

# Goats in North Kordofan Sudan: Production systems, Production characteristics and Breeding Objectives document

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## Acronyms and Abbreviations

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AEZ	Agroecological zone
CBOS	Central Bank of Sudan
CBRRP	Community-based Rangeland Rehabilitation for Carbon Sequestration and Biodiversity Project
FAO	Food and Agriculture Organization of the United Nations
ICARDA	International Centre for Agricultural Research in Dry Areas
IFAD	International Fund for Agricultural Development
ISM	Interactive Spatial and Temporal Modeling System as a tool for ecosystem management
HHs	Households
NKS	North Kordofan State
WSARP	Western Sudan Agricultural Research Development Project
WSRMP	Western Sudan Resource Management Program of the IFAD

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## Executive Summary

This report presents the findings of a study conducted for the International Centre for Agricultural Research in the Dry Areas (ICARDA). The overall objective was to describe the production systems, characterization of the population and defining breeding objectives of the goat breeds and populations in North Kordofan, Sudan.

- **Information used included both primary and secondary data.**
- **Secondary data** sources included Federal and North Kordofan State Ministries of Agriculture and Animal Resources, IFAD projects working in North Kordofan, Annual research reports of El-Obeid Research Station and others. Other secondary data sources were published and unpublished reports and documents covering goats in North Kordofan, Sudan and other similar areas. These documents were thoroughly reviewed for historical goat origin, breeds/types, production systems, husbandry practices, production characteristics, indigenous knowledge and practices and threats to goat resources in North Kordofan.
- **Primary data** were collected from various localities and villages in different agroecological zones in North Kordofan using various participatory approaches during the period Nov 4-15, 2018. Twelve focus group discussions and 124 individual farmer interviews were held in 12 villages in different agroecological zones of the State. Data and information collected were categorized and coded whenever necessary and analyzed using descriptive statistics. Questionnaire data were coded and analyzed using SPSS (ver. 24) software program to gain insight on reason for raising goats and breeding objectives.
- **Goat population** in Sudan is estimated at 32.2 million heads, with an annual growth rate of 2.5%. Goat population in North Kordofan State represented 37.1% of the total goat population in the Western Region and 8.5% of Sudan. Within North Kordofan State, goats accounted for 31.3% of the livestock population, which is second to sheep. The highest goat population was in the semidesert (41.9%), followed by the arid zone (35.0%), and the least number being in the desert (4.6%) and semiarid on clay (6.3%) zones.
- **Goat production systems** in North Kordofan are virtually traditional, with varying degrees of dependency on natural rangelands and crop fields after harvest. They could be classified into pastoral, agropastoral, sedentary and inter-urban systems.
- **Traditional Practices and Indigenous Knowledge on goat husbandry and management** focus on grazing management through mobility in pastoral and agropastoral systems, traditional measures and practices of disease and biting flies control, and other management aspects.
- **Goats in North Kordofan** can be classified into Nubian-Desert crosses, Desert and crosses between Desert and Mountain goats “Tagar”. Nubian goats constitute about 50% of total goats found in Sudan.
- **Nubian goat crosses** were found at Northern Localities (Sodari and Gabrat el Sheikh), Kheiran area North of Bara Locality and bearing different local and tribal names e.g. “*Halabiya*”, “*Kabashiya*”. Farmers in these areas stated that Nubian bucks were brought from River Nile and Northern States. These goats are considered good milk producers. Up to 2.3 liter/day had been reported by farmers at Damira in El Kheiran area of Bara locality in the State.
- **Desert goats** are distributed in dry areas generally to the north of 10°N in the State within arid and semiarid agroecological zones and represent about 17% of goat population in Sudan. It is raised under pastoral and agropastoral systems by tribes such as Shanabla and Bedeiria. Milk yield ranges from 0.125 to 0.500 liter/day.



- **Desert-Tagar goat crosses** are dwarf goats. “Tagar” goats represent 3% of the goat population found in Sudan, well known with rapid, light movement, bred for meat only and have a very low milk yield, highly prolific, raised mostly by the Baggara tribes who migrate from South Kordofan to North Kordofan during the rainy season and by sedentary farmers and those of Nubian ethnic origin in areas of Birkat el Daw villages close to southern borders of North Kordofan State.
- **Foreign goats’ breeds:** Saanen, Tugenburger, Anglo-Nubian and Alpine are frequently found in towns, owned by individuals and/or in hands of few goat keepers. They are mainly introduced to improve the milk yield of local breed. Damascus goats and bucks have also been introduced recently by IFAD WSRMP in Kordofan (2009) and by the “Zakat” (2010).
- **North Kordofan Goat subtypes** had high preweaning kid (10-18%) and adult (10-15%) mortalities. Desert-Tagar crosses had the highest twinning rates of over 50% and Desert-Nubian had an average twinning rate of 15%. Kidding rates per annum ranged from 86.5% for Desert-Nubian crosses to over 240% for Desert-Tagar ones.
- **Goat ownership, flock size and some husbandry practices:** Overall percentage of HHs owning goats within the surveyed villages was 70.9%, with average flock size of 6 heads. Average flock structure was 70.0% mature does (2.0-2.5 years old), over 3 years old does constituted (6.0%) and yearlings (24.0%). The majoring of goat flocks are owned by women who are responsible for their rearing, milking and different management aspects.  
No control of mating over goat flocks, with only few breeding bucks (5-10 bucks) present at the village, with an average of 90 goats per breeding buck. Villagers do not keep male kids; they are either sold or slaughtered immediately after weaning at three months of age. This could probably be attributed to that farmers tend to allow only few breeding bucks per village and/or meat quality (particularly odor) changes in adult males. Most of kidding occur in the rainy and winter seasons. Lactating goats are milked once a day every morning
- **Goats breeding objectives**
  - The most frequently reported purposes for keeping goat was milk production, followed by meat production and then income generation. Milk production as 1<sup>st</sup> priority objective was stated by 96.0% of the interviewed farmers. Income generation as 1<sup>st</sup> priority was mention by only 1.6% of the total interviewed farmers across all agroecological zones.
  - Raising goats for milk production as 1<sup>st</sup> priority was stated by 71.4 and 95.0% of interviewed farmers on desert and semiarid on clay zones, respectively. Farmers under semidesert and semiarid on sand zones unanimously stated that milk as their 1<sup>st</sup> priority.
  - Income generation and meat production as 1<sup>st</sup> priority were mentioned equally (14.3%) under the desert zone, while only 5.0% of interviewed farmers under the semiarid on clay zone stated income generation as 1<sup>st</sup> priority.
  - income generation as 2<sup>nd</sup> priority was reported by over 80% of all of the interviewed farmers. Highest percentages were at the semiarid on clay (95%), semiarid on sand (90.0%) and semidesert (80%) zones. Under the desert zone, meat was said to be the most important 2<sup>nd</sup> priority as stated by 58.3% of the interviewed farmers.
  - Third priority reasons for raising goats stated by farmers across all ecological zones were only milk and income, with income generation being minor priority under semiarid zones on clay and sand. Under these zones, sheep raising probably is the most important income generating activity than goats.

