	8.30
NSC	1.1 + .30	1	2	1.06 + .22	1	2	1.07 + 0.27	1	2	1.10 + .030	1	2
AFC	6.31 + 1.00	4.1	8.1	7.32 + 0.94	5.6	9.4	6.94 + 1.03	5.4	9.5	6.91 + 1.23	4.8	9.4
CI	2.1 + 0.26	1.7	3.0	2.11 + 0.32	1.4	3.0	2.16 + 0.28	1.6	2.9	2.28 + 0.24	1.7	2.7
NCC	4.35 + 1.61	2.0	8.0	5.58 + 1.91	2.0	8.0	4.58 + 1.71	2.0	8.0	4.77	2.0	8.0
AC	17.71 + 5.22	9.0	27.50	22.09 + 5.87	11.90	36.00	18.88 + 5.38	9.70	28.90	20.20 + 6.60	9.50	32.70

AFM- age at maturity, AFS – age at first service, NSC – number of service per conception, AFC – age at first calving, CI – calving interval, NCC – number of calves per she-camel, AC – age of she-camel, SD – standard deviation

The average number of calf per she-camel in the study was 4.35 ± 1.61, 5.58 ± 1.91, 4.58 ± 1.71 and 4.77 ± 2.07 in Abeala, Chifra, Dubti and Gewane districts, respectively (Table 2). Low calf crop production per she-camel was obtained in Abeala and Gewane districts than Chifra and Dubti. This may be influenced by variations due to overall management practices and other environmental factors such as chronic feed shortage and frequent drought occurrences.

3.3. Breeding practice and trait preference of camel

The source of camel breeding bull as practiced in the study area is presented in Table 3. About 89 percent of the respondents in this study revealed that more selection focus on the selection of breeding bulls than dams since they perceive a single bull could serve more females and provide hundreds of improved traits of offspring throughout its lifetime than its counterparts. The main source of breeding bull in the study area was home breed bull, neighboring bull, common bull and purchased bull with an index value of 0.27, 0.22, 0.18 and 0.14, respectively.

The breeding objectives of the farmers in the study districts were milk, meat, wealth, and social status, culture and insurances in the order of importance in the communities, respectively (Fig. 1). However; whenever farmers of both production systems are with the availability of no choice to use the first, second and third priorities of bulls for mating; mean a while they enforced to use either donated or unknown bulls for mating with no clear family history of the breeding bull.

Table 3
Source of camel breeding bulls as ranked by the respondents in the study area

Source of breeding bull	Rank						Index
	1st	2nd	3rd	4th	5th	6th	
Home breed own bull	83.75	8.75	2.50	1.88	1.88	1.25	0.27
Neighboring bull	13.75	63.75	12.5	6.88	2.5	0.63	0.22
Common bull	4.38	7.50	66.25	10.63	10	1.25	0.18
Purchased bull	1.25	3.13	6.88	81.88	3.13	1.88	0.14
Donated	1.88	8.13	10	14.38	61.87	3.75	0.12
Unknown bull	0	0	2.5	7.50	16.25	73.75	0.07

This is computed by the recipe Index *= Rn × C1 + Rn-1 × C2 ... + R1 × Cn / Σ(Rn × C1 + Rn-1 × C2 + ... + R1 × Cn) Where, Rn = the last rank. Cn = the % of respondents in the last rank, C1 = the % of respondents ranked 1st*

The primarily criteria pertaining in trait selection or preferences of the camel in the study area is presented in Table 4. The primordial trait preference for selection of breeding camel was based on milk yield, body size and conformation, disease and parasite resistance, fast growth and adaptation with an index value of 0.119, 0.105, 0.10, 0.096 and 0.094, respectively.

Breeding efficiency, offspring quality, short calving interval, longevity, temperament and attractive color were some of the unique quality traits of these camel breeds perceived by the farmers.

3.4. Challenges of productive and reproductive performance of camel

The main reasons (as indicated by the respondents in Table 5) limited for camel production performance in the study area were inadequate feed and recurrent drought, disease incidence, poor veterinary service, travelling long distance to search for feed and water and lack of modern breeding program with an index value of 0.20, 0.19, 0.16, 0.15 and 0.14, respectively. The major challenges of reproductive performance of camel was poor feed, long calving interval, long age at first service, poor veterinary service, calf mortality and abortion with an index value of 0.17, 0.17, 0.16, 0.15, 0.12 and 0.12, respectively.

