THE BLUE NILE REGION AS APOTENTIAL FOR LIVESTOCK PRODUCTION

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DEDICATION

To my wife, brothers and my babies

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THE BLUE NILE REGION AS A POTENTIAL FOR LIVESTOCK PRODUCTION

Ph.D

Eldaw Mohammed Elhassan Ebraheim

Animal Production

Abstract

This study was carried out in the Blue Nile area in central Sudan. This area comprises Sinnar and Blue Nile states; it is situated between longitude 32˚ and 36˚East and latitude 12˚ and 14˚ North. The total area is about 79,180 square Km. The main objective of this work study was to determine the prevailing conditions of the production systems, husbandry practices , and production constrains. The Blue Nile area varies in natural resources including climate, land, water, vegetation cover and animal resources. It is more eligible and qualified for leading an enormous agricultural industrial and social revolution than other States. The study was carried out by well designed questionnaires. The questionnaire for cattle owners covered two hundred cattle owners from twenty villages scattered in the two states.. The questionnaire was designed to obtain information on general household

characteristics, livestock and herd structure, herd management, breeding

practices, prevalence, production objectives, feeding management and production constraints. Another structured questionnaire was prepared and used to collect information from a total of twenty sheep owners. On the other hand; a survey was conducted through a questionnaire and guided interviews with camel owners in selected regions in the Blue Nile area. The SPSS statistical computer software was used to analyze the data. The results were represented mainly in the form of descriptive tabular summaries. All the cattle owners were males, and most of them had

" Khalwa " education, while only few joined elementary schools. The majority of cattle owners were farmers and livestock owners, while very few were small businessmen. The results showed that the main type of farming system was extensive system then partial grazing while few of cattle owner were adopted stall feeding. This study showed that all the cattle owners uses veterinary services like vaccination and diseases treatments. The most prevalent diseases in the study region were trypanosomiasis, pneumonia, sheep box, babesiasis and heart water. On the other hand, camel owners revealed that the livestock breeding was their main activity. They breed camels with other animal species (cattle, sheep and goat). The sedentary management system was the main production system for camels in the Blue Nile area followed by a traditionally nomadic system, while transhumant system was not adopted. The camels maintained regular patterm of seasonal north-south movements in search of water and pasture and to escape the Tse Tse beet zone and other insects. Camel owners stated that the disease prevalence was the most important limiting factor of productivity of their

camels. However, Lack of feeds and water supply were important factors in the production of their camels. The study showed that the herd population is continuously increasing due to the security, extensive natural vegetation, plenty of agricultural and industrial by-products such as sorghum stover and hulls, cotton by-products, oil cakes, baggass, molasses, wheat stover and bran, guar by-products and fodder production between 2002-2006. The study also showed different markets for various livestock species, some markets specialized in sheep others in camels and cattle. From the findings, covering the period 2002 -2006, the study conclude and confirmed that the Blue Nile area has an excellent potential for investment in livestock production than other States in the Sudan.

أمكانية منطقة النيل الازرق كمورد للانتاج الحيوانى

دكتوراه

انتاج حيوانى

الضو محمد الحسن ابراهيم

المستخلص

أجريت هذه الدراسة في منطقة النيل الأزرق في وسط السودان . تقع هذه المنطقة بين خطى الطول °32 و °36 شرقا وخطى العرض °12 و °14 شمالا. تبلغ المساحة الكلية حوالى 79180 كلم مربع . هدفت الدراسة أساسا إلى تحديد الظروف السائدة في نظم الإنتاج ، والممارسات في تربية الحيوان ، ومعوقات الإنتاج . هنالك تباين في منطقة النيل الأزرق فيما يتعلق بالموارد الطبيعية (المناخ, التربة, المياه, الغطاء النباتي ، الموارد الحيوانية) وبالتالي فهي أكثر تأهيلا من الولايات الأخرى لإحداث طفرة تنموية في المجال الزراعي والصناعي و الاجتماعي . أجريت الدراسة عن طريق الاستبيان مصمم بطريقة جيدة. غطى الاستبيان مائتين من أصحاب الأبقار في حوالي 20 قرية موزعة بين الولايتين. صمم الاستبيان للحصول على معلومات عن الخصائص العامة للأسس المعيشية لملاك الحيوان، وهيكلة القطيع، وإدارة القطيع، ونظم التربية الممارسة عند الملاك، ونوع الإنتاجية، وكيفية التغذية ومعوقات الإنتاج . اعد استبيان آخر واستخدم لجمع معلومات لحوالي عشرين من ملاك الأغنام. من ناحية أخرى، أجريت دراسة استقصائية عن طريق الاستبيان والمقابلات لملاك الهجن في مناطق مختارة في منطقة النيل الأزرق. تم استخدام برنامج الكمبيوتر (SPSS) لتحليل البيانات. مثلت النتائج.على شكل جداول وصفية مختصرة. جميع أصحاب الأبقار من الرجال، وان مستواهم التعليمي لا يتعدى الخلوة والقليل منهم درس مرحلة الأساس. معظم المربيين عبارة عن مزارعين وملاك حيوان، في حين كان عدد قليل منهم رجال أعمال حرة. أظهرت النتائج إن نظام الرعي هو النظام المفتوح مع الرعي الجزئي والقليل يمارس نظام التغذية داخل الحظائر. أظهرت هذه الدراسة أن جميع أصحاب الماشية يستعملون الخدمات البيطرية كالتطعيم وعلاج الأمراض. الأمراض الأكثر انتشارا في منطقة الدراسة هي مرض النوم والالتهابات الرئوية والبول

الدموى والخدر وجدري الأغنام. من جهة أخرى كشف أصحاب الإبل إن تربية الماشية هي

نشاط اساسى لهم وأنهم يربون الإبل بالإضافة إلى الأنواع الأخرى (الأبقار والأغنام والماعز). نظام الإدارة المستقرة هو نظام الإنتاج الرئيسي للجمال في منطقة النيل الأزرق ، و تليها نظام البدوية التقليدية، وفى حين لا يمارس نظام الترحال بالمنطقة. للجمال تحركات موسمية بين الشمال والجنوب بحثا عن الماء والكلأ وهربا من الذباب وغيرها من الحشرات. وذكر أصحاب الإبل إن انتشار الأمراض هي العائق الاساسى للإنتاج بالإضافة للشح في المياه والمرعى.

أيضا أوضحت الدراسة بان هنالك زيادة ملحوظة في القطعان نسبة لوجود الاستقرار الامنى وتوفر المراعى والمخلفات الزراعية والصناعية مثل حطب الذرة ، الردة ، مخلفات القطن ، الامبازات ، البقاس ، المولاس ، حطب القمح ، مخلفات القوار، والأعلاف الخضراء خلال الفترة من 2002 وحتى 2006 . أيضا أظهرت الدراسة أسواقا مختلفة لمختلف أنواع الحيوانات ، بعضا من هذه الأسواق مخصص للأغنام والأخرى للجمال والأبقار معا . هذه النتائج والتي غطت الفترة من 2002- 2006 أكدت إن منطقة النيل الأزرق لديها إمكانات ممتازة للاستثمار في إنتاج الثروة الحيوانية من اى ولاية أخرى .

CHAPTER ONE

1- Introduction

Sudan has one of the largest livestock population numbers in Africa with 40 million heads of cattle, 50 million sheep, 42 million goats and 4 million camels (M.A.R 2006). The total livestock population in the Study area is 16 million heads of cattle, sheep, goats and camels. The Blue Nile area is agricultural area with large proportion of its population depending on their income from land. The study area is one of the largest rain fed mechanized crop farming areas in the Sudan, which started in Eldali, Elmazmom, Agadi, and El-damazeen area since 1959 beside the expansion of unplanned rain fed area. Rains fed agriculture dominate the major part of the central clay plains of Blue Nile and which of great economic potential.

The livestock in the Blue Nile are under traditional nomadic systems in which the animals move for long distances to cope with the environmental stresses imposed on them by nature. The traditional method of livestock production is based on extensive grazing system where animals depend on the natural grazing land. The role of livestock in the study area is quite complex and extends beyond their traditional uses to supply meat and milk. They are certainly multi-purpose livestock are valued for one of the following traits: capital, credit, tradition, milk, meat, hides, fuel and fertilizers and in most areas they are for social and prestigious values. In the study area livestock play a critical role in maintaining a cash flow for poor farmers who grow their crops essentially to provide food for their own household.

The high monetary value of various agricultural cash crops and the relative ease with which market could be found for them have brought considerable progress in agricultural production. But the development in livestock production has not kept pace with progress in the other fields of agriculture. This may be due to the fact that milk and meat are perishable commodities and industrial development has been very slow or absent. Livestock husbandry is the major form of land use in the study area. The people inhabiting the study area pursed a purely pastoral economy based on traditional cattle and small ruminants extensive husbandry production. However, livestock owners have become adapted to the expansion of sorghum cultivation into their grazing domains through utilizing sorghum by-products to feed those livestock.

Unfortunately, there is considerable evidence to indicate that productivity of the Blue Nile range is decreasing rather than increasing. Large grazing areas have lost their plant cover as a result of over grazing and desertification. National grazing lands are becoming scarce and more degraded every year because of extensive crop farming. Dry season pasture dose not meet the maintenance requirement of the animals and lead to loss of weight and mortality in young animals. Like most developing states, Blue Nile areas hopes to meet the challenge of economic development by improving its rich resources. The animal wealth of Blue Nile constitutes 12% of Sudan total animal wealth and form the back bone of its economy.

Majority of livestock owners are nomads with traditional attitudes towards cattle raising, so that their animals tend to be interior and low producers. Improvement is handicapped by factors like vastness of the country and the way livestock is scattered in the fly belt zone together with lack of proper feeding, hygiene, breeding and marketing facilities.

In view of such condition the only hope for improvising livestock productive efficiency in Blue Nile is through collection of data base information about animal wealth, feeding hygiene and husbandry practices on local breeds which could be used for proper planning by technical advisors, polictors, planners and decision makers for improving livestock in Blue Nile area and should analyzed and amended or changed. Extension of these improved methods to remotest corner of the area in particular can bring about rapid improvement in this filed.

This study was carried out in the Blue Nile area in central Sudan with the objective to understand the conditions of production systems and to identify breeding objective, husbandry practices and production constrains as first step towards development of sustainable livestock improvement program for better use of potentialities of livestock and natural range in Blue Nile.

CHAPTER TWO

2- Literature Review

2.1. Sudanese cattle breeds

Sudanese cattle breeds are characterized by the presence of hump dewlap and considered for the most part to have reached North Africa from Asia in small numbers before the Arab invasion and subsequently in greater numbers (Hill, 1988). These breeds may be considered mainly as milk type (Kenana and Butana) or beef type as western Baggara. The majority of Sudanese cattle breeds are kept by nomadic or semi–nomadic people.

2.1.1. Cattle types in the Sudan

2.1.1.1. Northern or Arab

The northern cattle were divided into: Kenana, Butana, White Nile and Baggara types (Payne 1970).

2.1.1.1.1 Kenana:

Found largely in their traditional areas of origin, the plains adjacent to the white and Blue Nile rivers. In an area stretching south from Khartoum to the Ethiopian border. This ecological zone is typically a low rainfall savannah area, with high temperatures and low humidity. Traditional cattle keeping in the area involve seasonal migration, through not to the extent of the true nomadism found further west in Sudan. Kenana is an important cattle breed indigenous to northern Sudan with greater potential as producer of both milk and beef (Saeed *et al* 1987*)*. Kenana cattle are considered to have resulted from inter-breeding of Sanga cattle with short horn zebu during tribal migrations before recorded history (Rouse, 1972). The characteristic colour of the Kenana is light blue-grey, with gradations from nearly white to steel grey, shading to nearly black on head, neck, hump,

hindquarters and legs. Points of (muzzle, horns, tail tip, and hooves) are black. The individual hairs are black at the base and white (or occasionally red) at the tip. Darker coat colours, and darker areas, are due to the hair having a broader black band. The calves are frequently born red and change to grey after 3or 4 months, exceptionally, the red tip remains in the adult.Kenana cattle in habitat the low rainfall savannah region (300-800mm), with a dry season from November to April. This zone hosts some large scale irrigated agricultural schemes such as Gezira scheme which extends south into this zone, in addition to El-Suki, El-Rahad and Blue Nile Agricultural Corporation.

Kenana heifers should be well nourished to reach puberty earlier so as to replace the culled cows. Both protein and energy are important in normal reproductive performance (Saeed.&Hamad. (1985). Age at first calving is of significant importance if progeny testing is to be practiced. Age at first calving was found to range from 38.4 to 44.3 months. Osman (1970) and Rizgalla (1974) reported that the onset of puberty was found to be a function of weight rather than age (Ahmed 1978). It was reported that 170 kg. is the minimum weight for Kenana heifers to show estrous (Friend *et all*, 1981).