### ■ Threats to Goat Resources in North Kordofan State

- Drought episodes in North Kordofan, particularly 1984, have drastically affected livestock resources in the region. In that particular year, 50% of small ruminants (goats and sheep) in north Kordofan were lost.
- Livestock mixing in dry and rainy seasons camping areas lead to evolving of new animal types and at the same time erode the original genetic material and enhances diseases transmission.
- Insecurity in South Sudan and south Kordofan forced some tribes to move their animals out of the area, leading to negative impact on goat biodiversity.
- Migration routes have been blocked and agropastoral tribes in Kordofan have been forced to use new routes or new areas, leading to congestion of animals at certain locations, competition over limited grazing resources, health hazards and crossing between types.
- Several epidemic diseases are present in the region which are responsible for considerable loss in livestock resources. In addition, drugs, vaccines and vaccination campaigns are limited.
- Introductions of foreign goat bucks e.g Saanen, Tugenburger and Damascus and their random distribution to different localities in North Kordofan pose a threat on indigenous genetic goat resources.
- The last livestock census was conducted in 1975-77. Present estimates might over- or underestimate actual numbers in view of the many changes that have occurred in the region (droughts, insecurity, export).

Less attention is paid to more holistic breed improvement activities involving the design of breeding programs, animal recording, testing of alternative animal breeds, and the involvement of local farmers and traditional breeders (breed associations).

### ■ **Way forward:** Goats provide a biological capital for livelihoods, food security and poverty alleviation.

- Sustainable development planning should take into considerations the differences between and among goat subtypes and adaptational characters suited to different production environments.
- There is a high need for genetic characterization of different goat subtype/breeds in North Kordofan and Sudan at large.
- Goat husbandry and general management practices in terms of veterinary care and feeding should be giving due considerations when attempting productivity improvement efforts.
- The multipurpose nature of goats (milk, meat, cash, etc) under low-input traditional production system should be taken into considerations when attempting improvement programs.
- Producers/herders capacity building and involvement in the initial stages of planning is a prerequisite and participatory approaches be adopted when intending goat improvement programs. Recent formulation of producer groups for facilitation of services (microfinancing, insurance, marketing, etc.) provide a viable ground in attempting community-based goat breeding programs.

## 1. Introduction

Goats are one of the most important livestock species in rural farming systems in Sudan and the most widely distributed animal in the country. This is mainly so because it is easy to handle and can look after itself very well. Women are the major handlers of goats in the Sudan. Goats occupy the second position after sheep in population size and third position in economic importance after cattle and sheep. Devendra and McLeroy (1982) have indicated that they were domesticated in South East Asian and since then spread all over the globe (Zeuner, 1967 and Epstein, 1971).

Goats are important economic resources for household income, milk, meat and manure. Sales of goats and goat products (milk, meat and skins) by rural farming households are viable sources of cash for purchase of clothes, grains and other essential household commodities. In addition, goats are raised mostly to safeguard against crop failure and unfavorable crop prices in traditional cropping areas. They represent a more liquid form of capital than cattle and are readily tradable.

Increasing pressure on land and natural resources, poverty, hunger, changing climatic conditions, and pricing of livestock products driven by increased population and consumer demand present unprecedented development challenges for smallholder traditional farming communities. Under traditional small holder farming systems, improvement of livestock production using more productive livestock genotypes has been advocated as a means of improving the livelihoods of some of the poorest farmers (Freeman et al., 2007; Seré et al., 2007).

In Sudan, the productivity and the contribution of goats to the national economy is relatively low. The value of Livestock exports declined from US \$ 908.6 million in 2015 to US \$ 762.9 million in 2016 by 16.0%, as a result of decline in the value of goat and sheep exports by 39.5% and 26.2% respectively, with goat contribution of about 0.6% (CBOS, 2016). This may be due to different factors such as poor nutrition, prevalence of diseases, lack of appropriate breed and breeding strategies.

## 2. Purpose of the study

The International Center for Agricultural Research in the Dry Areas (ICARDA) in partnership with various institutes has been implementing Community-based breeding Programs (CBBPs) in different countries in the Dry areas. In partnership with ARC- Sudan, ICARDA is planning to implement a goat CBBP in North Kordofan targeting women-livestock owners. The overall objective of this study was to describe the production systems, characterize the population and define breeding objectives of the goat breeds and populations in North Kordofan, Sudan (Annex 1. Study ToR).

## 3. Methodology

- **Biophysical Environment of North Kordofan State:** Northern Kordofan State is in the central western part of Sudan on the northern edge of the Savannah belt, between latitudes 11-17°N and longitudes 27-32°E, with an area of 242,000 km<sup>2</sup> (Sudan NAP, 2016). The human population of the State is estimated at 2.921 million, amounting to 9.2% of

Sudan total population, with a male to female ratio of 0.93 (Sudan Population Census, 2008).

The State's climate is characterized by low rainfall, sparse vegetation and extreme temperatures, which reach as high as 49°C in the summer (March-Sept) and as low as 15.0°C in the winter (Oct-Feb) (Sudan NAP, 2016). The State was divided into four agro-ecological zones (AEZs) (Map 1); desert, semidesert, semiarid and arid (FAO and ILASA, 2000). The desert zone covers a very small area in North Kordofan State (5%), the semidesert 48%, arid zone 25% and semiarid zone 22% of the State area. The semiarid zone is further subdivided into semiarid on sand and semiarid on clay. Soils in the area include (Map 2) sandy soil which are the predominant soils (more 60%), clay soils (6%), Clay-loamy soils (18%), and other important soils include loamy soil locally known as "*Gardud*" soils (2%).