Table 4
Major camel trait preferences of respondents in the study areas

Trait	Rank											Index
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	
Milk yield	93.13	4.38	2.5	0	0	0	0	0	0	0	0	0.119
Body size & conformation	16.25	55.63	13.13	6.88	3.13	2.5	1.25	1.25	0	0	0	0.105
Drought, disease & parasite resistance	14.38	12.50	59.38	8.75	3.13	1.25	0.63	0	0	0	0	0.100
Fast growth	10	34.38	24.38	15	1.88	6.88	5	1.88	0.63	0	0	0.096
Adaptation	23.75	21.25	10	7.5	25.63	4.38	1.88	5	0.63	0	0	0.094
Offspring quality	10.63	15.63	20.63	36.25	6.88	1.88	2.5	0.63	3.13	1.25	0.63	0.091
Breeding efficiency	8.13	10.63	14.38	53.13	4.38	6.25	1.88	1.25	0	0	0	0.091
Short calving interval	9.38	8.13	10.63	12.50	47.5	3.75	1.88	0.63	5.5	0	0	0.084
Longtivity	6.88	14.38	9.38	10.63	13.13	28.75	8.75	3.13	5	0	0	0.079
Temperament	2.5	5.63	9.38	9.38	21.88	5.6	33.75	3.75	8.13	0	0	0.069
Attractive color	1.25	5	1.88	3.13	5.63	4.38	2.5	1.88	10.63	61.88	1.88	0.039
Other	0.63	1.88	0.63	4.38	1.88	3.75	6.88	8.13	9.38	26.88	35.63	0.029

This is computed by the recipe Index *= Rn × C1 + Rn-1 × C2 ... + R1 × Cn / Σ(Rn × C1 + Rn-1 × C2 + ... + R1 × Cn) Where, Rn = the last rank. Cn = the % of respondents in the last rank, C1 = the % of respondents ranked 1st*

Table 5
Major constraints of production and reproductive performances of camel in study areas

Constraints	Rank								Index
	1st	2nd	3rd	4th	5th	6th	7th	8th	
Productive constraints									
Inadequate feed	40	29.18	8.13	9.38	6.63	3.75	2.5		0.20
Disease incidence	25.63	31.88	20	10.63	5.63	4.38	1.88		0.19
Poor veterinary service	9.38	15.63	31.88	21.25	10.63	7.5	3.75		0.16
Travelling long distance to search feed and water	11.25	6.88	20	21.75	20.63	15.63	1.88		0.15
Lack of modern breeding program	7.5	8.75	18.13	16.88	42.5	1.25	5		0.14
No training	3.75	5.63	1.25	15	5.63	40.63	28.13		0.09
Others	2.5	1.88	0.63	3.13	8.13	26.88	56.88		0.06
Reproductive constraints									
Poor feed & nutrition	17.88	13.13	25.63	30.63	5.63	4.38	1.88	4.88	0.17
Long calving interval	27.5	15	10	17.5	18.13	4.38	5.63	1.88	0.17
Long age at first service	15.63	9	16.25	35.63	8.13	9.38	2.5	3.5	0.16
Poor veterinary service	10.63	32.5	13.13	13.75	8	5.63	6.88	3.25	0.15
Calf mortality	11.88	8.75	6	0.63	16.25	29.38	23.13	4	0.12
Abortion	8.13	7.5	10	0.63	22.5	24.38	22.5	4.38	0.12
Lack new reproductive technology	3.75	688	9.38	1.25	14.38	19.38	40	5	0.10
Others	0.63	1.88	1.25	0	1	0.63	4.38	0.25	0.01

This is computed by the recipe Index *= Rn × C1 + Rn-1 × C2 ... + R1 × Cn / Σ(Rn × C1 + Rn-1 × C2 + ... + R1 × Cn) Where, Rn = the last rank. Cn = the % of respondents in the last rank, C1 = the % of respondents ranked 1st*

3.5. Effect of districts on milk yield and body conformation traits (BCT)

Districts seemed to have been the highest contributing ($P < 0.05$) factors to the variation in body conformation traits (BCT) and milk yield (MY) of camel (Tables 6 and 7). The overall mean of navel height, body length, foreleg length, hind leg length, pelvic height, height at wither, chest length and hump factor was 2.04, 145.35, 149.24, 163.78, 20.52, 187.46, 39.3 and 67.19, respectively. However, the result in Tables 7 and 8 indicates that, there is no variation in the body BCT of chest length, navel length and milk yield. The variation of BCT of camel within the four districts might be due to quality and quantity of feed and management level. The naval height in Abeala (1.60) was shorter as compared to the naval height of Dubti (2.55) and Chefra, 2.03). Body length was significantly ($P < 0.05$) higher in Dubti districts than the other three districts. Body length, fore leg length and hind leg length of she-camel in Dubti were significantly ($p < 0.05$) higher compared to the three districts.

3.6. Effect of districts on milk yield and udder conformation traits (UCT)

The effect of districts on milk yield and udder conformation traits (UCT) are presented in Table 8. The overall mean of milk yield, distance between fore teat, distance between rear teat, fore teat circumference, fore teat height, hind teat circumference, udder size circumference, udder size height and udder size height was 837, 7.92, 7.06, 6.71, 5.09, 6.77, 45.13, 6.80 and 14.30, respectively. Milk yield and UCT of camel were affected by district and the average milk yield in Chefra, Gewane and Abeala

was higher than Dubti. The distance between fore and rear teat, udder size circumference and udder size height was significantly ($P < 0.05$) higher in Chefra district when compared to the other three districts. This may be due to the influence of the management level of the camel husbandry practices. The distance between rear teats in Dubti was higher than the distance of rear teat in Gewane and fore teat circumference in Abeala was significantly ($P < 0.05$) higher compared to other districts. Higher milk yield was obtained in Chefra than Dubti, Gewane and Abeala districts but not significant. Fore teat circumference and fore teat height were higher significantly ($P < 0.05$) Abeala, than Chefra districts and hind teat height was not revealed significant variation across all districts. Udder size circumference and udder size length were significantly ($P < 0.05$) higher in Chefera than Gewane and Abeala districts.