2.1.1.1.2 Butana:

Found in Butana area between the river Nile, Atbara River and the Blue Nile in the semi-arid zone. They are characterized by large hump and dewlap with bright red coat colour and black colour around the mouth and eyes.

2.1.1.1.3 Baggara cattle or western Sudan zebu cattle:

Found in the savannah regions between White Nile, Bahr EL Arab River and the western frontiers of the Sudan. They have no special characteristic coat colour, some are white with red or black markings and the majority are dark colour. The Baggara has the smallest hump, often cervico-

thoracic position in males. They are considered as the main source of beef for local consumption and contribute considerable to the export trade of beef.

2.1.1.1.4 White Nile:

Maybe white, red, black, fawn, and admixture of these colours (Hill, 1988).

2.1.1.2. Southern or Nilotic cattle:

These are groups of Sanga bred by Nilotic tribes in southern Sudan, white and cream coat colours characterize. Then, the horns are crescent or lyre-shaped and often very large and the hump is cervico- thoracic (Payne, 1970). They are considered as poor milk producers and average meat producers

2.1.1.3. Nuba mountain cattle:

These are found in Nuba Mountain in southern Kordofan. They have short broad heads and their horns are short but very variable in form, being lateral, straight or lyre- shaped. The hump is also very variable in size but is said to be thoracic in position and they possess a very well developed dewlap (Mason and Maule, 1960).

2.2 Small Ruminants:

Small ruminants fit well to arid and semi-arid ecological zones. The small size, low individual cost, rapid turnover, ability to adapt and the conversion of feed resources not eaten by man or other animals are distinct advantages of small ruminants husbandry. Despite these advantages, resource allocation and research on increasing food production from small ruminants has been quite inadequate in the Sudan in the arid and semi-arid areas in particular.

Sheep and goats in the Sudan were estimated to be 16.2 and 12.7 million heads respectively. Increasing at an annual rate of approximately 2.5 % (A.O.A.D,1982). This large number of small ruminants has customarily been maintained on feedstuffs that come from four main sources: (1) Natural rangeland grazing, which is of great importance across the majority of all ecological zones of the country, (2) Irrigated fodder crops, (3) Cereal grains and (4) Agro- industrial by-products.

2.2.1 Sheep:

There are four types of Sudanese sheep Desert, Nilotic, Arid Upland, and Equatorial Upland and including seventeen breeds (El-Hag 2001; 2006). Sudan Desert sheep comprise more than 65 percent of the total sheep in Sudan and nearly 100 percent of Sudanese sheep exports (El-Hag *et al* 2001; Mufarrih 1991). According to The ARSC (2003) reports there were 48.4 million sheep in Sudan (ARSC, 2004), up from 18 million in 1987 (Majok and Schwabe 1996). Nomads, transhumants, and sedentary farmers breed sheep to produce meat, milk, and to a lesser extent skins (Abdelgadir *et al* 1998). Sudan exports live sheep and sheep meat only to Saudi Arabia, with small amounts also exported to other Arab countries such as Libya, United Arab Emirates, and Jordan (ARSC, 2004). Although statistics for milk production are unreliable and vary widely. In 1996 the Ministry of Animal Resources estimated total milk production from sheep at 650,000 tons, or roughly 9 percent of Sudanese total milk production (Abdelgadir *et al* 1998).

2.2.1.1 Watish Sheep

These are ecotype of the desert sheep. Watish sheep has the ability to live in places of heavy clay soils. It is geographical distribution, mainly the banks of the Blue Nile.

2.2.1.1.1 Characteristics: The Watish sheep has a solid white coat color. Other multi coloured coat is presents (white with red).

2.2.1.1.2 Body measurements: The height at wither of the Watish is about 27-35 inches, heart girth is 29-32 inches while the body length is 19-24 inches and the tail length is 17-21 inches.

2.2.1.1.3 Breeding: Watish sheep have two seasons of breeding, the first is uncontrolled breeding known locally as (Bahlla). The other season is characterized by lambing throughout the year and this type require high sound nutrition. The age at first mating of the Watish is about 13 month of age, gestation period is 150 days, and lambing interval is about 210 days, while the average age at first lambing of the Watish ewe is 18 month (MAFNR, 1974).

2.2.1.2 Watish lambs:

Watish lambs were well documented by Ahmed *et al* (1979).They found that Watish lambs weaned at about four months of age, well grow adequately when grazed berseem, with or without the use of a concentrate supplement. The corresponding average daily gains value found by Pollott and Ahmed (1978) for Watish lambs weaned at four months of age on all concentrate diet were 148 and 108g. On the other hand, energy may be a limiting factor on growth when lambs are grazed berseem, although protein content appears to be adequate.

In lamb management two factors have an important effect on pre weaning lamb growth namely time of birth and the way that the lambs are managed, (Pollott& Ahmed 1979). The largest influence on pre weaning growth rate in the traditionally managed groups was probably by way of ewes milk supply.

Sending lambs to graze with their dams during the day improve lamb growth rates. Further improvements of lamb growth may be achieved by

giving additional feed to lambs at night. Natural grasses growing during the rainy-season are adequate to promote lamb growth in young watish lambs. However the poor quality of the material grazed probably has a limiting effect on growth *since* a comparable group of lambs, grazed on berseem, grew quicker (Pollott *et all* 1978).

The use of a fattening period after prolonged natural grazing led to higher weight gains than were found at grazing but which were similar to those from lambs grazing berseem. The alternatives to concentrate feeding may provide a cheaper means of improving lamb growth from such rain –fed system. The use of molasses is well known in this role, in other countries, a means of improving the utilization of roughage more effectively.

2.2.2 Goats:

Goats are important source of milk and meat in Sudan. The ARSC reports that in 2003, the goat population of Sudan was 42 million (ARSC 2004), up from 13 million in 1987 (Majok and Schwabe 1996). There are 11 breeds of goat in Sudan (Sudan 2006), the most common being Sudan Desert and Nubian goats. The Nubian goat is the only specialized milk breed (Kamal et al 2005). Three exotic breeds of goat (Saanen. Toggenburge, and Anglo-Nubian) were imported to Sudan in 1976 to improve the milk production of local breeds (Kamal 2005).

Goats are important socially and economically. Goats are important source of meat and milk, especially for poor families. Goats may also be used as a form of currency, for example as a bride price or payment of a debt. Goats are most commonly kept by sedentary farmers and families in Urban and peri-urban and peri-urban area, although some nomads and transhumants also keep them (Fadlalla and Ahmed 1997). Goat milk and meat is mainly consumed domestically, although goat skins are a growing

export: nearly 3 million goat skins were reportedly exported in 2003 (ARSC 2004).

2.2.2.1 Sudanese Nubian goats:

Conformation of Nubian goats is that head is small to medium, forehead prominent, profile markedly convex in males and usually so in females, depression just behind nostrils, prognathus to some degree. Horns when present rather light and of medium length, in male simple or partially twisted backwards or divergent sweep, in females backward sweeping, some diverge. Ears are long (25 cm), broad, pendulous. Wattles occur occasional in both sexes. The neck is moderately long and rather heavy. Chest fairly deep, high withers, long and straight back. Udder well developed. Color generally black except for ears which are grey or speckled grey; other colors from light fawn to dark chocolate brown also occur. The coat variable in length generally longer, hair on front legs and especially on hind quarters (Kiwuwa, 1986).

2.2.2.2 Sudanese Desert goats:

Conformation: Chest is shallow and often pinched. Back is short and straight. The head is fine, with a flat forehead and a straight or slightly dished profile. Horns are up to 35 cm long and bend outwards or backwards. Ears are medium to long (12-20 cm) and lop. Wattles occur in 15% of both sexes. Also, males may have amine on the shoulders or extending the whole length of the back. Mane is occasionally present in females. Except for the mane, coat is usually short and fine. Color is variable from white to black, grey is common but many mixed colors occur (Kiwuwa, 1986).

2.3 Camels:

There are five breeds of camels (camelus dromedaries) in Sudan. (Sudan 2006). The ARSC reported that in 2003 there were 3.5 million camels in Sudan (ARSC 2004), up from 2.7 million camels in 1987 (Majok and Sckhwabe 1996). Camels are generally found in the desert and semi-desert regions between latitudes 12 and 16 N°; most of the camels are located in the Darfur, Kordofan, and Eastern Sudan. Camels are also used to transport people and packs, and to a lesser degree for herding, draught, and oil milling (cf. Wilson, 1978).

2.3.1 Camel management:

Management is concerned with principal factors, which have direct effect on production and reproduction. According to Gihad (1995) the management systems of camel depend on factors including: composition and size of the herd, environmental conditions, and the degree of reliance of herders on their camels Abdel-Rahim and Al-Nazeir (1990) reported that poor management and lack of feeding supplements during the breeding season are the main causes of unsatisfactory reproductive performance.

Table (1): Estimate of livestock population by states2002

State	Cattle	Sheep	Goats	Camels	Total
North Kordofan	560602	3870134	2240190	631304	7302230
South Kordofan	2495073	1939881	1804598	169774	6409326
West Kordofan	3272809	3740167	1991280	429113	9433369
North Darfour	647456	3475419	2758752	414408	7296035
South Darfour	3967640	3552437	2862465	78203	10460745
West Darfour	3813671	3610200	3360285	299443	11083599
Elgedarif	975131	1963949	1008086	173116	4120282
Kassala	398738	904957	1178174	450167	2932036
Red sea	63166	336952	684502	234274	1318894
Blue Nile	3884734	4621056	3335394	149722	11990906
Sennar	1488358	1270790	1144986	81879	3986013
Elgezira	2254251	2286460	1626212	86558	6253481
White Nile	3288601	2334596	2227745	24730	7875672
Northern	315832	904957	1095204	34422	2350415
River Nile	94750	953093	1149134	80208	2277185
Khartoum	225030	409156	613978	4679	1252843
North upper Nile	983027	640209	439741	0	2062977
Unity	1180422	1487402	1754816	0	4422640
Gongoli	1464671	1400758	1207213	0	4072642
N. Bahr Elgazal	1579160	1285231	1630361	0	4494752
W.Bahr Elgazal	1247536	1164890	1120095	0	3532521
Albohairat	1310703	1232282	1464420	0	4007405
Warab	1527837	1290045	1369005	0	4186887
Bahr Elgabal	876434	1265977	1153283	0	3295694
E.Equatoria	888278	1025297	1132541	0	3046116
W. Equatoria	675090	1169705	1132540	0	2977335
Total	39479000	48136000	41485000	3342000	132442000

Source: Ministry of Animal Resources & Fisheries

Table (2): Estimate of livestock population by states2003

State	Cattle	Sheep	Goats	Camels	Total
North Kordofan	563300	3894576	2269620	661717	7389213
South Kordofan	2507081	1952132	1828305	177952	6465470
West Kordofan	3288560	3763788	2017440	449785	9519573
North Darfour	650572	3497368	2794995	434372	7377307
South Darfour	3986735	3574872	2900070	81970	10543647
West Darfour	3832025	3633000	3404430	313869	11183324
Elgedarif	979824	1976352	1021329	181455	4158960
Kassala	400657	910672	1193652	471854	2976835
Red sea	63470	339080	693495	245560	1341605
Blue Nile	3903430	4650240	3379212	156935	12089817
Sennar	1495521	1278816	1160028	85824	4020189
Elgezira	2265100	2300900	1647576	90728	6304304
White Nile	3304428	2349340	2257011	25922	7936701
Northern	317352	910672	1109592	36081	2373697
River Nile	95206	959112	1164231	84072	2302621
Khartoum	226113	411740	622044	4904	1264801
North upper Nile	987758	644252	45518	0	2077528
Unity	1186103	1496796	1777869	0	4460768
Gongoli	1471720	1409604	1223073	0	4104397
N. Bahr Elgazal	1586760	1293348	1651779	0	4531887
W.Bahr Elgazal	1253540	1172248	1134810	0	3560598
Albohairat	1317011	1240064	1483659	0	4040734
Warab	1535190	1298192	1386990	0	4220372
Bahr Elgabal	880652	1273972	1168434	0	3323058
E.Equatoria	892552	1031772	1147419	0	3071743
W. Equatoria	678340	1177092	1147419	0	3002851
Total	39669000	48440000	42030000	3503000	133642000