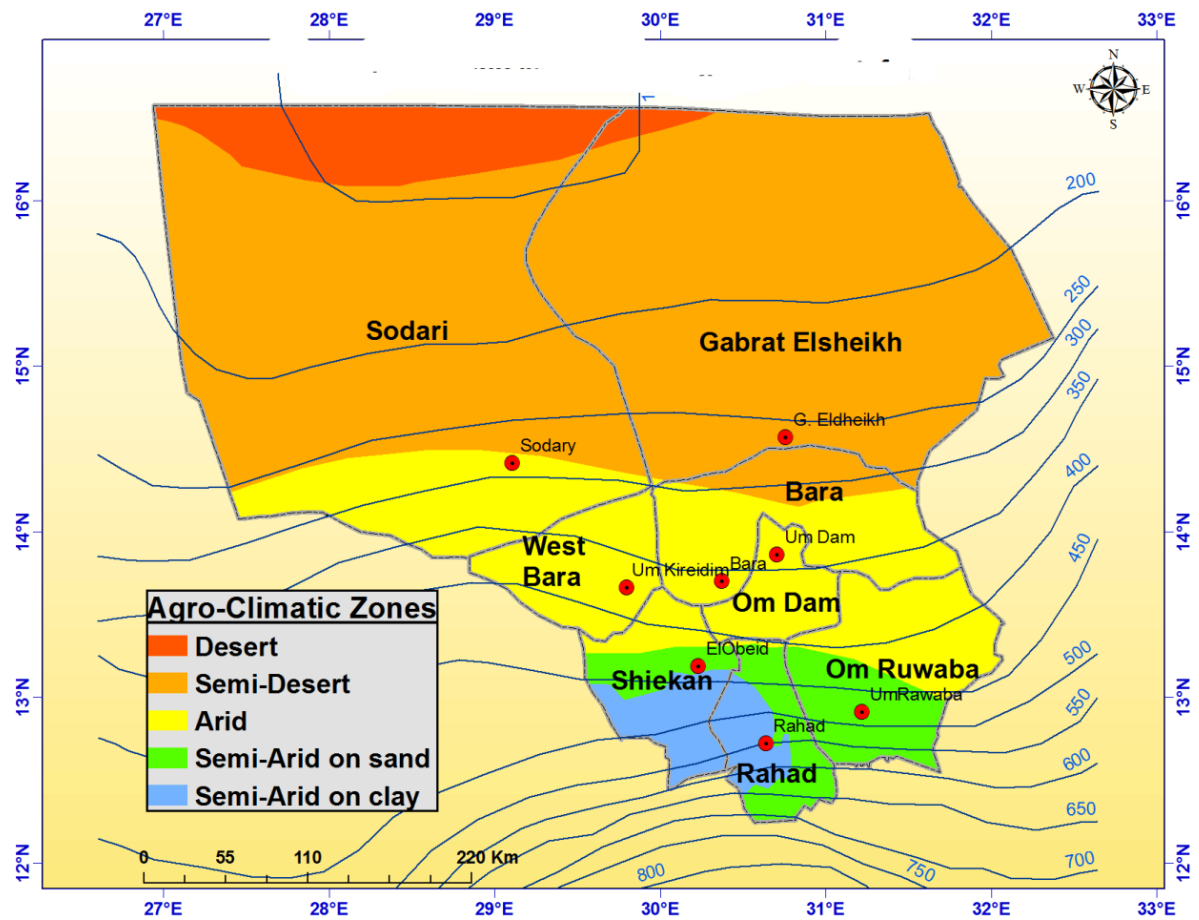
Several land use categories exist in North Kordofan. The important land use category is rangelands comprising about 50.6% of the State area, traditional rainfed agriculture 22.1%, forest area occupying 1.82%, bare areas 25.2% (Table 1).

Livelihoods have been affected by frequent drought cycles. The State also suffers from extreme fluctuations in rainfall which generally vary from 150-450 mm/year. Severe climatic conditions and land mismanagement (overgrazing, over cropping, deforestation) have caused vegetation cover to become very poor and the loss of endemic woody and range plants species that were once dominant.

- **Data Collection:** Information used for this study included both primary and secondary data. Sources of secondary data were Federal and Kordofan State Ministries of Agriculture and Animal Resources, IFAD projects working in North Kordofan, Annual research reports of El-Obeid Research Station and others. Other secondary data sources were published and unpublished reports, scientific articles and documents covering livestock in general and goats in North Kordofan in particular. These documents and others were thoroughly reviewed for historical goat origin and types, production systems and husbandry practices, production characteristics and constraints.

- **Assigning goat population in Agroecological zones (AEZs):** Goat data are usually recorded at administration level (Locality level), hence there is no data available at agroecological zone level. To do so, the method described by Toxopeus (1999) was adopted. In this method, area of each locality in a certain AEZ is calculated as percentage of the total area of that AEZ "Aerial factor". To calculate the total goat population in each AEZ, the goat statistic in each locality in that AEZ was multiplied by its "aerial factor" (Table 2).

Map 1. Agroecological zones, isohyets and localities of North Kordofan State, Sudan



Source: Study results (2018).

Map 2. Soils of North Kordofan State, Sudan

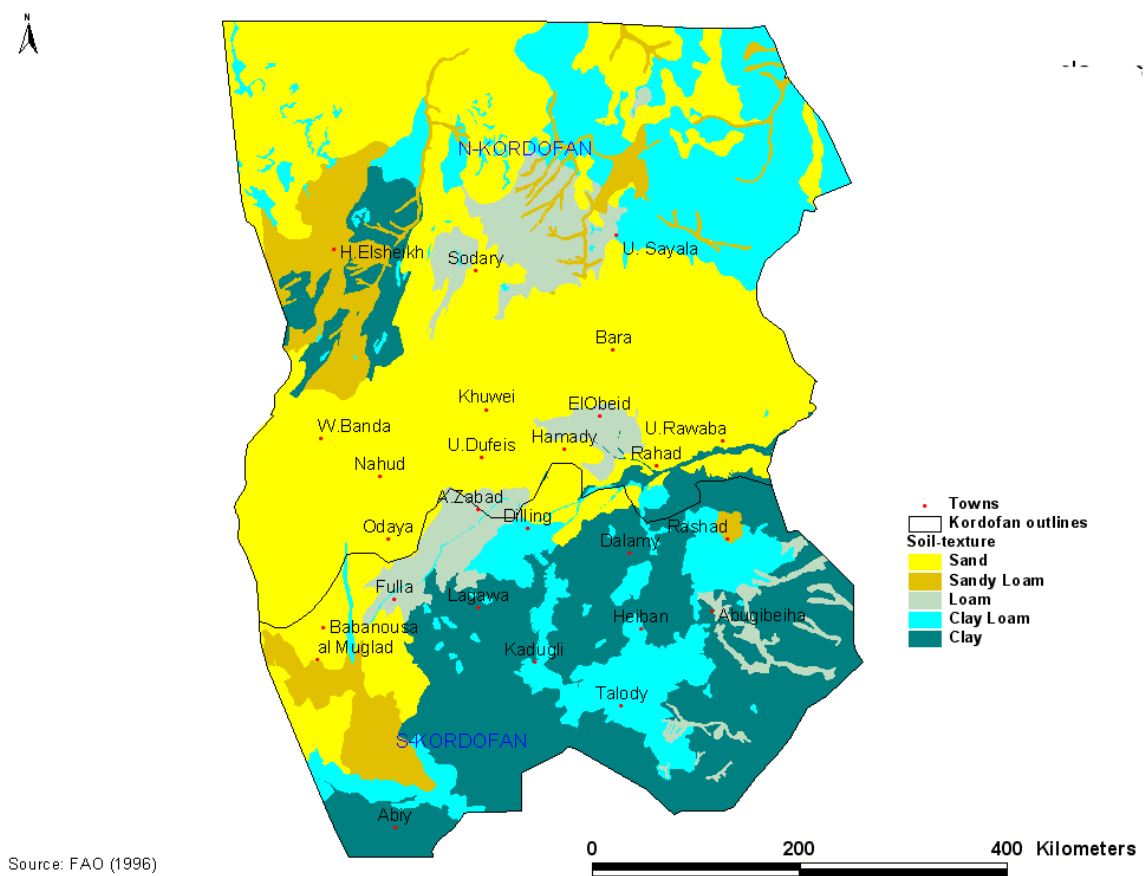


Table 1. Various land use categories and their areas ('000 ha) in the North Kordofan.

Land use	North Kordofan	As % of NK
Post flooding Agriculture	4.20	0.03
Mechanized Agriculture.	3.50	0.02
Rain-fed Agriculture	5,379.90	22.10
Rangeland	12,271.80	50.60
Forests	437.50	1.82
Water bodies	47.60	0.23
Bare area	6,121.70	25.20
<b>Total</b>	<b>24266.20</b>	<b>100.00</b>

Source: Study results (2018).