Table 6
Least square mean and standard error (LSM ± SE) of body conformation traits (cm) of camel

Districts	NH	NL	BL	FL	HL	PH
Overall	2.04 ± 0.06	2.46 ± 0.06	145.35 ± 1.39	149.24 ± 1.30	163.78 ± 1.19	20.52 ± 0.38
Chefra	2.03 ± 0.13^{b}	2.38 ± 0.12^{a}	145.23 ± 2.45^{ab}	143.23 ± 1.35^{b}	164.25 ± 1.65^{b}	21.95 ± 0.99^{a}
Dubti	2.55 ± 0.09^{a}	2.48 ± 0.11^{a}	152.90 ± 2.72^{a}	158.60 ± 2.10^{a}	172.68 ± 1.40^{a}	21.45 ± 0.60^{ab}
Abeala	1.60 ± 0.11^{c}	2.48 ± 0.15^{a}	137.83 ± 2.91^{b}	145.0 ± 3.33^{b}	157.75 ± 3.21^{b}	19.5 ± 0.72^{ab}
Gewane	2.0 ± 0.10^{b}	2.50 ± 0.10^{a}	145.45 ± 2.56^{ab}	150.13 ± 2.56^{ab}	160.43 ± 2.19^{b}	19.13 ± 0.59^{b}

a, b, c, means with the different superscripts across columns are significantly different at ($P < 0.05$), NH- naval height, NL- Naval length, BL- body length, FL-foreleg length, HL- Hind leg length, PH-pelvic height

Table 7
Least square mean and standard error (LSM ± SE) of milk yield (L) and body conformation traits (cm) of camel

Districts	PL	HW	HG	CL	HP	HC	MY
Overall	25.33 ± 0.31	187.46 ± 1.47	236.05 ± 1.87	39.3 ± 0.53	67.19 ± 1.57	78.51 ± 1.06	837.46 ± 7.66
Chefra	23.55 ± 0.69^{c}	182.03 ± 1.63^{bc}	229.53 ± 3.20^{b}	39.80 ± 0.88^{a}	73.18 ± 2.45^{a}	75.15 ± 1.73^{b}	897.90 ± 15.00^{a}
Dubti	27 ± 0.49^{a}	198.88 ± 2.21^{a}	226.88 ± 3.33^{b}	38.35 ± 1.01^{a}	56.03 ± 3.16^{b}	77.43 ± 1.87^{ab}	756.02 ± 13.04^{a}
Abeala	24.48 ± 0.67^{bc}	177.6 ± 3.58^{c}	237.95 ± 3.83^{ab}	39.43 ± 1.27^{a}	68.78 ± 3.38^{a}	78.5 ± 2.58^{ab}	827.82 ± 15.18^{a}
Gewane	26.3 ± 0.43^{ab}	191.35 ± 2.78^{ab}	249.85 ± 3.63^{a}	39.63 ± 1.05^{a}	70.8 ± 2.85^{a}	$82.95 + 2.12^{a}$	868.10 ± 16.76^{a}

a, b, c, means with the different superscripts across column's are significantly different at ($P < 0.05$), PL-pelvic length, HW-height at wither, HG- height girth, CL- chest length, HP- hump factor, HC- hump circumference, MY- milk yield, L - liter

Table 8
Least square mean and standard error (LSM ± SE) of milk yield (L) and udder conformation traits (cm) of camel

District	MY	DFT	DRT	FTC	FTH	HTC	HTH	USC	USH	USL
Overall	837.46 ± 7.66	7.92 ± 0.36	7.06 ± 0.21	6.71 ± 0.11	5.09 ± 0.08	6.77 ± 0.10	4.95 ± 0.07	45.13 ± 1.34	6.80 ± 0.27	14.30 ± 0.33
Chefra	897.90 ± 15.00^{a}	11.87 ± 0.79^{a}	7.92 ± 0.41^{a}	6.30 ± 0.20^{b}	4.71 ± 0.12^{b}	6.46 ± 0.20^{b}	4.88 ± 0.12^{a}	53.30 ± 3.42^{a}	9.79 ± 0.73^{a}	15.41 ± 0.75^{a}
Dubti	756.02 ± 13.04^{a}	7.42 ± 0.73^{b}	8.10 ± 0.45^{a}	6.54 ± 0.18^{ab}	5.02 ± 0.19^{ab}	6.58 ± 0.18^{b}	4.85 ± 0.17^{a}	40.68 ± 2.17^{b}	5.96 ± 0.37^{b}	15.30 ± 0.59^{a}
Abeala	827.82 ± 15.18^{a}	6.23 ± 0.42^{b}	6.25 ± 0.37^{b}	7.16 ± 0.27^{a}	5.36 ± 0.17^{a}	7.31 ± 0.20^{a}	4.94 ± 0.16^{a}	43.75 ± 2.31^{b}	5.64 ± 0.20^{b}	14.19 ± 0.69^{ab}
Gewane	868.10 ± 16.76^{a}	6.18 ± 0.48^{b}	5.99 ± 0.37^{b}	6.86 ± 0.21^{ab}	5.30 ± 0.16^{ab}	6.71 ± 0.17^{ab}	5.13 ± 0.14^{a}	42.78 ± 2.27^{b}	5.79 ± 0.38^{b}	12.31 ± 0.53^{b}