Source: Ministry of Animal Resources & Fisheries

Table (3): Estimate of livestock population by states2004

State	Cattle	Sheep	Goats	Camels	Total
North Kordofan	564592	3932364	2277666	703464	7478086
South Kordofan	2512832	1971073	1834787	189179	6507871
West Kordofan	3296104	3800307	2024592	478162	9599165
North Darfour	652064	3531302	2804904	461776	7450046
South Darfour	3995880	3609558	2910351	87142	10602931
West Darfour	3840816	3668250	3416499	333670	11259235
Elgedarif	982072	1995528	1024950	192903	4195453
Kassala	401576	919508	1197884	501623	3020591
Red sea	63616	342370	695953	261052	1362991
Blue Nile	3912384	4695360	3391192	166835	12165771
Sennar	1498952	1291224	1164140	91238	4045554
Elgezira	2270296	2323225	1653417	96452	6343390
White Nile	3312008	2372135	2265012	27558	7976713
Northern	318080	919508	113526	38357	2389471
River Nile	95424	968418	1168358	89375	2321575
Khartoum	226632	415735	624249	5214	1271830
North upper Nile	990024	650503	447097	0	2087624
Unity	1188824	1511319	1784171	0	4484314
Gongoli	1475096	1423281	1227409	0	4125786
N. Bahr Elgazal	1590400	1305897	1657635	0	4553932
W.Bahr Elgazal	1256416	1183622	1138833	0	3578871
Albohairat	1320032	1252096	1488919	0	4061047
Warab	1538712	1310788	1391907	0	4241407
Bahr Elgabal	882672	1286333	1172576	0	3341581
E.Equatoria	894600	1041783	1151487	0	3087870
W. Equatoria	679896	1188513	1151486	0	3019895
Total	39760000	48910000	42179000	3724000	134573000

Source: Ministry of Animal Resources & Fisheries

Table (4): Estimate of livestock population by states2005

State	Cattle	Sheep	Goats	Camels	Total
North Kordofan	573155	4003679	2296404	738221	7611459
South Kordofan	2550942	2006819	1849881	198526	6606168
West Kordofan	3346093	3869227	2041248	501787	9758355
North Darfour	661953	3595343	2827979	484592	7569867
South Darfour	4056482	3675019	2934294	91447	10757242
West Darfour	3899066	3734775	3444606	350157	11428604
Elgedarif	996966	2031718	1033382	202434	4264500
Kassala	407666	936184	1207738	526408	3077996
Red sea	64581	348579	701679	273951	1388790
Blue Nile	3971719	4780512	3419090	175079	12346400
Sennar	1521685	1314641	1173718	95746	4105790
Elgezira	2304727	2365357	1667019	101217	6438320
White Nile	3362238	2415154	2283646	28919	8089957
Northern	322904	936184	1122686	40253	2422027
River Nile	96871	985981	1177970	93792	2354614
Khartoum	230069	423274	629385	5471	1288199
North upper Nile	1005039	662300	450776	0	2118115
Unity	1206854	1538727	1798850	0	4544431
Gongoli	1497467	1449093	1237506	0	4184066
N. Bahr Elgazal	1614520	1329580	1671272	0	4615372
W.Bahr Elgazal	1275471	1205087	1148202	0	3628760
Albohairat	1340052	1274803	1501168	0	4116023
Warab	1562048	1334560	1403358	0	4299966
Bahr Elgabal	896057	1309661	1182223	0	3387941
E.Equatoria	908168	1060676	1160960	0	3129804
W. Equatoria	690207	1210067	1160960	0	3061234
Total	40363000	49797000	42526000	3908000	136594000

Source: Ministry of Animal Resources & Fisheries

Table (5): Estimate of livestock population by states2006

State	Cattle	Sheep	Goats	Camels	Total
North Kordofan	582115	4051356	2308824	770334	7712629
South Kordofan	2590821	2030717	1859886	207162	6688586
West Kordofan	3398403	3915303	2052288	523615	9889609
North Darfour	672302	3638158	2843274	505672	7659406
South Darfour	4119897	3718782	2950164	95425	10884268
West Darfour	3960020	3779250	3463236	365389	11567895
Elgedarif	1012552	2055912	1038971	211241	4318676
Kassala	414039	947332	1214270	549307	3124948
Red sea	65590	352730	705474	285868	1409662
Blue Nile	4033810	4837440	3437582	182695	12491527
Sennar	1545474	1330296	1180066	99911	4155747
Elgezira	2340757	2393525	1676035	105620	6515937
White Nile	3414800	2443915	2295997	30177	8184889
Northern	327952	947332	1128758	42003	2446045
River Nile	98386	997722	1184341	97872	2378321
Khartoum	233666	428315	632789	5709	1300479
North upper Nile	1020751	670187	453214	0	2144152
Unity	1225721	1557051	1808579	0	4591351
Gongoli	1520877	1466349	1244199	0	4231425
N. Bahr Elgazal	1639760	1345413	1680311	0	4665484
W.Bahr Elgazal	1295410	1219438	1154412	0	3669260
Albohairat	1361000	1289984	1509287	0	4160271
Warab	1586468	1350452	1410948	0	4347868
Bahr Elgabal	910067	1325257	1188617	0	3423941
E.Equatoria	922365	1073307	1167239	0	3162911
W. Equatoria	700997	1224477	1167239	0	3092713
Total	40994000	50390000	42756000	4078000	138218000

Source: Ministry of Animal Resources & Fisheries

Table (6): Estimates of Animal Products (000)T 2002-2006

Year	Red Meat	Milk	Fish	Poultry Meat	Eggs	Hides&Skins
2002	1628	7298	60	18	22	60.2
2003	1663	7387	58	20	25	64.5
2004	1672	7405	63	22	28	69.4
2005	1694	7534	65	24	30	70.8
2006	1721	7649	57	18	20	73.1

Source: Ministry of Animal Resources & Fisheries

Table (7): numbers of slaughtered and local consumption of meat during 2002 - 2006

Year	No. of Slaughtered Animal (000)H					Local Consumption(000)T				
	Cattle	Sheep	Goats	Camels	Total	Cattle	Sheep	Goats	Camels	Total
2002	5968	14041	14486	126	34621	746	154	116	19	1035
2003	4767	18495	16042	200	39504	858	222	128	46	1254
2004	5799	18738	16071	227	40835	860	225	129	35	1249
2005	5860	19655	16432	242	42189	863	236	131	37	1267
2006	5909	20239	16741	282	43171	863	243	134	43	1283

Souece: Ministry of Animal Resources & Fisheries

2.4 Livestock production system in Sudan:

2.4.1 Ruminant production systems in the Sudan:

Nur (2003) characterized the production of ruminants in Sudan into traditional systems, which includes pastoral nomadism, semi-nomadic pastoralism and agro pastoral systems.

2.4.1.1 Traditonal type:

This type is characterized by low ratio of livestock to land and is based on grazing, low inputs, low labour and management requirements per unit area (Nur, 2003). It is considered the most common system upon which more than 80% of livestock owners are dependent. It can be divided into three systems: pastoral, agro-pastoral and agricultural systems (Wilson, 1991). Ranching and commercial herding on natural pastures are systems which are both grazing based systems (Darag, 1994, Nur, 2003) and can be classified under traditional type. This system is dominant in the geographical zone between 13◦N to 16◦N (Northern part of the camel belt) (Al-Khouri and Majid, 2000). This is typically practiced by the Kababish tribe in Northern Kordofan State. The camel herders are continuously on the move in response to availability of grazing and water supplies.

2.4.1.1.1 Pastoral system:

Two major sub- systems within this system can be divided (Wilson, 1991):

2.4.1.1.2 Pure pastoral system:

In this system, little or no agriculture is practiced and the mobility is often high. Usually this system associated with the arid zone (less than 600 mm rainfall per year).

2.4.2 Semi-nomadic pastoral system:

In this sub- system livestock production is associated with dry land or rain fed agriculture. It is a pattern of herding where young people tackles livestock movement in search of pasture and water, while the rest of the family maintains the household sedentary activities e.g. subsistence cultivation. This system is found in eastern and southern regions of the camel belt and is practiced by semi-nomadic tribes (Al-Khouri and Majid, 2000). In this system a degree of settlement is experienced during the rainy season where rain-fed agriculture is practiced for stable food production and the crop residues provide feed supplement for camel populations (Bakheit, 1999). Tribes in Eastern Sudan practice a transhumant mode of range utilization (Abbas *et al.* 1992). They move from one area to another following certain migratory routes. The Rashaida spend the rainy season (July - October) around Kassala and move about 400 Km to spend the dry season (March - June) in the southern fringes of their traditional zone in Doka area. Members of the Shukria, Lahaween and Kawahla tribes stay in Butana plains during the rainy season, either to the south (Gadaref) or to the southeast along the Atbra River course (Agab and Abbas, 1993).

2.4.3 Agro- pastoral system:

In This system, livestock are usually sedentary and movement is restricted to short distances. Animal production is dependent on both livestock and cultivation. Example of this system are, the Nilotic tribes of the high rainfall savannah sub-humid southern Sudan, and Butana tribes in central eastern Sudan. This system is practiced in the eastern region of Sudan (east of River Nile and west of the Red Sea hills). It is also practiced in the agricultural areas in the central and southern parts of the camel belt (Al-Khouri and Majid, 2000). Bakheit (1999) stated that an intensive system

of production exists but it is limited in importance compared with these racing and dairy camels.

The three camel production systems: nomadic, transhumant and sedentary are also found in Pakistan (Aujla *et al*., 1998). Camel production systems in Sudan are interchangeable depending on conditions in the particular season and location. Camel owners can change from one system to another in response to financial, labor, climate, and investments factors.

2.4.4 Agricultural system:

It is a traditional village-based system usually associated with large irrigated areas. A few head of goats, sheep or cattle may be kept, with goats generally being more common than other types of livestock. Grazing of range, fallow land and along irrigation canals plus house waste and crop residues are the main sources of feed.

2.4.5 Ranching and commercial herding on natural pastures:

a- Commercial ranching: The government policy states that land can be based but not owned. As a result, the ranches that existed in Sudan were government initiatives. The experience of group ranching initiated by the Rural Development Department (Ministry of Agriculture) in Kordofan and the western Savannah Development scheme which was initiated with the intention to settle the nomadic tribes in Southern Darfur, both had very little success.

b- Commercial herding on natural pasture: In this system, commercial herds e.g. Sheep have the opportunity to graze natural pastures on a year round basis because water can be transported by tankers or supplied by other means to meet the dry season requirements.

2.4.6 Mixed crop- livestock system:

Darrag et al (1995) noted that the introduction of livestock into the crop rotations of the Gezira, (the largest irrigated agriculture scheme in Sudan,) has been attempted with the objectives of improving the socio-economic conditions of livestock keepers and to ensure adequate supply of neighbouring towns with milk , milk products and other animal products. Integration of livestock into farming systems in the major irrigated schemes of Rahad and New Halfa was also attempted with varying degree of success. In these schemes animals are transferred in groups to grazing areas during the wet season and brought back to feed agro-industrial by-products during the dry season.

2.5 Herd structure and herd composition:

Butana and Kenana herd size and composition were studied by Musa *et al* (2006). Mean herd size for Butana and Kenana were 17.42 + 2.42 and 23.13 +23.13 + 5.73, respectively. . Saeed *et al* (1987) studied the herd structure of Kenana cattle at Umbanein experimental stations with the following result 181cows, 42 heifers (3-4 years), 46 heifers (2-3 years) , 50 heifers (1-2 years), 101 calves and replacement bulls. Badi (1988) studied 102 herds in Barakat area in Gazira and revealed that the typical herd structure was: 59.0 % cows, 17.9 % dry heifers, 11.1 % heifer calves, 9.5 % bull calves and 2.5 % bulls. He also found that milking cows represented only 20.5 % of the total cows in the herd.

2.6 Feed resources and feeding system:

2.6.1 Feed and feed resources:

Natural range, crop residues, processed feed, and green fodder are different sources of feed in Sudan. Multi-purpose trees and shrubs, which are

utilizing within farming areas and rangeland, provide dry season feed and supplement. The dry grass with nutrition browses and pods.

Agro- industrial by- product including molasses, oil seed cake(cotton, ground nut, sesame , sunflower), grains and by –product of cereal milling plants, sugar factories and large crop production schemes. Likewise, crop residues, which are available from irrigation as well as rain fed areas, constitute the strategic source of feed for livestock during the dry season. These include cereal straw and stover (wheat, sorghum, millet, maize), cereal stubble, legume haulms (groundnut, cowpea, lablab) sugar cane tops and baggass.

Table (8): The total rain fed production of Durra in the Blue Nile State 2003-2006

Years	Land available(Fedan)	Cultivated area(Fedan)	Yield(Tons)
2003	651980	316793	71278
2004	805167	684486	184811
2005	655515	442472	125043
2006	683864	607691	240646
Total	2796526	2051442	621778

Source: The Blue Nile Ministry of agriculture& Animal resources2007.

2.6.2 Feeding systems:

2.6.2.1 Free grazing feeding system:

Free grazing of commercial rangeland is the most common feeding system in the Sudan. Where as pasture is well available during the wet season, it decline in both quantity and quality to the extent that it fails to satisfy the minimum requirements of the grazing animals.

2.6.2.2 The cut-and-carry feeding system:

Large commercial dairy farms produce irrigated fodder crops such as sorghum, alfalfa to feed dairy herds, while a good part of the production is sold in the local markets.