Table 2. Localities aerial factors\* in each agroecological zone

Locality / AEZ	Desert	Semidesert	Arid	Semiarid on Clay	Semiarid on Sand
Sodari	0.1584	0.6833	0.1584	0.0000	0.0000
Gabrat el Sheikh	0.0165	0.9829	0.0006	0.0000	0.0000
Bara	0.0000	0.2550	0.7448	0.0000	0.0000
Um Ruwaba	0.0000	0.0000	0.5575	0.0000	0.4429
Um Daam	0.0000	0.0000	1.0007	0.0000	0.0000
Er Rahad	0.0000	0.0000	0.0249	0.4161	0.5605
West Bara	0.0000	0.0000	0.9994	0.0000	0.0000
Sheikan	0.0000	0.0000	0.2565	0.4680	0.2761

Source: Study results (calculated according to Toxopeus, 1999).

▪ **Primary data** were collected from various localities and villages in different agroecological zones in North Kordofan (Map 1), using various methods during the period Nov 4-15, 2018. These included:

○ **Direct field observations:** Direct field observations were confined to visual indicators or aspects of goat types and breeds within each agroecological zone, flock husbandry, structures, diseases, other constraints, and indigenous knowledge and practices usually performed to management, breeding and general husbandry as perceived by farmers/herders/producers (both men and women). Different breeds/types within each type/breed of goats were documented with a digital camera.

○ **Rapid Rural Appraisal (RRA):** The main techniques used were performed through a checklist using focus group discussions with goat owners (men and women) in chosen villages in different agroecological zones. Issues discussed during group discussions using a checklist included the following:

- Total number of households owning goats within communities
- Size of goat holdings per household
- Goat flock structure
- Wet and dry season feed resources
- Herding/feeding practices and responsibilities
- Flock breeding season and management (Buck : Doe ratio, controlled breeding, castration, etc)
- Reproductive performance (conception, kidding, abortion, twining, mortality rates etc.)
- Husbandry practices (rearing, disease control and prevention, culling, offtake, etc.)
- Major constraints faced and coping strategies (if any)

○ **Key Informants (KIs):** Discussion with key informants was an integral activity in focus group discussion. Key informants included individuals involved in the service sector of livestock, agriculture, producer groups, and executive authorities and local leaders. Whenever possible, key informants were involved in focus group discussions.

○ **Individual Farmer Questionnaire:** A short personal interview was conducted to gain insight on the reasons for raising goats at the four agroecological zones in North Kordofan. Fourteen (14) farmers were interviewed at the desert zone, 50 at the semidesert zone, 40 at the semiarid on sand zone and 20 at the semiarid on clay zone. Farmers were asked individually to mention their reasons for raising goats and to rank their answers as 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> priority.

- **Data Arrangement and Analysis:** Data and information collected through focus group discussions were categorized and coded whenever necessary and analyzed using descriptive statistics. Questionnaire data were coded and analyzed using SPSS (ver. 24) software program to gain insight on reason for raising goats and breeding objectives.

## 4. Results and discussion

### 4.1 Goats in North Kordofan

The goat population in Sudan is estimated at 32.2 million heads (MARF, 2016). The goat national flock annual growth rate was 2.5%. Goat population in North Kordofan State (2.654 million heads) represented 37.1% of the total goat population in the Western Region (Greater Kordofan and Greater Darfur; 7.2 million goats) and 8.5% of Sudan (Table 3). Within North Kordofan State, goats accounted for 31.3% of the livestock population, which is second to sheep. The highest goat population was found to be in Sodari Locality in the Northern part of the State and the lowest was in Er Rahad Locality (Figure 1).

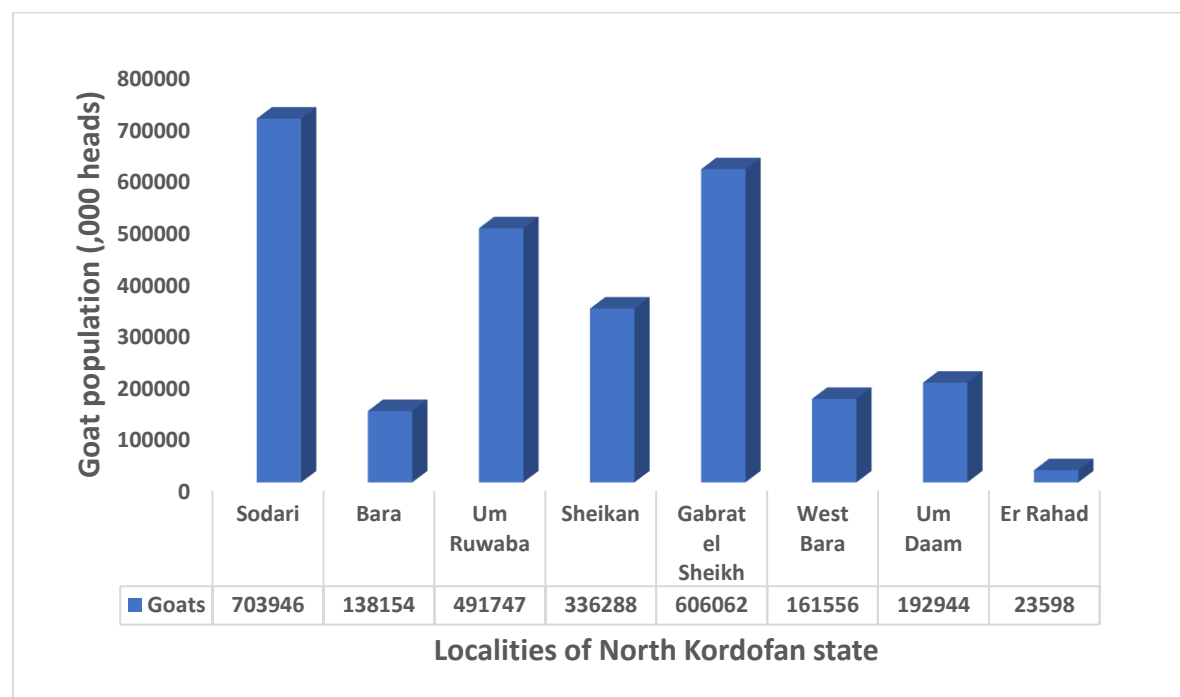
Table 3. Livestock population by class of animal in North Kordofan in relation to Western Sudan and Sudan.

	<b>Camels</b>	<b>Goats</b>	<b>Sheep</b>	<b>Cattle</b>	<b>Total</b>
North Kordofan	923328	2654295	4141630	759400	8478653
Sudan	4809000	31227957	40208546	30376002	106621505
As % of Sudan	19.2	8.5	10.3	2.5	7.9
As % of North Kordofan of livestock population	10.9	31.3	48.8	8.9	
Western region	1801451	7150983	10595335	8605521	28153290
As % of Western Region	51.3	37.1	39.1	8.8	30.1

Source: Study results



Figure 1. Goat distribution in the different localities of North Kordofan State, Sudan.



Source: Study results (2018).