MY- milk yield, DFT- distance b/n fore teat, DRT- distance b/n rear teat, FTC- fore teat circumference, FTH- fore teat height, HTC- hind teat circumference, HTH- hind teat height, USC- udder size circumference, USH- udder size height, USL- udder size length, a, b, c, means with the different superscripts across column's are significant at ($P < 0.05$), L - liter

3.7. Phenotypic correlation between milk yield and body conformation traits of camel

The phenotypic correlation coefficients between milk yield and body conformation traits within districts are presented in Table 9. Chest girth was positively correlated with milk off-take in Chefra, Dubti and Gewane ($r = 0.455$, 0.529 and 0.526, $P < 0.01$), respectively, but Abeala was positively correlated but non-significant. However, in Gewane districts hump circumference, hump factor, height at wither, foreleg length, hind leg length, pelvic height was positively correlated with milk off take, and this is not significant but low and negative (Chefra) and positive (Dubti and Abeala) correlated with milk yield. Generally, body conformation traits (height at girth and chest length) positively correlated with milk off-take, and the best measure for she-camels of all districts.

Table 9
Correlation between milk yield and body conformation traits of camel

Conformation trait	Districts			
	Chefra	Dubti	Abeala	Gewane
Naval Height	.095	− .023	− .247	.182
Naval Length	.015	.258	− .024	.297
Body length	.222	− .109	− .070	.145
Foreleg length	− .050	.059	.095	.300
Hind leg length	.398*	− .016	.323*	.310
Pelvic height	.251	− .031	.074	.279
Pelvic length	.091	− .209	− .144	.120
Height at wither	− .084	.114	.107	.245
Height at girth	.528**	.583**	.607**	.389*
Chest length	.455**	.529**	.251	.526**
Hump factor	− .058	.275	.214	.259
Hump circumference	.014	.145	.522**	.247
*. Correlation is significant at the 0.05 level (2-tailed).				
**. Correlation is significant at the 0.01 level (2-tailed).				

3.8. Phenotypic correlation between milk yield and under conformation traits

The association of milk off-take with distance between fore teat in Chefra, Dubti, and Gewane camel shows positive and significant correlation (r = 0.392, 0.273, and 0.334 $P < 0.05$), respectively (Table 10). However, correlations between milk off-take and distance between fore teat in Abeala was positive correlated but not significant. Generally, the phenotypic correlation between milk yield and udder size length, udder size circumference and hind teat circumference was positively correlated in all districts. Udder size height was positively correlated in Chefra, Abeala and Gewane with milk yield or off take nonetheless negative correlated in Dubti and not significant in all districts.

Table 10
Correlation between milk yield and udder conformation trait of camel in afar region

Conformation traits	Districts			
	Chefra	Dubti	Abeala	Gewane
Distance between fore teat	.392*	.273*	.112	.334*
Distance between rear teat	.330*	.259*	.176	.156
Fore teat circumference	.375*	− .062	.281	.049
Fore teat height	.386*	.101	.056	.259
Hind teat circumference	.574**	.426**	.686**	.570**
Hind teat height	.216	− .008	.065	.306
Udder size circumference	.487**	.450**	.469**	.490**
Udder size height	.291	− .222	.256	.303
Udder size length	.652**	.636**	.426**	.609**
*. Correlation is significant at the 0.05 level (2-tailed).				
**. Correlation is significant at the 0.01 level (2-tailed).				

4. Discussion

Reproductive performance

The productive and reproductive performance of camel can be affected by several factors like inadequate feed, incidence of disease, occurrence of drought and poor veterinary service. This is in line with [6, 9]. The result of the present study on the overall average age at first calving, calving interval and number of service per conception was in agreement with the observation of [7] in mille of Afar region and Jijiga, Somalia region. However, the mean values are lower than the reported by Yohannes *et al.* [15].

The mean value of age at first calving in Abeala and Chifra district were 6.31 and 7.32 year, respectively and higher than the values those reported by Tefera and Fesah [16], Musa *et al.* [14], Mayouf *et al.* [17] and Sisay *et al.* [12]. The overall calving interval in the study was 2.16 year. This finding is in congruent with [17, 12] but higher than the values reported by Musa *et al.* [14] and Tarek *et al.* [18].

The number of service per conception in Abeala, Chifra, Dubti and Gewane were 1.1, 1.06, 1.07 and 1.10 year, respectively. The current finding is lower than the value reported by El-Malky et al. [19]. According to the report of Tarek *et al.* [18], the number of service per conception of camel with supplementation of Zn-Methionine and without is 2.7 and 4.3 years, respectively. The number of calves per she-camel in the study was lower than the value of number of calve per she-camel in El-Oued region, Algeria [17].