2.6.2.3 Stall feeding:

This system is practiced mainly in commercial dairies, poultry and fattening operations. Cecilia Kulneff (2006) noted that feed is served in iron troughs along the sides outside the pens mostly in modern dairies and inside pens in traditional management dairy farms. Lactating cows are given more concentrate than dry cows. Additional meal of concentrate can be given to lactating cows in milking parlour during milking times. Dry cows are fed dry straw alone, or with some concentrates but of a different composition. Usually, sorghum straw is fed two times a day in big troughs scattered around the pen or spread on the ground. Eldierani (1986) reported that sorghum grain, crop residues and agro-industrial by-products are used in finishing beef cattle and sheep in feedlot in Sudan.

2.7 Grasses, herbs and trees for animal feeding.

2.7.1 Grass:

Forages can be classified into two main groups (Longuo et al., 1989) as (1) epherneral annual plants which germinate and remain green for only a few weeks after rain and (2) perennial shrubs are characterized by a slow vegetative cycle, with a growing period from March to June and are present all year. The ability of native grasses in tropical rangelands to support cattle growth is constrained by their content of N and P (Norton, 1994).

In small- holder farming system, native forages and agriculture by-products are the main sources for ruminant feeds. The potential of any feed to support animal production depends on the quantity consumed by the

animal and the extent to which the feed meets energy, protein, mineral and vitamin requirements (Minson 1990). The use of pasture as a primary source of energy in the diet of dairy cows is potentially economically advantageous in Sudan. However, one of the challenges in tropical countries, or anywhere else in optimizing the nutrition of dairy cows under grazing is to know to what extent fresh grass can meet the energy requirements of dairy cows. Cattle consuming poor-quality forage generally respond positively to supplemental ruminally degradable protein (RDP), typically as a result of improvements in forage intake and digestion (Koster et al., 1996; Olson et al., 1999; Mathis et al., 2000). Forage supplements have enormous potential for ruminant production in the tropics because of their easy availability in the farms; high nutritive value and reduced feeding cost. Of the forage supplements used, legumes have been particularly advantageous. Elephant grass (Pennisetum Purpureum), also know as Napier grass, is native to tropical Africa, but has been grown in many other tropical countries around the world. It is mainly suited to coastal climates with an annual rainfall of over 1000mm. but has been grown successfully in frost-free sub-coastal conditions. Elephant grass is a cane-like grass with thick, strong stems which may reach a height of 4.5m. The main growing period is in the summer, when the temperature and humidity are high (Frank Sauers and Sons, 1992).

2.7.2 Trees and Tree Shrubs for animal feeding:

The use of browse species as fodder for ruminant is increasingly becoming important in many parts of the tropics. Generally, tree fodder is richer in crude protein (cp), Minerals and digestible nutrients than grasses (Devendra, 1990; Topps, 1992). The use of tree legume fodder as supplement has improved intake, digestibility and animal performance (Norton, 1994; Abdulrazak *et al*., 1996). In Kenya, there is limited

information on the nutritive value of tree shrubs fed to livestock (Abdulrazak, 1995). Moreover, studies on native tree species are limited than those of the introduced tree species like Leucaena, Gliricidia, Calliandra and Sesbania. The recent infestation of Leucaena Leucocephala by the pest heteropsylla cubana (Reynolds and Bimbuzi, 1993) and the low palatability of Gliricidia sepium (Abdulrazak, 1995) suggest the importance of screening other browses for further use in farming system. Acacia trees dominate in many parts of the arid and semi arid areas of Sub-Saharan Africa, and have multiple uses. They provide food, medicine, fodder a side from being resistant to diseases and the harsh climatic conditions (Le Houerou, 1980). The presence of phenolic compounds in acacia species has a negative effect on their nutritional value and also on their intake by livestock (Degen et al., 1998). Tannins have been attributed to be one of the major causes of their limited use as livestock fodder (Makkar, 1993). Generally, tannins in fodder tree are known to have a negative effect on intake and digestibility (Kumar and D Mello, 1995). Studies on some acacias have shown them to have either appositive (Ben Salem *et al*., 1999) or a negative effect (Degen *et al*., 1998) on animal performance.

2.8 Agricultural and Agro-industrial by-products:

2.8.1 Sugar cane tops (SCT):

Sugar cane tops constitute a major byproducts of the sugar industry which is often left in the field unutilized after harvest. The sugar cane tops consist of 3 distinct parts: the green leaves (blades) the leaf a heath bundle and a variable amount of immature (Buivan *et al*., 2000). They are available in abundance as one hectare of sugar cane yields 30 tons (Preston 1991). The yield of tops varies considerably with variety, age at harvest, growing conditions and management practices (Ngugen *et al.,* 1997).

Sugar cane tops burned or not were used mainly as feed for livestock (Mann and Buchanan, 1992) and also can be converted into good quality silage (Ranjhan, 1993); however in feeding sugar cane tops a little supplement of protein is necessary.

In all sugar producing countries there is a great potential of feed stuffs, available in the form of cane tops, baggasse and molasses which could feed millions of livestock in these countries leading to cut down of feed imports and increase of meat and milk production particularly in developing countries. in Sudan the annual yield of sugar cane tops was found to be about 1035.000 tons (Norman Elli, 1982), this amount has multiplied now as a result of the great extension of the cane fields especially in Kenana sugar company.

Sugar cane tops are by-products making up to 18-205 of the total biomass of the plant and have been widely studied as a basal diet for fatting and milking cattle (Ferreior and Preston 1976 and Chenost and Sansoucy, 1991). Sugar cane tops were a more economical basal diet for lactating goats than guinea grass and supported slightly higher milk production and growth in the kids (Nguggen *et al*., 1997). Similarly Dinhvan Binh and Preston, (1995) found that there was a tendency for milk production to be higher on basal diets of sugar cane tops than on guinea grass and feed costs were least on the diet of sugar cane tops.

Cantner (1987) reported that sugar cane tops had 6.3% CP and 35% CF, therefore it was considered as crude fiber rich waste products. Few reports, where sugar cane tops have been fed alone to ruminants, showed that sugar cane tops was a highly palatable forage with good voluntary consumption indices and when fed, the animal either lose condition or just maintain themselves or at best have very low levels of production (Naseeven, (1988).

A part from the judicious use of appropriate supplements with SCT rations, attempts have been made to treat SCT for improving its nutritive value especially with alkali (Perston and Willis, 1974). However, the advantage of the urea treatment is an increase in the crude protein content to levels optimal for microbial degradation (Naseeven, 1988). Physical treatment carried out by chopping, Ferreiro and Preston (1977) found that fine chopping of SCT decreased the voluntary intake while coarse chopping 5-15 cm significantly increases it. This aspect could be important in the design for better chopping equipments and improvement of feed intake.

Many studies on the utilization of whole sugar cane as animal feed, especially for cattle, have been done in many countries (Perston and Leny, 1976; Perston, 1995). The sugar cane which is probably the most productive crop in the tropics can be used as the basis of intensive animal production system (Perston, 1995). The three possibilities for using this crop are: in the form of by product after extraction of the sugar, as integral whole sugar cane and by fractionation into different end products without extraction of sugar. The sugar cane is widely used directly and indirectly as animal feed (Hudson, 1991). The plant is the most efficient as far as storing food energy is concerned, because sugar cane may be harvested as it is needed for feed, and by chopping the whole sugar cane finely, it practically all become edible as feed. Being rich in sucrose content, sugar cane has very energy value compared to cultivated grasses (Baconawa, 1988). The intake was 1.02% of live weight and rate of rumen empty was 0.9% per h, when used ad libitum with urea = (2.5 kg) minerals for milk production (Gonzalez *et al*., 1990). While Gonzalez *et al*., (1991) found that the DM intake was 1.19, 2.02 and 2.09 kg/100kg live weight for sugar cane forage and 3 levels of nitrogen supplements.

2.8.2 Sugar cane leaves:

According to Gohi (1993) the fresh sugar cane decreases account for 10 -12% of the total sugar cane biomass. The sugar cane leaves have high crude fiber content (40 -42 % of dry matter), but are also rich in soluble carbohydrates (Buivan, *et al.,* 2000) there for, they are potential feed resources for ruminants in the dry season.

Table (9): West Sinnar Factory by- products production: 2005-2007

Years	2005	2006	2007
Area harvested(Fedans)	22518	22848	28839
Cane crushed (Tons)	894168.52	941281.47	871447.47
Molasses (Tons)	23606	23155.5	25615
Baggasse (Tons)	360618	379618.8	419940

Source: West Sinnar Factory 2005-2007.

2.9 Oil seeds crops:

Oilseeds belong to the family legumes. They are mainly cultivated for their seeds compared to cereals, oil seeds are relatively rich in protein (20-30 %) Giri *et al*., (2000) studied the effect of grain less concentrate containing different supplemented protein sources along with wheat straw based diet on feed intake, nutrient digestibility, plane of nutrition and daily
live weight gain of growing bulls. Bulls in control received barley 30% in concentrate mixture as source of grain, while the bulls received concentrate mixture contained only wheat bran (diet 2) or wheat bran supplemented with 2.5% urea (diet 3) , 21.5% ground nut oil- cake (diet 4) or 27% mustard oil-cake (diet 5) as source of supplemented nitrogen. They found that the mean dry matter (DM) intake and digestibility of the nutrients (expect crude protein CP) were similar in all the groups. CP digestibility was significantly higher in urea fed animals. A marginal less daily live weight

gain was recorded with diet (2) fed animals and results were non-significant. They concluded that an active growth could be obtained in animals fed grainless concentrates having wheat bran as its main component with different nitrogen sources, at an amount of 1% of the live weight daily-gain without showing significant influence on nutritional status and growth growing bulls.

Oil seeds are relatively rich in protein, the quality of protein in the oil seeds differs among, species and varieties. They are generally deficient in sulphur containing amino acid methionine and cystine. All the species (Soybean, field pea, lupine, beans, vetch, etc.) are rich in lysine and all oil seeds contain components, which possess anti-nutritional properties (McDonald, *et al*., 1978). Among the chemical factors that may create problems in feeding oil seeds are protease inhibitors. The protease inhibitors, moist heat (cooking), germination (enzymatic), fermentation (microbial) and microwave processing (dry heat) can destroy most of the protease inhibitors and consequently reduce the risk of feeding oil seed to animals.

The excessive cooking on the other hand can reduce the biological value of the protein. The rivals of oil seeds as protein sources include the oil meals (groundnut cake, cotton seed cake, sesame cake, soybean and sunflower cake), which are usually well processed emerging without anti-nutritional and toxic substances. Most of oil seeds are used primarily for human and it can be fed to livestock effectively as oil seed meals or cakes after the removal of oil.

2.9.1 Oil- cake and meals:

Oil-seed cake or meals are residues remaining after the removals of greater part of oil from oil seeds. Most of these are of tropical origin. They include linseed, groundnut, sunflower, cottonseed, sesame and soybean. The

residues are rich in protein (20 to 50%) most are valuable feeds for animals. Two main processes are used for removing oil from the oil seed, one by using the pressure to force out the oil, while the other uses an organic solvent, usually hexane but occasionally trichloroethylene to dissolve the oil from the seed (McDonald *et al*., 1981).

2.9.2 Cottonseed meal (cake) (C.S.C):

McDonald et al., (1981) reported that protein of cottonseed cake is of good quality but the common disadvantage its low content of cystine, methionine and lysine but it's a good though variable source of thiamine . Cottonseed meal supplementation in ewes fed prairie hay caused increased hay intake but had minimal affects on ruminal ammonia concentrations, (Krysl *et al*., 1987).

In a comparative study with ruminating Holstein calves, Zerbini and Polan (1985) compared four iso-nitrogenous diets, (15.5% crude protein) contained different protein sources cottonseed meal, soybean meal, corn gluten meal or fish meal. They reported that fishmeal and soybean meal groups have generated highest rates of gain than those of cottonseed and corn gluten meal. Apparent dry matter and nitrogen digestibility were greater for corn gluten meal and fishmeal than for soybean and cottonseed meal diets. Ruminal ammonia nitrogen was higher for soybean meal and cottonseed meal than corn gluten and fishmeal diets, indicating to lower degradation rate of latter groups. Molar proportions of rumen votile fatty acid were not different among diets, but concentration was lower for fishmeal diets. Microbial nitrogen in the abomasums was 33.6% of the total nitrogen for corn gluten meal and 42% of soybean meal.