Goat population distribution across the different agroecological zone is calculated as indicated in Table 4. The Desert AEZ had 0.16 of the goats found in Sodari (111,520 heads) and 0.017 of goats found in Gabrat el Sheikh (9,982 heads), totaling the number of goats in Desert AEZ to 121,502 head. Overall, the highest goat population was found in semidesert (41.9%), followed by the arid zone (35.0%). These two agroecological zones had over 75% of goat population of North Kordofan State, with the least numbers in the desert (4.6%) and semiarid on clay (6.3%) zones (Table 4).

Table 4. Total numbers of goats in each AEZ

Locality / AEZ	Desert	Semi-desert	Arid	Semi-arid/Clay	Semi-arid/Sand
Sodari	111,520	480,992	111,486	-	-
Gabrat el Sheikh	9,982	595,709	385	-	-
Bara	-	35,236	102,896	-	-
Um Ruwaba	-	-	274,153	-	217,796
Um Daam	-	-	193,083	-	-
Er Rahad	-	-	588	9,820	13,227
West Bara	-	-	161,456	-	-
Sheikan	-	-	86,263	157,384	92,839
<b>Total goats</b>	<b>121,479</b>	<b>1,111,719</b>	<b>930,128</b>	<b>167,170</b>	<b>323,799</b>
<b>As % of total goats in NK</b>	<b>4.6</b>	<b>41.9</b>	<b>35.0</b>	<b>6.3</b>	<b>12.2</b>

Source: Study results

## 4.2 Goat production systems

Livestock production systems in Sudan in general and North Kordofan in particular, are virtually traditional, with varying degrees of dependency on natural rangelands and crop fields after harvest. They could be classified into pastoral, agropastoral, sedentary and inter-urban systems.

○ **Pastoral systems** livelihoods, more than 50% of the gross household revenue is derived from livestock, migrate in search of water and forage. A good example of this system is the Shanabla, Kababish and Hawaweer tribes of North Kordofan. The system is distinguished and characterized by individual ownership of animal resources and communal ownership of grazing resources, extensive use of vast areas, dynamic nature of people and livestock, year-long management of land use. Here, seasonality is met by rhythmic migration, reduced offtake and lack of market facilities, heterogeneous animal populations; camels (being the main animal), sheep, goats (El-Hag, et al., 2011). Pastoralists in the northern part of North Kordofan traditionally made long range migrations to the “*gizu*” grazing in North Darfur and as far as Dongola in the Northern State. However, recent droughts have brought them south earlier and further as far as the Nuba Mountains and beyond.

○ **Agropastoral (transhumant) production system** is characterized by seasonal migration along defined traditional grazing routes. Cropping activities play relatively minor roles in the system. Crops grown include millet, sorghum, sesame, groundnut, and watermelon. Transhumants usually raise cattle (as a dominant animal) together with sheep and goats. The civil war in the South Kordofan has caused agropastoral tribes to stay longer in their wet-season grazing areas in North Kordofan. Until the late 1980s they tended to move in small camps with relatively small numbers of livestock; with growing insecurity the sizes of these groups have increased.

○ **Sedentary system** includes both agronomic and livestock components and is dominated by cropping activities. Sheep are the predominant animal raised with considerable numbers of goats. The Bederia and Gawama ethnic groups are examples of this system. This system is distinguished and characterized by intensive use of areas around settlements or small favorable sites, relative immobility of residence and short growing season depending on rains (Osman et al., 2012). Under sedentary village-based production systems, goats are usually taken to nearby range lands and crop fields after crop harvest, by hired young boys and girls. The interviewed producers stated that small flocks belonging to neighboring households are collectively taken to grazing in the morning, rest under tree shade during mid hours and set to grazing until evening then taken back to spend the night in thorny enclosures “*Zaribas*” close to the village. They also stated that goats and sheep are usually set to grazing in separate flocks. Lactating goats during the dry season are reported to be kept close to huts and fed on crop residues and harvested dry range grasses.

○ **Inter-Urban systems** predominate in urban towns in North Kordofan State. Here, the system is not that different from sedentary one. Goats roam around on the streets and roads (Figure 2) and either attended or not attended and return home at evenings where they spend the nights in closed areas.



Figure 2. Inter-Urban goat production system

### 4.3 Traditional Practices and Indigenous Knowledge

Traditional practices deal with people's knowledge, skills, methods, practices and beliefs about the care of their animals. This knowledge is acquired through practical experience and has traditionally been passed down orally from generation to generation. According to the WHO, at least 80% of people in developing countries depend largely on indigenous and ethnoveterinary practices.

- **Mobility:** Pastoral and agropastoral tribes in Kordofan practice mobility as an adaptive strategy to overcome limitations of grazing, water scarcity and other constraints. This involve the actual planning of stock movement and collection and evaluation of various kinds of information relating to grazing resources, disease and water availability.

- **Disease and other problems:** Pastoralists and agopastoralists herds and flocks have been plagued by several common diseases. Small ruminants (sheep and goats) diseases are sheep pox, foot rot, mange, pneumonia and parasites. Some of the different methods used to control disease include:

- **Quarantine measures** where infected animals are usually kept in isolation to ensure that others remain healthy.

- **Sheep pox:** Fumigation with a dead Abu El Gunfud where a dead Hedgelog (porcupine; *Erethizon dorsatum*) is burned and the animals are fumigated with its smoke. This is traditionally done against sheep pox. In case of bloat, agropastoralists respond by first drenching the animal with a solution of soap and oil. If this does not help, they resort to piercing or puncturing the animal rumen with a knife to release the gases "*Trocarization*".

- **Control of biting flies through the** use the smoke of fire from animal dung to repel these flies.

- **Retained placenta,** when afterbirth tissues are not expelled within half an hour to three hours after kidding, farmers drench goats experiencing placenta retention with the juice of crushed and boiled nuts of *Voandzeia subterranean*; a herbaceous plant known locally as "*Ful Abun gawe*".

### 4.4 Goat breeds/subtypes in North Kordofan State

Classification of goat breeds in Sudan in general and North Kordofan, in particular, is still not clear as cattle. Goats in Kordofan can be classified into Nubian-Desert crosses, Desert and crosses between Desert and Mountain goats.

- **Desert-Nubian goats crosses:** Nubian goats (Syn. Shukria in eastern Sudan and Eritrea): The Nubian is one of a group of similar goats common throughout the Middle East and extending as far eastwards as India. The center of origin of this type was most likely in Iran during Assyrian times (Wilson, 1991).

Nubian goats constitute about 50% of total goats found in Sudan. They are distributed in arid and extreme arid areas but, as noted, essentially along rivers and in urban or peri-urban areas north of 12°N and westwards to E1 Obeid. Found at Northern Localities (Sodari and Gabrat el Sheikh), Kheiran area North of Bara Locality in North Kordofan and bearing different names e.g. Halabiya, Kabashiya (Plate II) (IFAD-WSRMP, 2012). Farmers in these areas stated that Nubian bucks have been brought from River Nile and Northern States long time ago.