Brigitte [20] reported that the average age at first calving and calving interval of 4.87 and 2.28 years, respectively, under pastoral management in northern Kenya. On the other hand, average age at first calving 4.78 year and calving interval 23.8 month in pastoralists of Nigeria [21]. The average values for age at first calving and age at first service in the present finding were higher than the reported by Brigitte [20], Abdussamad *et al.* [21] and Simenew *et al.* [6]. This might be due to poor availability veterinary service, high incidence of disease and poor management system. The mean age at first maturity in the

current study was 5.38 year. This finding is in line with [6]. The result of the present finding on the calving interval and number of service per conception (NSC) were lower with the values reported for [17] for Mille and Amibara district, [6] in Somalia region.

The purpose or breeding objective of the respondents in the study were milk, meat, wealth and social status. This finding is in concurrent with those reports of Abdussamad *et al* [21] and Faye [22]. The main source of breeding bull of camel in the study area was home based breed bull, neighboring bull and common bull. This result is in line with the report of [9, 6] in Mille and Amibara district of Afar and [6] in Somalia region. However, few respondents have no choice to use first or second for priority of bull for mating, while they enforced to use either donated or unknown bull with no clear family history of the breeding bulls. This finding agrees with the finding what had been reported by [23] in Ankole cattle.

The primordial trait preference for selection of breeding she-camel were based on milk yield, which is ranked first. This is in line with the report of Yosef *et al.* [9]. Body size and conformation, disease and parasite resistance, fast growth and adaptation-preferred traits followed milk yield. According to the report of Yosef *et al.* [9] adaptability, breeding efficiency, growth, ability to give birth to more female and draught capacity ranked as second, third, fourth and fifth followed milk production.

In the current study, the major challenge or bottleneck of productive and reproductive performance of she-camel in afar region are presented in Table 6. The major camel productive performance hinder were inadequate feed, disease incidence, poor veterinary service and lack of modern breeding program. The present finding is in concurrent with [9, 6] those who reported similar challenge of camel productive performance in Afar and Somali region. The prevalent challenge of reproductive performance of she-camel in the present finding were poor feed and nutrition, long calving interval and age at first service, calf mortality and abortion. Abdisa *et al.* [24] reported the main hinder reproductive performance of she-camel was late maturity, long calving interval and calf mortality in Yabello District, Oromia Regional State,

Effect of districts on milk yield and body measurement of camel

Districts is the main source of variation in body measurement of she-camel in the study area and this might be due to the management level/non genetic factors. This finding is in line with the report of Mahrous *et al.* [25] and Abdallah and Bernard [26] geographically difference is main source of variation in body measurement of camel population in Saudi Arabia. The body length, hind leg length and foreleg length of camel in this study was 145.35 cm, 149.24 cm and 163.78 cm, respectively. This value is higher than Shinille and Mille district [9] but lower than in India [27, 2]. The superiority of body measurement in this study over Shinille and Jijiga Somali region could be a result of the variation of feed availability and management systems. Height at wither and hump circumference in this study was 187.46 cm and 78.51 cm, respectively. This result is in line with the report of [9, 26]. The calculated average hind leg length and foreleg length of Gewane, Dubti, and Chefra camels are higher than values reported by [9] in Mille district of Afar region.

The value of height girth of she-camel in this study was higher when compared to the report of [2, 9, 28] in Jijiga, Mille and India, respectively. The average calculated hump circumference in this finding was 78.51 cm and lower than the value reported by [9] in Jijiga and Mille and [27] in double humped camel of Ladakh, India. The lower value of hump circumference recorded for this study may be due to the inadequate feed availability and disease prevalence. The chest girth obtained in this finding are higher with the result of Rashaidi and Bishari camel breeds in Sudan [29, 30].

Milk yield and under conformation traits

There was an excessive source of variation in milk yield and udder conformation traits of she-camel (Table 9). This might be different factors like udder health, stage of lactation, feed quality and husbandry practice [31]. The average milk yield obtained in this study was higher with the report of [32] under intensive management of dairy camel farm located in Dubai, United Arab Emirates. This difference might be due to genetic and non-genetic factors. The average value of DFT, DRT, USC and USH finding in this study was lower than the average value of dromedary camel with on farm in Sudan [33] and udder

size length with on station study in Saudi Arabia [34]. The mean value of milk yield and udder length resulted in this study was lower than the average value of Dromedries camels under large-scale camel dairy farm [31]. Udder measurements reported in this finding were lower than the reported by Atigui *et al.* [35] for Maghrebi camel's intensive system and Eisa *et al.* [36] for Arabi-Lahwee camels in semi intensive system. Furthermore, udder measurements are in concurrent with the value reported by Ayadi *et al.* [34] at late sage of lactation.

5. Conclusion

The primary breeding objective of pastoral and agro-pastoral camel keepers in the study area is milk, meat, wealth and social status and cultural value of the society. The achievements of the breeding objectives of camel producers were generally poor due to the lack of institutional support and uncontrolled environmental factors. Hence, pastoralists and agro pastoralists consider majority of mental recording genealogy and body conformation trait to select camel for reproduction, production performances and replacement stock strategies in the absence of no available choice of breeding program in this harsh environments.