The effects of time interval of cottonseed meal (CSM) supplementation predominately meadow fescue grass hay (CP 6.6%) on nutrient digestion

and growth performance of beef steers, was administrated by Hunt *et al*., (1989) they reported that when cottonseed meal was supplemented to grass hay, steers were consumed more digestible DM ($P<0.5$) and had greater ($P<0.05$) daily gain compared with un-supplemented group. In the study in situ trial used to determine NDF and ADF degradation, and ruminal VFA concentration. Ruminal VFA concentrations were greater ($P<0.05$) when CSM was added, the delivery of CSM at various times did not affect ($P>0.10$) these variable measured. Similar results were obtained by (Judkins *et al*., 1991)

In another experiment Brown and Pate (1997) reported that supplementation of graded levels of crude protein (0.7, 14 and 21kg per day from cottonseed cake) to ammonite hay plus a liquid cane molasses- based diet. Resulted in linear increases in average daily gain and feed efficiency ratio by increasing crude protein supplementation. Similar results were obtained when feather meal replaced cottonseed meal, which no differences were observed between both sources.

To assess the feeding value of whole cottonseed ensiled with corn silage fed to withers (35kg), two digestion and nitrogen metabolism trials were conducted by Keery *et al*., (1991). Dietary treatments were ensiled whole cottonseed, untreated whole cotton, and 21- or 13% cottonseed meal in a basal diet of corn silage. They observed no differences among treatment for dry matter and average daily feed intake. Whole cottonseed decreased digestibility of dry matter. Digestibility of crude protein was similar for the 21% cottonseed meal and whole cottonseed treatments. Nitrogen retention was similar for all treatments.

Attempts for degossiypolization of cottonseed meal (CSM) and evaluation of its nutritional value as a possible protein for human feeding

were undertaken. Chemical methods for degossiypolization were most effective. But all treatment used for degossiypolization caused a decreased in diet and protein quality (El Nahry *et al*., 1983).

Nikokyris *et al*., (1991) studied the effect of gossypol content of cottonseed cake given as source of (CP) for lambs fed rations contained 0.15 and 30% cottonseed cake for 62 day. They reported that the plasma total protein and globulins were higher at day 30th of the experimental period, but the plasma albumin concentration, hematocrit and hemoglobin were higher at the beginning of the experiment, plasma urea concentration was higher at day 60th, and plasma glucose concentration was lower at day 30 of experiment. Liver examination showed significant differences in free gossypol content and accumulation, total N, and total protein percentages among the three treatments. Gossypol toxicity was not observed.

Table (10): total rain fed production of Cotton in the Blue Nile State 2003-2006.

Years	Land available(Fedan)	Cultivated area(Fedan)	Yield(kuntar)
2003	6352	5220	31320
2004	4330	4330	69280
2005	2330	1747	6988
2006	12000	9600	72000
Total	25012	20897	179588

Source: The Blue Nile Ministry of agriculture & animal resources 2007.

2.9.3 Groundnut cake (GNC):

Groundnut (Archishy Pogaea) is of south American origin but has now spread through out the world tropic and also warm temperature area to 40 and 45 N. it an important crop grown for seeds, which are rich in oil and protein (Bogdan, 1977).

The seeds of groundnut are borne in pods, usually in pairs or three, the pod or husk is largely fibrous. The seed contain 25-30% of crude protein and 35 to 60% of lipids material (Mcdonald *et al*., 1978). The protein of groundnut meals has sub-optimal amounts of cystine and methionine, although the orgnine content is higher and limited amino acid is lysine, also it deficient in vitamin B_{12} and calcium while is has a higher levels of magnesium, manganese and selenium than soybean (McDonald and Greenhalgh, 1972). Okan (1985) found that groundnut meal gave the same performance as fishmeal in broiler finisher diets.

Orskov and Macleod (1982) signed that groundnut meal has a higher degradability compared with linseed meal and fishmeal. Similar result was resignated by Stanton (1999) who classified and graded the feedstuff according to degradation of protein, that peanut meal has a low by-pass protein. In vivo and in vitro procedure (Siddons *et al*., 1985) estimated that degradability of groundnut meal, soybean meal and fishmeal. They found that nitrogen degradability values were 0.88, 0.76 and 0.57 for soybean meal, groundnut meal and fishmeal respectively. The fractional rate of N disappearance (n) was high (0.082) for groundnut meal and lowest of fishmeal (0.037).

2.9.4 Sunflower seed meal (SFM) or cake (SFC):

Sunflower seed meal has protein content varying between 26 for unhulled and 44% for dehulled material. Lysine content is markedly low but

methionine and arginine concentrations are higher than soybean meal, also is richer calcium, phosphorus and magnesium compared with soybean meal (Bouge and Fiems, 1988).

Chemical composition of (SFM) revealed that it had 30.0% crude protein 10.5% crude fiber, 11.5% ether extract and 7.7% ash, (Amal *et al*., 1993). Similar crude protein value was reported by Ibrahim and El Zubeir (1991). Vaugh, (1970) recorded that seed contained 25 to 30% oil. Protein content 67.8% (Tibus and Fritz, 1971). However the different values of chemical composition of (SFM) could be related to geographical location, climate, soil condition and method of extraction of oil.

Jaky *et al.,* (1980) studies Flungarian and Russian varieties of sunflower. They found that sunflower seed protein contain 4.0% lysine and 4.4% methionine. Marinou *et al*., (1985) analyzed sunflower seed meal produced from hybrid seed. They found that the crude protein, crude fiber and ether extract were 35.75, 17.36 and 2.2% respectively. Rose *et al*., (1972) found that the metabolizable energy (ME) values for different varieties of sunflower seed meal were 2.50% and 2.139 kcal/kg on dry matter basis for 44% protein and 31% protein from sunflower meal respectively.

True digestibility of most essential amino acid in sunflower is equal or greater than that of soybean but lysine soybean was more digestible than in sunflower (Green *et al*., 1987). To evaluate the nutritional value of sunflower seeds protein products Taha *et al*., (1980) reported that sunflower seed product primarily limited in lysine. Food consumption, feed gain and feed efficiency ratio reveal superior performance of lysine and methionine enriched meal, as compared to the corresponding non- enriched products offered to chicks.

Villamide and San Juan (1998) studied the effect of chemical composition of sunflower seed meal on its true metabolizable energy and amino acid digestibility. They found that type of sunflower seed meal was affected the true metabolizable energy and total amino acid digestibility. The true metabolizable energy and total amino acid digestibility were significantly increased with the sunflower meal crude protein content increased. The nutritive value intake, digestibility and nitrogen balance of farm grown and prepared sunflower based dairy calf meals more determent by Mandibaya *et al*., (1999) they recommended that farm –grown and prepared sunflower based meals was suitable for feeding young calves.

Sutter *et al*., (1984) reported that the daily feed gains were similar for protected fat, rapeseed and linseed treatment (1240 g/d on average), but were lower with sunflower seed (1135g/d and coconut oil (1038g/d). corresponding difference in carcass weight were observed. Mostly no significant effect on other carcass quality (dressing %, conformation score) and meat quality traits (final PH, cooking loss, sheer force) as well as composition (dry matter, fat, and collagen) accrued.

Table (11): The total rain fed production of Sunflower seeds in the Blue Nile State 2003-2006.

years	Land available(Fedan)	Cultivated area(Fedan)	Yield(Tons)
2003	5830	4081	34280
2004	5970	4620	25318
2005	4285	2271	16351
2006	8000	6000	64800
Total	24085	16972	140749

Source: The Blue Nile ministry of agriculture & animal resources2007**.**

2.9.5 Sesame cake or meal (SC):

Sesame (*Sesamum indicum*, L.) meal; is a high protein concentrate containing about 46% crude protein, rich in arginine and lucine but low in lysine and methionine and may be used in feeding farm animals in much the same way as groundnut meal (McDonald *et al*., 1981). Comparison of sesame cake and cottonseed as supplementary source of protein, was conducted by Little, *et al*., (1991) they were reported that there was no significant differences between bulls given sesame cake and cottonseed on daily live weight gain.

Sesame press cake represents an important potential protein sources from human consumption. Some of the limiting factors were its high crude fiber content, oxalic acid content, and its better taste. By fractionation of solvent extracted sesame meal, several preparations were obtained which were analyzed for their nutrient content, protein utilization and digestibility. Protein efficiency ratio (PER) values was low, and supplementation with lysine, skim milk powder, soybean or fishmeal, improved PER values considerably. Based on the findings, formules for use as protein supplement for children are presented (Guerra *et al*., 1984).

2.10 Others non-conventional feed sources:

2.10.1 The Guar:

Guar (Cyamopsis Tertragonloba) is a drought to leant summer legume which belongs to the family Fablea with common name cluster bean or Calculta lucern. . Like soybean, Guar is photoperiodic plant (Singh *et al*., 1962). It is used as human food because of its high content of protein and as fodder for cattle too.

The industrial and commercial importance of guar is due to the presence of high rate of glactommanan (42%) in its endosperm. It is used in

many industries such as thickening agent, mining, oil well drilling, cosmatics and hand lotions together with its incorporation in food industries as ice cream and bakery products, etc. and as binding materials (Anderson, 1949).

2.10.2 The guar germ:

The germ contains most of the protein in the seed (Abdeen and Mohmoud, 1990). Guar germ contains 47.8% CP, 5.5% fat, 8.3%CF, 32.9% NFE, and 5.51% Ash (Kukrejia and Aroya, 1981). The crude protein content of guar was found to vary according to different location . In Indiana guar gum contains 41.4 crude proteins, 11.70 crude fibers, 31.28% NFE and 13.27% carbohydrates on only matters basis (Nagra, 1985). In Sudan, Guar gum contains 95.33DM, 42.3 CP, 47 ether extract, 12.22%crude fiber 6.32% total ash, 42 calcium, 0.57phosphorus and 0.3 magnesium (S.G.C, 1995).

2.10.3 Guar hull:

The Guar hull is one of the three major parts of Guar. It is the out fibrous cover. A nutritive substance is rich in fiber and useful as animal feed. It contains a high rate of protein (26%) since the hull is produced in fire powder form , it may be used as basic raw material for processing of fodder making ,granular or pelleting (S.G.C,2001).

Table (12): The total rain fed production of Guar in the Blue Nile State 2003-2006.

years	Land available(Fedan)	Cultivated area(Fedan)	Yield(Tons)
2003	5220	283	345
2004	3400	600	72
2005	2260	1469	147
2006	5000	4000	800
Total	15880	6352	1364

Source: The Blue Nile Ministry of agriculture & animal resources2007

2.11 Molasses:

Molasses is the most important, and is widely used for feeding livestock in the Sudan. Its greatest value is associated with the fact that it enhances palatability, acts as an energy supplement to roughage by- products such as rice straw, often as carrier of these, and also of non- protein nitrogenous (NPN) sources like urea. Because of the content of mainly soluble sugars, it is also an excellent substrate for microbial growth (Preston, 1974)

2.12 Natural Rangelands:

Natural rangelands in the Sudan cover approximately 26.3% of the area of the country. This area supports about 50 million heads of livestock of which 28.7 million heads are small ruminants (A.O.A.D., 1982). The forest lands which also provide for natural grazing cover an area of about 22.9% and extend from the Savannah woodland In the North to Gallery Forests in the mountains of uplands. This indicates that the grazing resources constitute approximately 50% of the total area of the country. In addition, it is estimate that, in this country about 200 million feddans are potential agricultural

lands. However, only 10% of this area (20 million feddans are presently utilized for production of crops.

2.12.1 Range rehabilitation using seeding:

The deterioration of the range land in Sudan is the result of several integrated factors, including overgrazing, uncontrolled fires, cultivation of marginal lands and uneven distribution of watering points. Two approaches were tested to revegetate degraded range, firstly allowing natural plant succession to take place by excluding the causes for degradation, i.e. grazing, cultivation, fire etc. This would require fencing and recovery found to be slow. Secondly intervention such as reseeding with appropriate pioneering and adaptable species along with soil and water conservation.

2.13 Grazing Potentialities and stocking Rate:

Apart from existing cultivated areas (26 million feddans) and areas currently unavailable for agriculture or grazing uses (48.5%) the range resources comprises almost 279.4 million feddans (50% of total area). The best immediate measure of range productivity was the number of livestock that is supported by the grazing resources. 1979/1980 census indicated that the livestock population amounted 27.7 million animal units (AU). According to estimates of range forage nutritive value (AOAD/1979). The dry matter contents of range forage amount to 95% and the TDN amount to 31.4% of the dry matter. If long requirement of TDN per AU is estimated as 1.44 Ton/au/year (Kordfan 1962/65). During 1979 Range Management and Pasture Administration total forage production from usable range areas within different regions.

Table (13): Estimates of Animal units in (000) head (Sudan).

Year	Cattle	Sheep	Goats	Camels	Total
2002	39479	5776	2904	4345	25504
2003	39669	5813	2942	4554	52978
2004	39760	5869	2953	4841	53423
2005	40468	5976	2977	5080	54501
2006	40994	6047	2993	5301	55335

Source: Ministry of Animal Resources & Fisheries

Tropical Animal Unit (TAU) (Standard unit; Cattle): CATTLE=1

Sheep=0.12 //CAMELS=1.3 // GOATS=0.07

Table (14): Estimations of total forage production in Sudan regions.