**Physical characteristics:** Large size 70-75 cm; Weight: male 50-70 kg; female 40-60 kg. Kid weight at birth ranges from 1.98 for twin female kids to 2.6 for single male ones, with a daily growth rate of 44 g/day for female kids to 55 g/day for males up to 1 year of age (Table 5). Head small to medium, forehead prominent, profile markedly convex in males and usually so in females, depression just behind nostrils, prognathous to some degree (Figure 3). Horns when present are rather light and of medium length, simple or partially twisted backwards or divergent sweep in males; usually backward sweeping in females but some diverge. Ears long (25 cm), broad, pendulous with bottom one-third turning upwards; trail on ground when head down for feeding. Toggles, short in length, occur occasionally in both sexes. Beard is usually absent. Knot of hair on forehead common. Neck is moderately long and rather heavy. Chest is fairly deep. High withers, back long and straight. Croup well developed with tail set high, and long but well-proportioned legs. Udder is well developed and known for being high milk producer, a yield of up to 2.3 litre/day have been reported by farmers at Damira in Elkheiran area of Bara locality in North Kordofan State (IFAD-WSRMP, 2012). Color is generally black except for ears which are grey or speckled grey; other colors from light fawn (Halabiya; Figure 3) through to dark chocolate brown also occur. Coat variable in length, generally long, longer hair on front legs and especially on hindquarters and hind legs give appearance of breeches.

Table 5. average weight at birth and daily weight gains in Nubian goat kids.

Character	Average live body weight (kg)		Average daily weight gain (g)	
	Male	Female	Male	Female
Singles	2.60	2.42		
Twins	2.00	1.98		
Triplets	1.80	1.35		
Overall average	2.25	2.11		
<b>Postweaning weights:</b>				
3 months	8.10	7.00	79.00	54.00
6 months	12.80	10.40	49.00	38.00
9 months	17.60	14.00	53.00	40.00
12 months	22.3	18.00	51.00	44.00
From birth up 1 year of age			55.00	44.00

Source: Elnaeim (1979)



A Desert- Nubian goat flock near Damira (Kheiran area), west Bara



Halabiya (Kabashia) goats



Desert-Nubian goat “notice the long ears”

Figure 3. Nubian goats and crosses in North Kordofan State, Sudan

Source: Study results (Nov. 2018).

o **Desert goats: (syn. Sudanese Desert):** Origins. Savanna type, similar to West African Long-Legged. It is distributed in dry areas generally to the north of 10°N in North Kordofan State within arid and semiarid agroecological zones and represents about 17% of goat population in Sudan (IFAD-WSRMP, 2012). It is raised under pastoral and agropastoral systems by tribes such as Shanabla and Bedeiria.

**Physical characteristics:** Desert goat (Figure 4) is physically characterized by large size 65-85 cm. Weight: male 40-60 kg; female 32.7±5.22 kg. Head is fine, with flat forehead and straight or slightly dished profile. Horns are present in 95% of both sexes: large and flattened in cross-section in males, homonymous twisted, up to 35 cm long, projecting outwards or backwards; females have finer horns, curving upwards and backwards, up to 30 cm in length. Ears are medium to very long (12-20 cm), lopped. Toggles are present in 15% of both sexes. Beards are also found in both sexes, very bushy in males. Males may have a mane to the shoulders or extending the whole length of the back, mane occasionally present in females. Neck is rather short, chest shallow and often pinched. Withers are prominent (male 69-83 cm; female 65.5 cm). Back is short and straight. Croup very weak and sharply sloping with tail set low. Legs long and poorly boned. Color is variable from white to black, greys common but many mixed colors: black stripe in dark colors and grey in light colors (Wilson, 1991; IFAD-WSRMP, 2012). Coat usually short and fine except for mane. Milk yield ranges from as low as 0.125 to 0.500 liter/day (Osman et al., 2012).

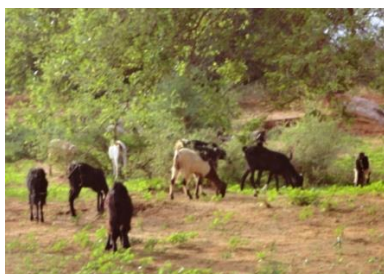


Figure 4. Sudan Desert goats (notice high color variability)

Source: Study results (Nov. 2018).

o **Desert-Tagar goat crosses:** These goats (Figure 5) have short legs and ears, grey, brown, white or mixed colors, long hair around the neck (mane and apron) represent 3% of the goat population found in Sudan well known with rapid, light movement, bred for meat only and



have a very meager milk yield for the kids, they are highly prolific. They are raised mostly by the Baggara tribes who migrate from South Kordofan to North Kordofan during the rainy season and by sedentary farmers or by those of Nubian ethnic origin in areas of Birka el Daw villages close to southern borders of North Kordofan State with northern border of South Kordofan State.



Figure 5. Desert-Tagar goat crosses

Source: Study results (Nov. 2018)

o **Foreign goats' breeds:** There are a number of exotic breeds of goat's that have been imported into the Sudan (Abulazayim, 1996). This has started since 1976. The temperate goat breeds (Figure 6) were Saanen, Toggenburg, Anglo-Nubian and Alpine which are frequently owned by individuals and/or in hands of few goat keepers in the country. They are mainly introduced to improve the local breed productivity particularly milk yield. Damascus goats and bucks have also been introduced recently by IFAD WSRMP in Kordofan in September 2009 and by the "Zakat" in 2010 to improve milk yield production.



Saanen goats

Syrian (Damascus) buck

A Toggenburger cross buck

Figure 6. Foreign goat breeds that had been introduced into Kordofan, Sudan.

Source: Study results (Nov. 2018).

## 4.5 Goats production characteristics

Desert-Nubian goat crosses breeding age is about 6 months; first kidding is about 8 months with a kidding interval of about 8 months. Desert goat puberty was at 5.87 months in males and 5.54 months in females. Mean age at first kidding was 10 months and kidding interval was 265 days (Mohammed and El-imam, 2007). Desert-Tagar goat crosses age at puberty was 7 months in males and 8 months in females. Age at first service was about 7 months in males and about 8 months in females. Age at first kidding was 13 months with kidding interval of 245 days (El-imam et. al. 2007; WSARP, 1985-90).

Overall performance of goat subtypes indicated high preweaning kid mortality rates of 10-18% and adult mortality rates in range of 10-15% (Table 6). Desert-Tagar crosses had the highest twinning rates of over 50% and Desert-Nubian had an average twinning rate of 15%. Kidding rates per annum ranged from 86.5% for Desert-Nubian crosses to over 240% for Desert-Tagar ones (Table 6).

Table 6. Some reproductive and productive characteristics of goat subtypes in North Kordofan

Parameter	Desert goat	Desert-Nubian	Desert-Tagar
Kidding interval (mo)	8-9	8	9
Age at 1 <sup>st</sup> kidding (mo)	9-11	8	11-14
Breeding age (mo)	6-7	6	9
No. kids born/breeding female	4-7	5-8	4-10
Twinning (%)	30.0	15.0	53.6
Kidding rate/annum (%)	173.6	86.8	241.0
Preweaning mortality (%)	18.0	10.0	10.0
Adult mortality (%)	10.0-15.0	10.0-12.0	10.0-15.0

**Source:** WSARP Reports (1985-90); El-imam et. al. (2007); IFAD-WSRMP (2012); Osman et al. (2012). Wilson (1991)

## 4.6 Size of Goat Holdings, flock structure and some husbandry practices

Focus group discussions were held in twelve villages in North Kordofan State covering all localities (Table 7). Total number of households in these villages was 1,478 HHs, with a range of 50-280 HHs per village. Overall percentage of HHs owning goats within these village was 70.9% of the total HHS. Overall size of goat holdings was 6 heads per HH, with a range of 3-10 goats/HH.