Majority of the respondents in this study revealed that more selection focus on the selection of breeding bulls than dams since they perceive a single bull could serve more females and provide hundreds of improved traits of offspring throughout its lifetime than its counterparts. The major challenges of reproductive performance of camel was poor feed, long calving interval, long age at first service, poor veterinary service, calf mortality and abortion with an index value of 0.17, 0.17, 0.16, 0.15, 0.12 and 0.12, respectively.

Districts had a significant ($p < 0.05$) effect or variation on milk yield, body conformation trait and udder conformation trait. Statistically phenotypic relationships occur between milk yield, some udder conformation, and body conformation traits in all districts significantly and shows low to moderate correlations. Therefore, it recommended that further on station evaluation of the performance of Afar camel breed should be carried out to estimate the heritability's of conformation traits, phenotypic and genetic correlations with milk yield, to recipe standard decision-making criterions for indigenous she-camel and selection criteria for breeding camel for its future prospects.

Declarations

Authors' contributions

BH is the principal researcher, prepared interview schedule to collect data, analysis and prepared this manuscript. AH, MG, SG and ST have prepared schedule, collect data while FH have analyze data, writing up article and guided BH. They helped for BH in data entry, analysis, revised manuscript minutely with critical comments and suggestions and drafted the manuscript. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The datasets used and analyzed during the current study are available from the author on reasonable request.

Consent for publication

All data and information are generated from the main authors, and verbal informed consent was received to collect data and for publication during data collection.

Ethics approval and consent to participate

Not applicable.

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Significance statements

This study will help the researcher to uncover the critical area of breeding practice and correlation of conformation traits with milk offtake that many researchers were not able to explore. This study discovers the effect of district on milk yield, conformation traits and the relationship between udder conformation traits with milk yield of she-camels. These value used as reference in the future studies on the genetic characterization and improvement through conservation of the breeds.

References

1. Abbas, AM, Mousa, HM, Lechner-Doll, M, Von Engelhardt, W. 1995. Nutritional value of plants selected by camels (Camelus dromedaries) in the Butana area of Sudan. Journal of anmal physiology and nutrition. 74: 1–8
2. 19. El-Malky OM, Mostafa TH, Abd El-Salaam AM, Ayyat MS. Effect of reproductive disorders on productivity and reproductive efficiency of dromedary she-camels in relation to cytokine concentration. Tropical Animal Health and Production. (2018); 50(5):1079–1087.
3. 20. Brigitte KA. Reproductive performance of camels (Camelus dromedarius) under pastoral management and its influence on herd development. Livestock Production Science. (2005); 92: 17–29.
4. 21. Abdussamad AM, Holtz W, Gauly M, Suleiman MS, Bello MB. Reproduction and breeding in dromedary camels: insights from pastoralists in some selected villages of the Nigeria-Niger corridor. Livestock Research for Rural Development. (2011); 23(8).
5. 22. Faye B. The Camel today: assets and potentials." Anthropozoologica. (2014); 49 (2): xx-xx.
6. 23. Kugonza DR, Kiwuwa GH, Mpairwe D, Jianlin H, Nabasirye M, Okeyo AM, Hanotte O. Accuracy of pastoralists' memory based kinship assignment of Ankole: a microsatellite DNA analysis. Journal of Animal Breeding and Genetics. (2011a); 129(1):30–40.
7. 24. Abdisa T, Wubishet Z, Etsay K. Study on Major Constraints of Camel Production, Management and Their Impacts in and Around Yabello District, Oromia Regional State, Southern.Journal of Dairy and Veterinary Sciences. (2017); 3(1): 555–604.
8. 25. Mahrous KF, Ramadan HA, Abdel-Aziem SH, Abd-El Mordy M, Hemdan DM.Genetic variations between camels breeds using microsatellite markers and RAPD techniques. Journal of Applied Bioscience. (2011); 39: 2626–2634.
9. 26. Abdallah HR, Bernard F. Phenotypic classification of Saudi Arabian camel (Camelus dromedarius) by their body measurements." Emir. J. Food Agric. (2012); 24 (3): 272–280.