Region	Ecological Zone	Range area (feddan.)	Average Prod.(Ton/Fed.)	Tot. Prod.(Tons)
Northern R.	(Desert/Semi-desert)	11,046,780	0.082	905,836
Eastern R	(Desert/Semi-desert/LRFS)	43,419,850	0.15	6,512,978
Central R.	(Semi-desert/LRFS)	15,148,920	0.64	9,695,309
Khartoum	(Semi-desert)	3,830,900	0.14	536,326
Kordofan	(Desert/Semi-desert/LRFS/Flood)	53,502,370	0.27	14,445,639
Darfur R.	(" " ")	64,743,850	0.23	14,891.085
Southern R.	(HFRS/Flood Region)	87,803,890	0.35	30,731,361
Total		279,496,560		77,718,534

Source: Range Management and Pasture Administration (1979).

Table(15) : Forage Production (000) T (Sudan).

Type	2002	2003	2004	2005	2006
Natural pasture	60	62	55	81	NA
Green Fodder	0.146	0.225	3	1	NA
Agricultural byproducts	12.494	1.995	18.710	18	NA
Agro-Industrial byproducts	3.772	2.900	3.366	3.366	NA
Total	76.412	66.620	80.076	103	NA

Source: Range Management and Pasture Administration

Table (16): Animal Units by states 2002(Sudan).

State	Cattle	Sheep	Goats	Camels	Total
North Kordofan	560602	464416	156813	820695	2002526
South Kordofan	2495073	232786	126322	220706	3074886
West Kordofan	3272809	448820	139390	557847	4418865
North Darfour	647456	417050	193113	538730	1796349
South Darfour	3967640	426292	200373	101664	4695968
West Darfour	3813671	433224	235220	389276	4871392
Elgedarif	975131	235674	70566	225050	1506421
Kassala	398738	108595	82472	585218	1175023
Red sea	63166	40434	47915	304556	456072
Blue Nile	3884734	554527	233478	194638	4867376
Sennar	1488358	152495	80149	106443	1827445
Elgezira	2254251	274375	113835	112525	2754986
White Nile	3288601	280152	155942	32150	3756844
Northern	315832	108595	76664	44749	545840
River Nile	94750	114371	80439	104270	393831
Khartoum	225030	49099	42978	6082	323190
North upper Nile	983027	76825	30782	0	1090634
Unity	1180422	178488	122837	0	1481747
Gongoli	1464671	168091	84505	0	1717267
N. Bahr Elgazal	1579160	154228	114125	0	1847513
W.Bahr Elgazal	1247536	139787	78407	0	1465730
Albohairat	1310703	147874	102509	0	1561086
Warab	1527837	154805	95830	0	1778473
Bahr Elgabal	876434	151917	80730	0	1109081
E.Equatoria	888278	123036	79278	0	1090591
W. Equatoria	675091	140365	79278	0	894733
Total	39479000	5776320	2903950	4344600	52503870

Source: Ministry of Animal Resources & Fisheries

Table (17): Animal Units by states 2003(Sudan).

State	Cattle	Sheep	Goats	Camels	Total
North Kordofan	563300	467349	158873	860232	2049754
South Kordofan	2507081	234256	127981	231338	3100656
West Kordofan	3288560	451655	141221	584721	4466156
North Darfour	650572	419684	195650	564684	1830589
South Darfour	3986735	428985	203005	106561	4725285
West Darfour	3832025	435960	238310	408029	4914325
Elgedarif	979824	237162	71493	235892	1524372
Kassala	400657	109281	83556	613410	1206904
Red sea	63470	40690	48545	319228	471933
Blue Nile	3903430	558029	236545	204015	4902018
Sennar	1495521	153458	81202	111571	1841752
Elgezira	2265100	276108	115330	117946	2774484
White Nile	3304428	281921	157991	33699	3778038
Northern	317352	109281	77671	46905	551209
River Nile	95206	115093	81496	109294	401089
Khartoum	226113	49409	43543	6375	325441
North upper Nile	987758	77310	31186	0	1096255
Unity	1186103	179616	124451	0	1490169
Gongoli	1471720	169152	85615	0	1726487
N. Bahr Elgazal	1586760	155202	115625	0	1857586
W.Bahr Elgazal	1253540	140670	79437	0	1473647
Albohairat	1317011	148808	103856	0	1569675
Warab	1535190	155783	97089	0	1788063
Bahr Elgabal	880652	152877	81790	0	1115319
E.Equatoria	892553	123813	80319	0	1096684
W. Equatoria	678340	141251	80319	0	899910
Total	39669000	5812800	2942100	4553900	52977800

Source: Ministry of Animal Resources & Fisheries

Table (18): Animal Units by states 2004(Sudan).

State	Cattle	Sheep	Goats	Camels	Total
North Kordofan	564592	471884	159437	914503	2110415
South Kordofan	2512832	236529	128435	245933	3123729
West Kordofan	3296104	456037	141721	621610	4515472
North Darfour	652064	423756	196343	600309	1872472
South Darfour	3995880	433147	203725	113284	47460336
West Darfour	3840816	440190	239155	433772	4953932
Elgedarif	982072	239463	71746	250774	1544056
Kassala	401576	110341	83852	652110	1247878
Red sea	63616	41084	48717	339368	492785
Blue Nile	3912384	563443	237383	216886	4930096
Sennar	1498952	154947	81490	118609	1853998
Elgezira	2270296	278787	115739	125387	2790209
White Nile	3312008	284656	158551	35825	3791040
Northern	318080	110341	77947	49864	556232
River Nile	95424	116210	81785	116189	409608
Khartoum	226632	49888	43697	6778	326995
North upper Nile	990024	78060	31297	0	1099381
Unity	1188824	181358	124892	0	1495074
Gongoli	1475096	170794	85919	0	1731808
N. Bahr Elgazal	1590400	156708	116034	0	1863142
W.Bahr Elgazal	1256416	142035	79718	0	1478169
Albohairat	1320032	150252	104224	0	1574508
Warab	1538712	157295	97433	0	1793440
Bahr Elgabal	882672	154360	82080	0	1119112
E.Equatoria	894600	125014	80604	0	1100218
W. Equatoria	679896	142622	80604	0	903122
Total	39760000	5869200	2952530	4841200	53422930

Source: Ministry of Animal Resources & Fisheries

Table (19): Animal Units by states 2005(Sudan).

State	Cattle	Sheep	Goats	Camels	Total
North Kordofan	573155	480441	160748	959688	2174032
South Kordofan	2550942	240818	129492	258084	3179336
West Kordofan	3346093	464307	142887	652323	4605611
North Darfour	661953	431441	197959	629970	1921323
South Darfour	4056482	441002	205401	118881	4821766
West Darfour	3899066	448173	241122	455204	5043565
Elgedarif	996966	243806	72337	263165	1576274
Kassala	407666	112342	84542	684330	1288880
Red sea	64581	41829	49118	356136	511664
Blue Nile	3971719	573661	239336	227602	5012319
Sennar	1521685	157757	82160	124470	1886072
Elgezira	2304727	283843	116691	131582	2836844
White Nile	3362238	289819	159855	37595	3849507
Northern	32904	112342	78588	52328	566162
River Nile	96871	118318	82458	121930	419576
Khartoum	230069	50793	44057	7113	332032
North upper Nile	1005039	79476	31554	0	1116069
Unity	1206854	184647	125919	0	1517420
Gongoli	1497467	173891	86625	0	1757984
N. Bahr Elgazal	1614520	159550	116989	0	1891059
W.Bahr Elgazal	1275471	144610	80374	0	1500455
Albohairat	1340052	152976	105082	0	1598110
Warab	1562048	160147	98235	0	1820430
Bahr Elgabal	896059	157159	82756	0	1135974
E.Equatoria	908168	127281	81267	0	1116716
W. Equatoria	690207	145208	81267	0	916683
Total	40363000	5975640	2976820	5080400	54395860

Source: Ministry of Animal Resources & Fisheries

Table (20): Animal Units by states 2006(Sudan).

State	Cattle	Sheep	Goats	Camels	Total
North Kordofan	582115	486163	161618	1001434	2231330
South Kordofan	2590821	243686	130192	269311	3234010
West Kordofan	3398403	469836	143660	680700	4692599
North Darfour	672302	436579	199029	657374	1965283
South Darfour	4119897	446254	206511	124053	4896715
West Darfour	3960020	453510	242427	475005	5130962
Elgedarif	1012552	246709	72728	274613	1606602
Kassala	414039	113680	84999	714099	1326817
Red sea	65590	42328	49383	371628	528929
Blue Nile	4033810	580493	240631	237503	5092436
Sennar	15455474	159636	82605	129884	1917598
Elgezira	2340757	287223	117322	137306	2882609
White Nile	3414800	293270	160720	39230	3908020
Northern	327952	113680	79013	54604	575249
River Nile	98386	119727	82904	127234	428250
Khartoum	233666	51398	44295	7422	336781
North upper Nile	1020751	80422	31725	0	1132898
Unity	1225721	186846	126601	0	1539167
Gongoli	1520877	175962	87094	0	1783933
N. Bahr Elgazal	1639760	161450	117622	0	1918831
W.Bahr Elgazal	1295410	146333	80809	0	1522552
Albohairat	1361001	154798	105650	0	1621449
Warab	1586468	162054	98766	0	1847288
Bahr Elgabal	910067	159031	83203	0	1152301
E.Equatoria	922365	128797	81707	0	1132869
W. Equatoria	700997	146937	81707	0	929641
Total	40994000	6046800	2992920	5301400	55335120

Source: Ministry of Animal Resources & Fisheries

2.14 Feeds and water:

The Quality of the forage is often poor in arid and semiarid zones as plants are less digestible, and the growth of the forage is slow except for in the rainy season (Payne &Wilson, 1999). Generally plants on pasture contain low levels of ruminants and high amounts of lignin. Grazing behavior is also affected as shown by day time grazing being diminished in hot and dry areas compared to cooler climates. However, this can be compensated by night time grazing, if there is enough forage available on the pasture and if it is safe for the livestock. When possible for the farmer, supplementary feeding is another way to increase the feed intake and to compensate for low pasture quality. Higher environmental temperatures require higher water intake, since the water is needed for the ability to loose heat (Payne &Wilson, 1999). If the temperature of the drinking water is lower than that of the body, excessive heat will be lost by direct cooling at drinking. Animals in a tropical climate maintain the normal body temperature for example by decreasing production (indirectly by decreasing digestive metabolism) and exercise, increasing sweating and panting, excreting urine and feces at body temperature, and seeking shadow. Knoess (1977) stated that the most important feeding characteristic of the camel is its ability to utilize plants that grow well under arid conditions and not replished by other grazing animals. Camels obtain about 44% of their feeding requirements from natural grazing land over the whole year (Rees *et al.* 1988). Kohler-Rollefson *et al.* (1991) studied the pastoral camel production system of Rashaida tribe in Sudan. They revealed that Dura (sorghum) stalks, which remained after mechanized harvesting, have become an important, nutritionally adequate type of fodder. In Ereteria, Gebrehiwet (1998) mentioned that camels live in desert and semi-desert

regions browsing and grazing all year round without any supplementary feeding. Aujla *et al.* (1998) found in Pakistan that the water requirements of camels varied from season to season from 5 to 15 liters per day. Ramet (2001) concluded that where green forage is available in wild climates, the camel may go several months without drinking. Camels under hot conditions may drink only once every eight to ten days and lose up to 30% of its body weight through dehydration (Yagil, 1982 and Wilson, 1984). Koheler-Rollefson *et al.* (1991) in their study of Rashaida camel in Sudan found that camels required watering approximately once every six days.

2.15 Marketing system:

The livestock marketing system starts with the primary producer and moves through various stages of middlemen to wholesale, retail, and export outlets. Sudanese major livestock markets (except Kosti) operate on a "silent auction" system whereby the price for livestock is negotiated by a broker who communicates separately with a buyer and seller. Animals are sold by group prices (not by weight), and the purchase price is known only to the buyer, seller, and broker (ARSC 2004; Aklilu 2002). Supplies at terminal markets vary seasonally and are affected by armed conflict, environmental conditions, and political instability. Major production areas are generally 600-1,400 km from terminal markets, to which livestock are transported on hoof, by truck, or on rail. The primary producer may receive as little as one –eight of the export (free on board) price (World Bank 2003; cf. Morton 2005).

The marketing system in Sudan is dominated by middlemen (brokers) . Some of these brokers may work as independent small-scale traders (Jelaba) and some as agents (Wakils) or sub-agents for the big traders. The brokers collect cattle and (small ruminants) from the scattered villages and

sell them to another broker in the primary markets. The second broker may sell to a third broker in the same market or in a secondary market and this process goes on until the livestock are bulked into larger lots and reach the terminal markets. The final transaction in the terminal markets is also processed through brokers. Agents or sub-agents also organize the trekking of cattle to the terminal markets for the big traders.