The majority of HH's goat flock was found to be composed of 70.0% does within the age range of 2.0-2.5 years old, does over 3 years old constituted a smaller proportion of HH goat flocks (6.0%) whereas yearlings intended for replacement purposes were found to account for 24.0% of the flock (Table 7). The majoring of goat flocks within these villages are owned by women who are responsible for their rearing, milking and different management aspects. All respondents in group discussions within these villages stated that they impose no mating control over their goat flocks, with only few breeding bucks present at the village. Number of breeding bucks per village ranged from 5-10, giving an average number of 90 does per breeding buck. Villagers stated that they usually do not retain male kids and were either sold or slaughtered immediately after weaning at three months of age. This could probably be attributed to that farmers tend to allow only few breeding bucks with a village and/or meat quality (particularly odor) changes in adult males. Despite no control over mating in village goat flocks, famers stated that the majority of kidding occur in the rainy and winter seasons. This could be justified by the fact that the majority of farmers stated that their goats depend mainly on natural grazing and browsing. Natural rangeland vegetation had their highest nutrient contents during the rainy season (El-Hag, 1992) and crop residues are accessible to grazing after crop harvest. Higher nutritious grazing resources at these times could have a flushing effect on does and prepare them for mating and conception. Attempts to alleviate dry season poor feed resources were undertaken by the NAPA project at West

Bara Locality where this project has organized women into groups and provided them with a feed mill for increasing milk production of their goat flocks during the dry season (NAPA Goat Nucleus Program Report, 2015). It is worth mentioning here that all individually interviewed farmers stated that they milk their goats once a day in the morning, except for a very few individuals who stated that they milk their goats twice a day (Table 7).

Table 7. Size of goat holdings, goats/buck, and some management practices

Parameter	Values
Total No. of villages surveyed	12
Total No. of HHs	1,478
Average No. of HHs per village	123
Total No. of HHs owning goats	1048
No. of HHs owning goats as % of total HHs	70.9%
Range of HHs per village	50-280
Total No. of goats in all villages surveyed	6,400
Average No. of Goats per HH	6
Goats range per HH	3-10
<b>Average goat flock structure:</b>	
▪ Does 3-4 years old	6.00%
▪ Does 1-2.5 years old	70.00%
▪ Yearlings female goats	24.00%
Range of No. breeding bucks per village	5-10
Average number of goats per buck	90
Range of No. goats per Buck	50-155
<b>Goat milking:</b>	
▪ Once a day	99.8%
▪ Twice a day	0.2%
Breeding season	All year round
Kidding season	Rainy and Winter
Feed resources	Natural Rangelands and crop residues

HH = Household

Source: Study focus group discussions (Nov. 2018)

#### 4.7 Reasons for Keeping Goats and breeding objectives

The interviewed farmers when mentioning their reasons for raising goats ranked their priorities as 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup>, therefore, the number of answers was larger than the number of total farmers interviewed. Overall number of farmers interviewed across all agroecological zones was 122 while the number of answers was 364. The most frequently reported purposes for keeping goat was milk production, followed by meat production and then income generation (Table 8). Over 96.0% of interviewed farmers stated that milk production was their first priority for raising goats. Income generation as a first priority came next to milk and meat as was mention by only 1.6% of the total interviewed farmers across all agroecological zones. Raising goats for milk production as a first priority reason was stated by 71.4 and 95.0% of farmers on desert and semiarid on clay zones, respectively. Farmers under semidesert and semiarid on sand agroecological zones unanimously stated that milk was their first priority reason for raising goats. Income generation and meat production as a first priority was mentioned equally by 14.3% of the interviewed farmers under the desert agroecological zone, while only 5.0% under the semiarid on clay zone



stated income generation as a first priority. Income generation as a first priority was mostly stated by men farmers.

Income generation as a second priority for raising goats was reported by over 80% of all of the interviewed farmers. Highest percentages were in semiarid on clay (95%), semiarid on sand (90.0%) and semidesert (80%) zones, whereas only 25.0% of the those under the desert agroecological zone stated income generation as a second priority reason for raising goats. Under the desert zone, meat was said to be the most important second priority reason for raising goats as stated by 58.3% of the interviewed farmers.

Third priority reasons for raising goats stated by farmers across all ecological zones were only milk and income, with income generation being minor priority under semiarid zones on clay and sand. Under these zones, sheep raising probably is the most important income generating activity than goats.

The overall results clearly indicated that milk is the most important reason for raising goats, followed by income generation and then meat. Interviewed farmers reported that whenever they need meat for household consumption, they resort to selling live goats and buy meat from butchers and reserve additional cash gained for purchasing other family needs.

Table 8. Purpose for raising goats and priorities as reported by interviewed farmers (N=364).

Rank and Purpose	Desert		Semidesert		Semiarid on sand		Semiarid on clay		Total	
As 1 <sup>st</sup> Priority:	N	%	N	%	N	%	N	%	N	%
▪ Milk	10	71.4	50	100.0	40	100.0	19	95.0	119	96.0
▪ Meat	2	14.3	0	0.0	0	0.0	0	0.0	2	1.6
▪ Income generation	2	14.3	0	0.0	0	0.0	1	5.0	3	2.7
▪ Total	14	11.3	50	40.3	40	32.3	20	16.1	124	100.0
As 2 <sup>nd</sup> Priority:										
▪ Milk	2	16.7	0	0	0	0	1	5.0	3	2.5
▪ Meat	7	58.3	10	20.0	4	10.0	0	0.0	21	17.2
▪ Income generation	3	25.0	40	80.0	36	90.0	19	95.0	98	80.3
▪ Total	12	9.8	50	41.0	40	32.8	20	16.4	122	100.0
As 3 <sup>rd</sup> Priority:										
▪ Milk	3	37.5	40	80.0	36	90.0	20	100.0	99	83.9
▪ Income generation	5	62.5	10	20.0	4	10.0	0	0.0	19	16.1
▪ Total	8	6.8	50	42.4	40	33.9	20	16.9	118	100.0

Source: Study individual farmer interviews (Nov. 2018).

#### 4.8 Threats to Goat Genetic Resources in North Kordofan State

○ **Droughts:** Drought episodes (1975, 1984/86, 1991, 2003) in Kordofan, particularly 1984, have drastically affected livestock resources in the region. In that particular year, 50% of small ruminants (goats and sheep) in north Kordofan were lost.

○ **Drought spells** (1975, 1984, 1990, 2003) have forced pastoralists to move deep into south Kordofan. This poses health hazards (flies, ticks) on these animals. In addition, it leads to mixing of different animal types (Desert goats with tagar and nilotic goats) leading to inevitable crossing.

○ **Livestock mixing** in dry and rainy seasons camping areas: A number of tribes utilize Bahr el Arab area for dry season camping. These tribes include Baggara of Kordofan (Messerya and Hawazma) and nilotic tribes of southern Sudan (Dinka, Nieur). Baggara goats are also

vulnerable to crossing with nilotic ones. This would eventually lead to evolving of new animal types and at the same time erode the original genetic material. Moreover, diseases are easily transmitted subjecting animals to health problems. At the rainy season camping areas in north Kordofan, crossing between Baggara and Desert goats (Shenbali, Hamari, Kabashi) is also probable.