10. 27. Dil MM, Gazi MA, Showkat-ul N, Shakeel A. Morphometric studies on adult double humped camel of Ladakh, India. Emir. J. Food Agric. (2013); 27(7):544–548.
11. 28. Yoseph WL, Dunn CD, Mauldin MR, Ordonez-Garza N, Rowden GR, Gebre YM, Kurtu MY, Mohammed Ali S, Whibesilassie WD, Ballou M, Tefera M, Perry G, Bradley RD. Morphometric and genetic variation in 8 breeds of Ethiopian camels (Camelus dromedaries). Journal of Animal Science. (2018); 96:4925–4934.
12. 29. Amir MO, Abu kashwa SM, Elobied AA, Ali AS, Ibrahim MT, Salih MM. Body Measurements of Five Types of Sudanese Camel Breed in Gadarif State. Sudan Journal of Science and Technology. (2015); 16(1): 76–81.
13. 30. Ishag IA, Reissmann M, Peters KJ,. Musa LMA, Ahmed MKA. Phenotypic and molecular characterization of six Sudanese camel breeds. South African Journal of Animal Science. (2010); 40(4):319–326.
14. 31. Abdelgadir M, Bernard F, Ahmed K, Moez A, Aljumaah RS. Change in Udder Measurements Traits during Lactation and Its Relationship with Milk Yield in Dairy Camel (Camelus Dromedaries)." IOSR Journal of Agriculture and Veterinary Science. (2017); 10(12): 76–83.
15. 32. Nagy P, Fábri ZsN, Varga L, Reiczige J, Juhász J. Effect of genetic and nongenetic factors on chemical composition of individual milk samples from dromedary camels (Camelus dromedarius) under intensive management. Journal of Dairy Science. (2017); 100 (11):8680–8693.
16. 33. Shehadeh K. Udder Morphology and Machine Milking Ability in Dromedary Camels. International Journal of Research in Agricultural Sciences. (2018) 5(2): 2348–3997.
17. 34. Ayadi M, Aljumaah RS, Musaad A, Samara EM, Abelrahman MM, Alshaikh MA, Saleh SK, Faye B. Relationship between udder morphology traits, alveolar and cisternal milk compartments and machine milking performances of dairy camels (Camelus dromedarius). Spanish Journal of Agricultural Research. (2013); 11(3): 790–797.
18. 35. Atigui, M, Marnet PG, Harrabi H, Bessalah S, Khorchani T, Hammadi M. Relationship between external and internal udder and teat measurements of machine milked dromedary camels. Tropical animal health and production. (2016); 48(5):935–942.
19. 36. Eisa MO, Ishag IA, Abu-Nikhaila AM. Anote on the relationship between udder morphometric and milk yield of Lahween camel (camelus dromedaries). Livestock Reserarch and Rural development. (2010); 22(10).
20. 8. Eyassu S. Analysis on the contributions of and constraints to camel production in Shinile and Jijiga zones, eastern Ethiopia. Journal of Agriculture and Environment for International Development. (2009); 103 (3): 213–224.
21. 9. Yosef T, Mengistu U, Solomon A, Mohammed YK, Kefelegn K, Tadelle D. Husbandry and breeding practices of dromedary camels among pastoral communities of Afar and Somali regional states, Ethiopia. Journal of Agriculture and Environment for International Development. (2014); 108(2):167–189.
22. 10. Ahmad S, Yaqoob M, Hashmi N, Ahmad S, Zaman MA, Tariq M. Economic Importance of Camel: Unique Alternative under Crisis. Pakistan Veterinary Journal. (2010); 30(x): xxx.
23. 11. Bekele M. An epidemiological study of major camel diseases in the Borana lowland, Southern Ethiopia. Country Report. https://www.eldis.org/document/A56725. Accessed 09 Sep. (2010)
24. 12. Sisay K, Getachew A, Lemma Z. The contribution of camel milk to pastoralist livelihoods in Ethiopia: An economic assessment in Somali Regional State. IIED Country Report London.: IIED, 2015.
25. 13. Zewdu W. Indigenous cattle genetic resources, their husbandry practices and breeding objectives in North-western Ethiopia. MSc Thesis, Halemaya University, Ethiopia. (2004); Pp128
26. 14. Musa HH, Shuiep ES, Ibtisam EM, Chen GH. Some reproductive and productive tarits of camel in Western Sudan. Journal of Animal and Veterinary Advance. (2006); 5(7), 590–592.
27. 15. Yohannes M, Getachew G, Zeleke M. Reproductive Performance of Camels in Babilie and Kebribeyah Districts of the Jijiga zone, Somali Region, Ethiopia. International Scientific Conference of Camel Research and Production. Accesed 18 Apr. (2013).
28. 16. Tefera M, Fesha G. A study on the productivity and disease of camels in eastern Ethiopia. Tropical Animal Health and Production. (2001); 33(4): 265–274.