At the final point of sale, animals are transported to Port Sudan for live export or slaughtered for domestic consumption. The role of middlemen is widely perceived as a weakness in Sudanese marketing system, Producers generally sell when they need cash, but under the current marketing system payments to producers are often deferred. Traders and brokers pass the risks of livestock sales to producers, who are paid only after a final sale, but sometimes not at all (Aklilu 2002). Producers also may lack information about prices at the terminal market or internationally that could inform their decisions to sell animals. Consumers are believed to suffer because middlemen (and taxes) are blamed for unnecessarily increasing in the cost of meat in livestock-rich Sudan. Exporters reportedly suffer when middlemen drive the cost of livestock close to the international price, thereby cutting into the exporters' profits.

2.16 Taxes and Fees:

Taxes and fees on livestock are levied throughout the marketing chain, from the village level all the way to the terminal markets. At the village level, annual per- head livestock taxes are collected by local leaders at different rates for different classes of stock (Morton 2005; Aklilu 2002).

Table (21): Exported Livestock (head) 2002-2006(Sudan).

Year	Cattle	Sheep	Goats	Camels
2002	2655	1602638	53164	155710
2003	184	1315399	57639	88423
2004	750	1703562	101899	132602
2005	501	1271787	109650	131156
2006	0	1422209	102378	116184

Source: Ministry of Animal Resources & Fisheries

Table (22): Export of Meat (Ton) 2002-2006(Sudan)

Year	Total	Beef	Mutton	Goats meat	Camels meat
2002	7821.4	347.1	7113.8	353.8	6.6
2003	8253.0	178.21	7837.11	221.3	16.4
2004	6610.7	765.3	5570.9	217.1	57.4
2005	5423.0	656.4	4710.5	29.2	27.0
2006	2282.5	0.0	2264.0	8.4	10.2

Source: Ministry of Animal Resources & Fisheries

These taxes are important source of revenue for local-level governments. When livestock are sold by primary producers and enter the commodity chain, twenty or more taxes and fees may be levied before they reach terminal markets in Khartoum or Port-Sudan (Aklilu 2002; cf. Wiliams 1990). In some cases these taxes or fees are used to pay for services, such as for veterinary care or water access and grazing (Morton 2005; Aklilu 2002).

Taxes on traders and exporters affect the producer price and export markets, and could therefore be reformed by the National Assembly to become pro-poor (Williams 1990; Morton 2005).

2.17 Disease control:

For Sudaneses main livestock (cattle, sheep, goats, camels), disease control efforts are focused on vaccination, screening at quarantine centers prior to export, and training of community animal health workers (CAHWs) who administer drugs and vaccines on a fee-recovery basis. The federal government retains responsibility for controlling infectious disease and states are responsible for control of general disease. The federal government produces and distributes vaccines but the private sector provides animal medicines. Disease control efforts in Sudan are largely conducted and/or funded by international organizations (e.g. FAO, UNICEF, and VSF) and local non-governmental organizations, with the cooperation of the government. The Sudanese government coordinates its disease control efforts through the Animal Health and Disease Control General Directorate, which is administratively under the Ministry of animal Resources but receives funding and support directly from the Ministry of Finance and the Ministry of Science and Technology (Aklilu 2002).

To be profitable, animal production requires good management of healthy animals (Payne &Wilson, 1999). Health depends on proper feeding and access to enough water of good quality as well as protection against environmental factors (such as heat) and health hazards. On the other hand, an animal in good condition is more resistant to disease than a weak one. Generally, by providing good hygienic conditions, the disease pressure can be diminished (Payne &Wilson, 1999) by proper management of the grazing environment; many parasitic diseases can be controlled.

CHAPTER THREE

3- Materials and Methods

3.1. Description of the study Area:

3.1.1. Location:

The study area is situated between longitude 32-36˚East and latitude 12-14˚ North and have boarders with Jazeera, White Nile, Gedarif states and Ethiopia Fig. (1). Studied area is about 79,180 square Km. The studied area involves Sinnar and the Blue Nile states. The area is under the umbrella is the first site where the Blue Nile will be connected with the White Nile to form the River Nile at Khartoum city.

Fig (1): Site of Studied area

Study area (Sinnar and Blue Nile states)

3.1.2. Topography of studied area:

3.1.2.1. Soil:

The area is characterized by the presence of various soil types, the most important being the southern central clay plain. The soil is heavy cracking clay with dark grey or dark brown colours. Soil type is variable from area to another. These soils are clay while others are sandy. The surface layers in some of them are acidic and lower layers are alkaline. These areas are used for growing various crops, trees and pastures. Other soils, which occupy small fractions of the area, include sands of varying depth on the banks of the seasonal rivers.

3.1.2.2. Climate:

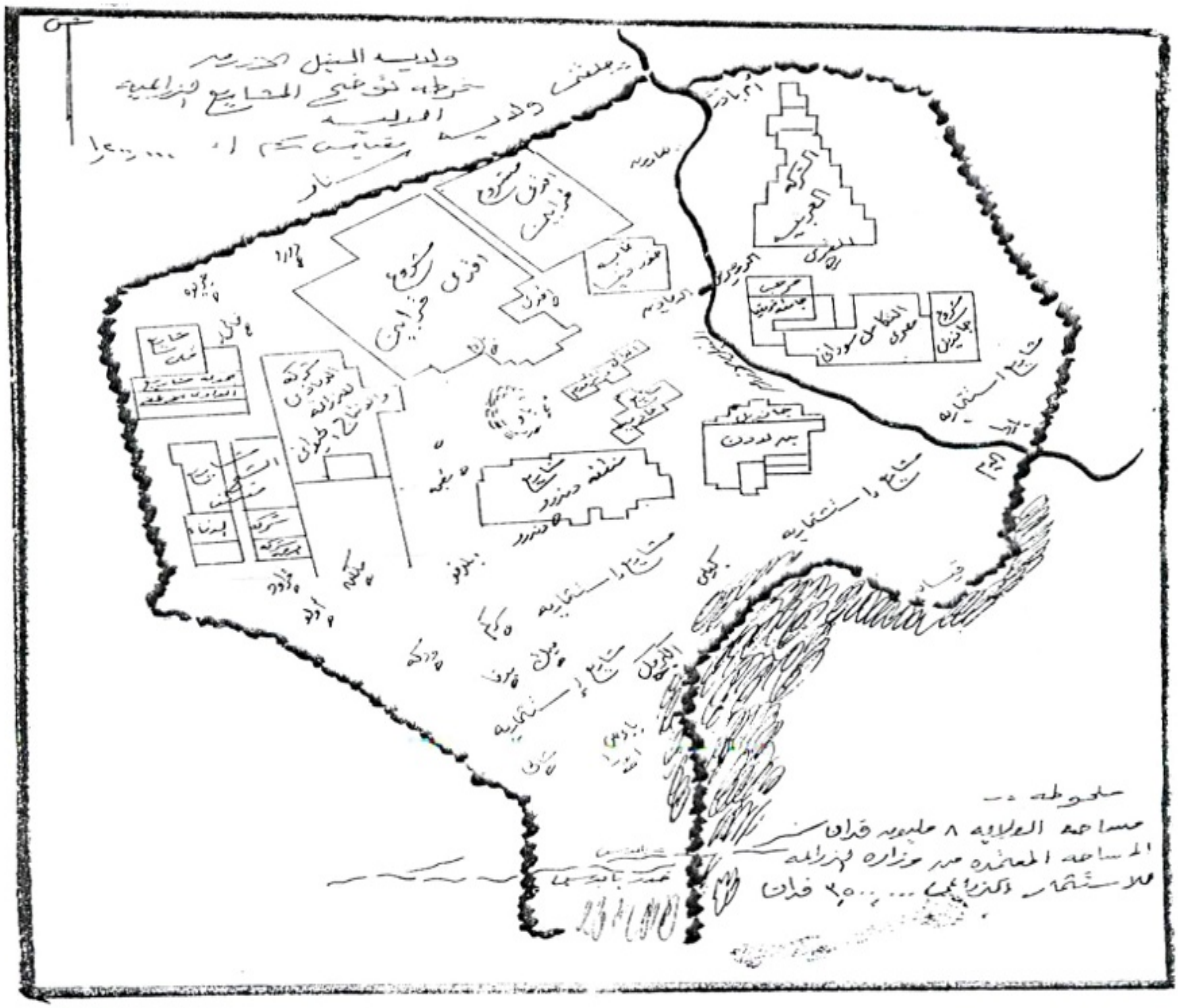
The Blue Nile and Sinnar States are large states (total area about 79,180 squares Km) with varying land uses and socio economic activities and with varying conditions that range from semi-savannah north to wet savannah south. Metrological data showed that the average rainfall in the study area was 456 mm. from May to October (wet season). However, the average temperature was 36.5˚C with extremes over 40˚C during April and May. The lowest degree temperatures were recorded in January with an average of 14.8˚C. On the other, relative humidity at 006 GMT was 47.5%. The lowest relative humidity was recorded in March and April, the highest in August.

3.1.2.3. Vegetation:

The study area is reputed for its rich and extensive natural vegetation cover, which is available for natural grazing. This cover is present in the herd grazing routes, Khors and reserved forests. There are eight grazing routes, 1380 km long and 4 km wide, which occupy 1000 Fedans. There are also twelve Khors with an average width of 6 km. The available grazing area in forests is around 4 million Fedans. The vegetation cover varies with amount and distribution of rains, soil type and elevation above sea level. Further more, the forest area is characterized by a thick cover of trees which constitute 75% of the total area. The species vary depending on amount of rains and predominant environmental conditions. The area is, therefore, the richest in tree cover compared to others. There are two types of forests. The first type grows on the Nile banks and is predominantly Sunut (*Acacia nilotica*) trees. The second type is known as *Dahra* forests which depend on rains and are composed of Talih (*Acacia seyal*), Hashab , Kitir , Higlig , Loat and other spiny trees in the north. The area has an excellent pastures and the best grazing land in Sudan. The grasses are palatable with high

nutritional value for animals. This is why many nomadic tribes from adjacent as well as far away states use it as grazing land during and after the rainy season. In addition a lot of varieties of grasses and other plants are available (Table 23).

Fig (2): Private Agricultural companies in the Blue Nile State.



Source: Blue Nile state Range management& Pasture administration

Table (23): Shows name of some grasses, Herbs and trees in the study area.

Grass		Trees and Herbs	
Latin name	Arabic name	Latin name	Arabic name
Cenchrus ciliaris	الحسكنيت	Balanites egyptiaca	الهجليج
Panicum turgidum	تمام	Ziziphus spina christi	السدر
Cyprus rotundus	السعدة	Acacia syal	الطلح
Aristida mutaablis	الغباش	Acacia melifera	الكتر
Sorghum halepenes	العدار	Acacia nubica	اللعوت
Leucas urticifplia	أم قلوط	Indigofera blongfolia	الدهسير
Ipomea cordioscpala	الحنتوت	Calotropis procera	العشر
Forskalea tenacissima	اللوصيك	Capparis decidua	الطندب
Euphorbia spp.	أم لبينة	Acacia sengal	الهشاب
Aristida palida	أم صميمة	Acacia nilotica	السنط

3.1.2.4. Agricultural schemes:

The area is 13 millions feddans, and 80% of this area is suitable for agricultural production. The private agricultural companies using an area of 3.5 million feddans and 38 irrigated agricultural schemes occupying 1.2 million feddans. In the rain fed sector, large areas of sorghum, sesame, sunflower, cotton and guar are grown on a commercial scale.

Table (24): Irrigated agricultural Schemes in the study area.