◦ **Insecurity:** Civil war in southern Sudan and south Kordofan has its negative impact on livestock biodiversity in the region. This war has forced some tribes to move their animals out of the area.

◦ **Migration routes** have been blocked and transhumant tribes in Kordofan have been forced to use new routes or new areas. This has led to congestion of animals at certain locations (Map 3) leading to competition over limited grazing resources, health hazards and crossing between types.

◦ **Diseases:** Several epidemic diseases are present in the region which are responsible for considerable loss in livestock resources. In addition, drugs, vaccines and vaccination campaigns are limited.

◦ **Introductions of new breeds into the area:** Goat breeding program through introduction of foreign goat bucks e.g Saanen, Tugenburger and Damascus.

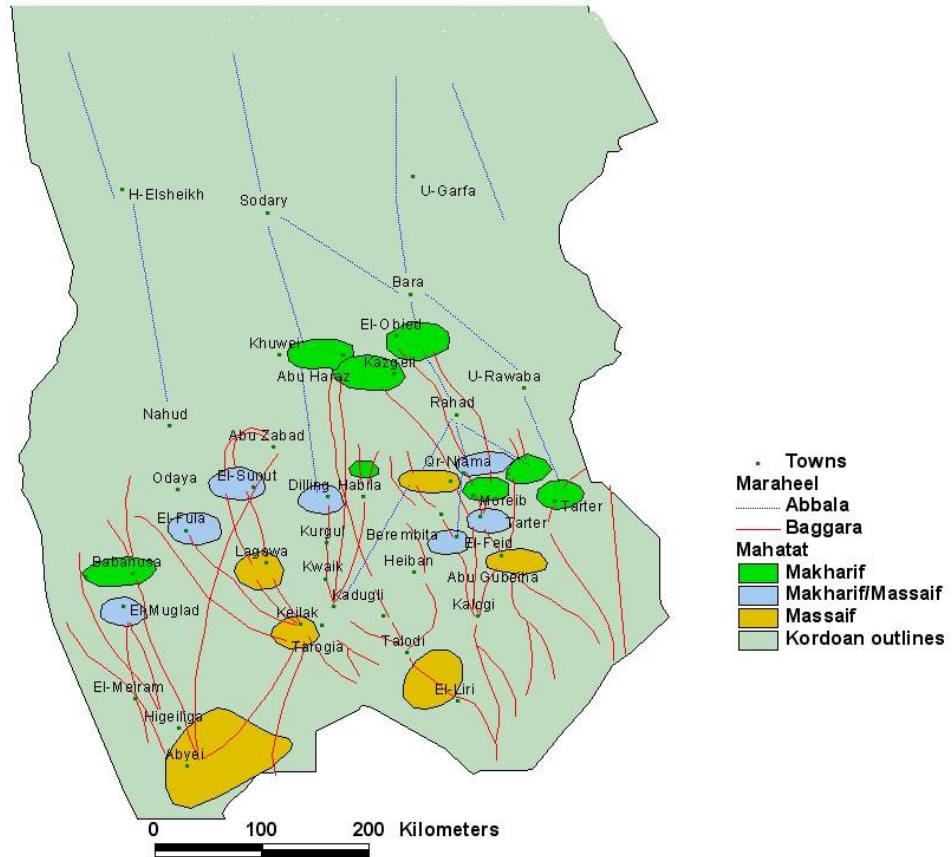
◦ **Policy and institutional threats:** One of the mandates of the Animal Resources Department in North Kordofan and the Federal State Ministry of Animal Resources (MARF) is to improve animal productivity through crossing with foreign breeds. This is particularly evident in goats where introductions and distributions to different areas in Sudan have started since 1976.

◦ NGOs (SCF, CARE, FAR) UN projects (ADS, ARS, GRRP) in Kordofan conduct development programs on animal improvement through introduction of foreign breeds (bucks in GRRP, ARS south Kordofan). CBRRP in North Kordofan also performed a restocking program to replace goats with sheep on the wrong assumption that goats are destructive to natural tree cover and enhance desert encroachment.

◦ **Lack of proper statistics on goat resources** and their wild relatives in the Sudan as a whole: The last livestock census was conducted in 1975-77. Present figures are based on growth rates which might over- or underestimate actual numbers in view of the many changes that have occurred in the region (droughts, insecurity, export).

◦ **Less attention is paid to more holistic breed improvement activities** involving the design of breeding programs, establishment and support of animal recording systems, testing of alternative animal breeds, and the involvement of local farmers and traditional breeders (breed associations).

Map 3. Pastoralists and agropastorlists migration routes and areas of livestock concentration



## 5. Way Forward

- Goats provide a biological capital for livelihoods, food security and poverty alleviation. Sustainable development planning should take into considerations the differences between and among goat subtypes and adaptational characters suited to different production environments (FAO, 2011). Further, there is a high need for genetic characterization of different goat subtype/breeds in North Kordofan and Sudan at large.
- Goat husbandry and general management practices in terms of veterinary care and feeding should be giving due considerations for improving goat productivity.
- The multipurpose nature of goats (milk, meat, cash, etc) under low-input traditional production system should be taken into considerations when attempting improvement programs.
- Producers/herders capacity building on goat farming and their involvement in the initial stages of planning is a prerequisite and participatory approaches be adopted when intending goat improvement programs. Recent formulation of producer groups for facilitation of services (microfinancing, insurance, marketing, etc.) provide a viable ground in attempting community-based goat breeding programs.

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## Annex I.

**Study Terms of Reference (ToR)**  
**Defining breeding objectives of communities in Kordofan, Sudan**  
**Consultancy contract**  
**Location: Khartoum-North Kordofan, Sudan**  
**Terms of references**

### **Background**

The International Center for Agricultural Research in the Dry Areas (ICARDA) in partnership with various institutes has been implementing Community-based breeding programs (CBBPs) in different countries in the Dry areas. In partnership with ARC- Sudan we plan to implement a goat CBBP in North Kordofan targeting women-livestock owners.

Implementation of CBBP requires, among others, description of the production system, characterization of the population and defining breeding objectives of the communities. We plan to hire a consultant to help us achieve these outputs.

Under the supervision of Dr. Mourad Rekik & Dr. Aynalem Haile

**Objective:** To describe the production system, characterization of the population and defining breeding objectives of the goat breeds and populations in North Kordofan, Sudan

**Contract period:** November 1<sup>st</sup>, 2018 to November 30, 2018 (15 working days)

**Responsibility:** The consultant is expected to: ☐ Collect data/information related to production system, characteristics of the goat breeds/populations and breeding objectives set by the communities from available documents and interviews ☐ Analyze data and write report

**Deliverables:** ☐ Deliverable 1: Submit draft report to ICARDA supervisors. The team will review the report and give feedback. ☐ Deliverable 2: Submit final report to ICARDA supervisors.

**Payment:** Daily rate of \$200 for 15 days (total \$3,000) will be paid in two installments at the submission of the draft report and at the submission of the final report.