29. 17. Mayouf R, Benaissa MH, Bentria Y, Aoun FZ, Halis Y. Reproductive performance of Camelus dromedarius in the El-Oued region, Algeria. Online Journal of Animal and Feed Research. (2014); 4(4): 102–106.
30. 18. Tarek HM, Adel AB, Mohamed S. Reproductive and Productive Efficiency of Maghrebi Dairy She-Camels Fed diets Supplemented with Zinc-Methionine. Biological Trace Element Research. (2019); 194:135–144.
31. 19. El-Malky OM, Mostafa TH, Abd El-Salaam AM, Ayyat MS. Effect of reproductive disorders on productivity and reproductive efficiency of dromedary she-camels in relation to cytokine concentration. Tropical Animal Health and Production. (2018); 50(5):1079–1087.
32. 20. Brigitte KA. Reproductive performance of camels (Camelus dromedarius) under pastoral management and its influence on herd development. Livestock Production Science. (2005); 92: 17–29.
33. 21. Abdussamad AM, Holtz W, Gauly M, Suleiman MS, Bello MB. Reproduction and breeding in dromedary camels: insights from pastoralists in some selected villages of the Nigeria-Niger corridor. Livestock Research for Rural Development. (2011); 23(8).
34. 22. Faye B. The Camel today: assets and potentials." Anthropozoologica. (2014); 49 (2): xx-xx.
35. 23. Kugonza DR, Kiwuwa GH, Mpairwe D, Jianlin H, Nabasirye M, Okeyo AM, Hanotte O. Accuracy of pastoralists' memory based kinship assignment of Ankole: a microsatellite DNA analysis. Journal of Animal Breeding and Genetics. (2011a); 129(1):30–40.
36. 24. Abdisa T, Wubishet Z, Etsay K. Study on Major Constraints of Camel Production, Management and Their Impacts in and Around Yabello District, Oromia Regional State, Southern. Journal of Dairy and Veterinary Sciences. (2017); 3(1): 555–604.
37. 25. Mahrous KF, Ramadan HA, Abdel-Aziem SH, Abd-El Mordy M, Hemdan DM.Genetic variations between camels breeds using microsatellite markers and RAPD techniques. Journal of Applied Bioscience. (2011); 39: 2626–2634.
38. 26. Abdallah HR, Bernard F. Phenotypic classification of Saudi Arabian camel (Camelus dromedarius) by their body measurements." Emir. J. Food Agric. (2012); 24 (3): 272–280.
39. 27. Dil MM, Gazi MA, Showkat-ul N, Shakeel A. Morphometric studies on adult double humped camel of Ladakh, India. Emir. J. Food Agric. (2013); 27(7):544–548.
40. 28. Yoseph WL, Dunn CD, Mauldin MR, Ordonez-Garza N, Rowden GR, Gebre YM, Kurtu MY, Mohammed Ali S, Whibesilassie WD, Ballou M, Tefera M, Perry G, Bradley RD. Morphometric and genetic variation in 8 breeds of Ethiopian camels (Camelus dromedaries). Journal of Animal Science. (2018); 96:4925–4934.
41. 29. Amir MO, Abu kashwa SM, Elobied AA, Ali AS, Ibrahim MT, Salih MM. Body Measurements of Five Types of Sudanese Camel Breed in Gadarif State. Sudan Journal of Science and Technology. (2015); 16(1): 76–81.
42. 30. Ishag IA, Reissmann M, Peters KJ,. Musa LMA, Ahmed MKA. Phenotypic and molecular characterization of six Sudanese camel breeds. South African Journal of Animal Science. (2010); 40(4):319–326.
43. 31. Abdelgadir M, Bernard F, Ahmed K, Moez A, Aljumaah RS. Change in Udder Measurements Traits during Lactation and Its Relationship with Milk Yield in Dairy Camel (Camelus Dromedaries)." IOSR Journal of Agriculture and Veterinary Science. (2017); 10(12): 76–83.
44. 32. Nagy P, Fábri ZsN, Varga L, Reiczige J, Juhász J. Effect of genetic and nongenetic factors on chemical composition of individual milk samples from dromedary camels (Camelus dromedarius) under intensive management. Journal of Dairy Science. (2017); 100 (11):8680–8693.
45. 33. Shehadeh K. Udder Morphology and Machine Milking Ability in Dromedary Camels. International Journal of Research in Agricultural Sciences. (2018) 5(2): 2348–3997.
46. 34. Ayadi M, Aljumaah RS, Musaad A, Samara EM, Abelrahman MM, Alshaikh MA, Saleh SK, Faye B. Relationship between udder morphology traits, alveolar and cisternal milk compartments and machine milking performances of dairy camels (Camelus dromedarius). Spanish Journal of Agricultural Research. (2013); 11(3): 790–797.
47. 35. Atigui, M, Marnet PG, Harrabi H, Bessalah S, Khorchani T, Hammadi M. Relationship between external and internal udder and teat measurements of machine milked dromedary camels. Tropical animal health and production. (2016);

48(5):935–942.

48. 36. Eisa MO, Ishag IA, Abu-Nikhaila AM. Anote on the relationship between udder morphometric and milk yield of Lahween camel (camelus dromedaries). Livestock Reserarch and Rural development. (2010); 22(10).

Figures

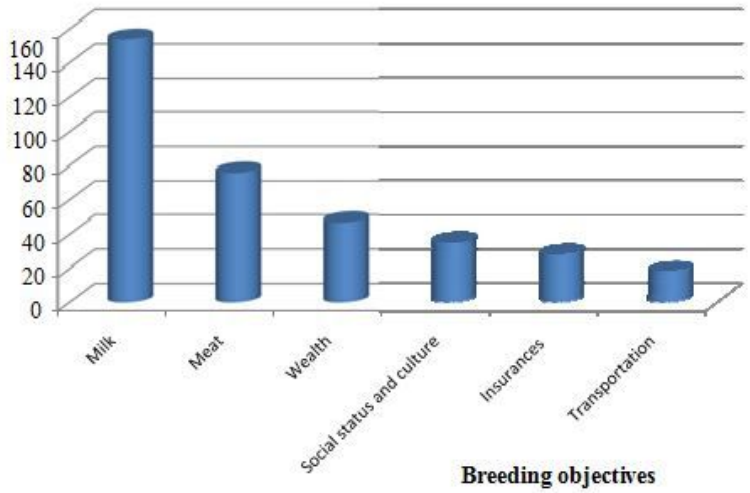

Figure 1

Breeding objectives of farmers in the production system