Name	Area/feddan	Name	Area/feddan
Wad Hashim left	8574	Bunzuga	1875
Wad Hashim west	3516	Tama	1500
Mayerno left	1800	Zumorka	1200
Mayerno The middle	6000	Elgeran	9360
Mayerno west	3600	Elamara	1275
Dar Elshefa	1815	Wad Elabas	1535
Elmrafa	1800	Elkheran	9000
Eleslah	800	Kssab left	1524
Abdein	1200	Kssab El galeen	1250
Wad Elata	1200	Kssab west	2400
Elflllahein	1245	Rewena	3090
Um shoka	1350	Ellah left	1250
Elnyra	2000	Ellah west	720
Um mareh	4500	Elmosran	3015
Elluona	9975	Trera Elkoufa	900
Sero	1800	Elbusata	1749
Elbarsi-Kadein	7140	Mena Wad Elfour	2400
Assar	4500	Kurkoog	7000
Kersli-Awlad nseir	2250	El azaza	4775

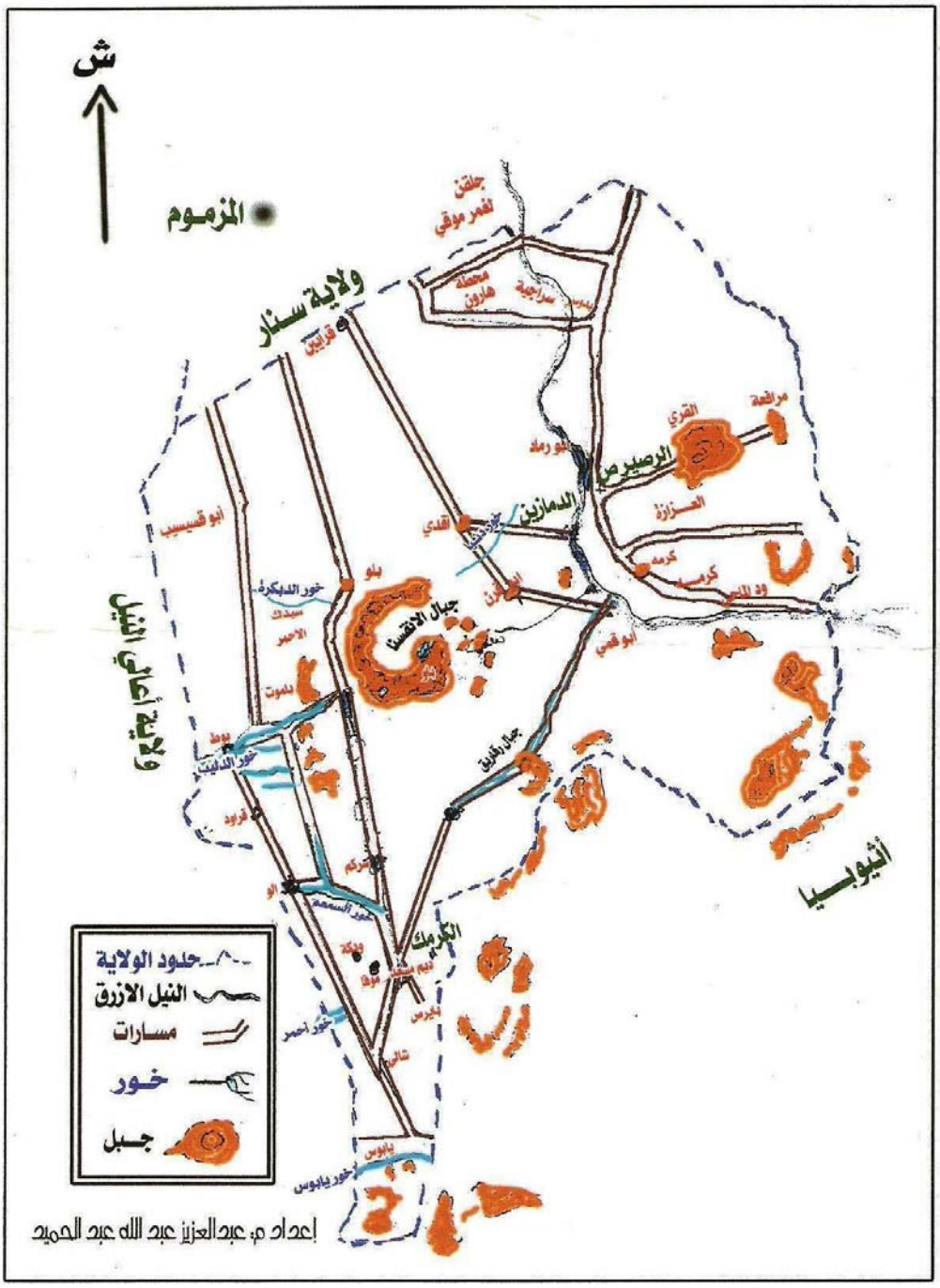
Source: Sinnar State Ministry of Agriculture 2008

Table (25): Total Area / Fedan for the Rain fed Mechanized Agriculture in the Blue Nile State.

No.	Location	(Area/ Fedan)
1	El Reheed	70,000
2	Gouz Roum	50,000
3	Guli & West El Soudi	7,350
4	Guli West	13,000
5	Bout	23,000
6	El Wadi El Akhder	21,000
7	Agadi East	273,000
8	Agadi West	153,500
9	Agadi South	110,450
10	El Soudi Project (North Elkhour)	66,500
11	El Soudi Project (South Elkhour)	45,000
12	El Rosseris Locality	212,050
Total		1,022,650

Source: The Blue Nile State: Ministry of Agriculture & Animal Resources.

Fig (3): Migratory routes in the Blue Nile State.



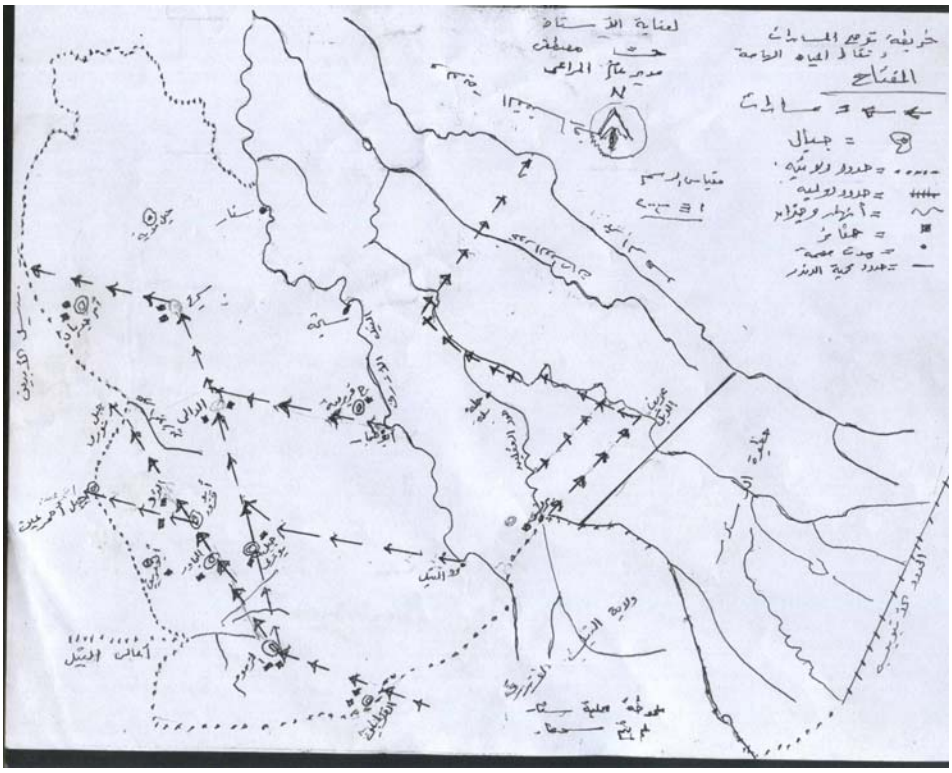
Source: The Blue Nile State. Range Management and Pasture Administration

Table (26): Migratory routes in Sinnar state

No.	Routes	Length of route/ km	No.of Hafeir
1	Hafeira El Troos-Khour El Nabag-Abu Deloug	45	5
2	Hafeira El Rehaid-El True- and El traw-Ahmer aein	120	10
3	El garabein-El mazmoum-Bouzi-El Dali-Sereig-Um Gedyan-Gabal Beyout	240	24
4	Wad Elnyal-Tozei-Bozi	74	8
5	Haroun station-Homyra Kukari	25	3
6	Abi Higar project-Um Hereen-El Dali	74	7
7	Eennar-Gabal Moya Gabal Beyout	20	0
8	Seraig-Hella Wad Salma	30	0
9	Um Sag-Um Gedyan- Seraig-El Dali	30	0
10	Wad Elnimir-El erada-El Gou-El Hyari	80	0
11	Salama El Basha-El Managil	40	0
12	Breesh-Areef El Deeg	14	0
13	El dilaba-Duraba	14	0
14	Areef El Deeg-Kubri Elseteen	172	0
15	Kubri Elseteen-El Rahad River	50	0

Source: Sinnar state Ministry of Agriculture& Animal Resources (Range Management & Pasture Administration).

Fig (4): Sinnar state migratory routes



Source: Sinnar state Range management & Pasture Adiministration

3.2. Data collection

3.2.1. Questionnaire methodology:

The study was carried out by well designed questionnaires as seen in the Appendix. The questionnaires were designed to obtain information on general household characteristics, livestock and herd structure, herd management, breeding practices, disease prevalence, production objectives, feeding management and production constraints. The questionnaires were pre-tested to check clarity and appropriateness of the questions. Some of the information collected during interviews was supported by observation. Twenty villages scattered around the two states were used for filling out the questionnaire (Table,28). Over two hundred cattle owners were used for filling out the questionnaire (Table, 27). In addition several meetings were

held with chief of tribes and other involved in agricultural policy. Journals, internet, government documents were also consulted. On the other hand, the survey was conducted through a questionnaire and guided interviews with sheep owners. A structured questionnaire were prepared and used to collect information from a total of 20 sheep owners.

Also the survey was conducted through a questionnaire and guided interviews with camel owners in selected regions of the camel habitat in Blue Nile area. A set of detailed structured questionnaires were prepared and used to collect information from a total of 24 camel owners conducted over two visits. Some of the information collected during interviews was supported by observation. The questionnaires were designed to obtain information on general household characteristics, livestock and herd structure, herd management, breeding practices, disease prevalence, production objectives, feeding management and production constraints.

Table (27): Number of animal owners included in the study area

Study area	Number of animals owners
West of the Blue Nile	100
East of the Blue Nile	100
Total	200

3.2.1.1. Field visits:

The required data was collected during several planned visits in different season of the year. The questionnaire was answered during 15 months.

Table (28): The villages selected for the survey in the Blue Nile area

No.	West Nile	No.	East Nile
1	Sinnar	11	El Suki
2	Umbenin	12	Kubri (8)
3	Um-Biaga	13	Banasu
4	ElEngifaw	14	Bonzega
5	El-Rawda	15	Wad Ayess
6	El-Sabonabi	16	El-Hegairat
7	El –Tofogia	17	El-lacandi
8	Abi-Higar	18	El-Azaza
9	Abi-Neama	19	El-Garee
10	Gunofa	20	ELrosseres

Plate (1): collecting data from field (El engifaw 2007).

3.2.1.2. Team work:

This questionnaire was collected by myself and my colleague in ministry of Animal Resources in the Blue Nile State especially veterinarian and animal production specialists.

3.2.1.3. Official documentation:

Visits to the government authorities concerned on ministry of Animal Resources Departments, Pasture Department of the Blue Nile State and Umbanein Livestock Research Station were carried out to collect information and data.

3.2.1.4. Statistical Analysis:

The SPSS statistical computer software (SPSS for windows, release 15.0, 2006) was used to analyze the data. Results are represented mainly in the form of descriptive tabular summaries.

CHAPTER FOUR

4. Results

4.1. Survey results derived from questionnaire of cattle owner's:

4.1.1. Household characteristics:

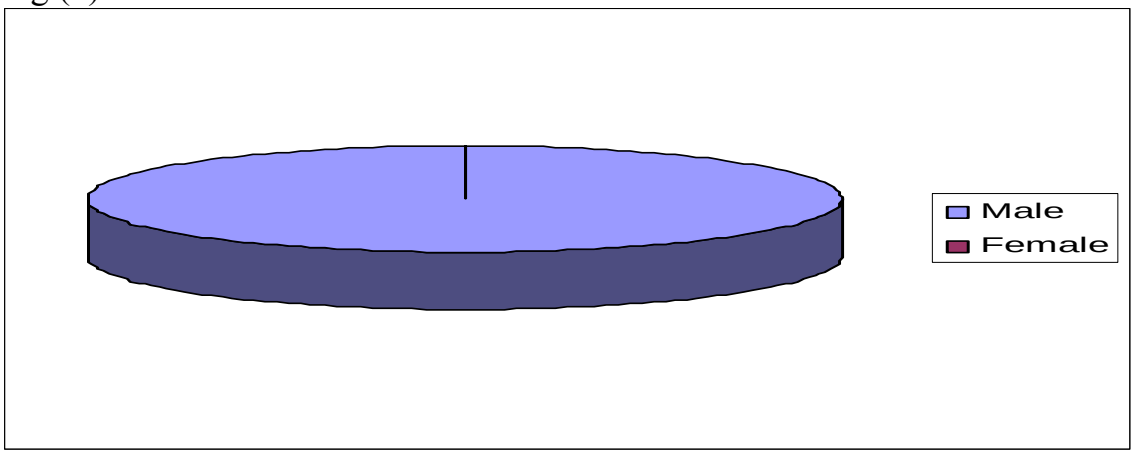
4.1.1.1. Gender of household

Table (29) and figures (1) show gender of households, the results explained that all the cattle owner's or respondents (100%) are male while females were contributing (0.0%).

Table (29): Gender of households

Gender	Frequency	Percent	Cumulative percent
Male	200	100.0	100.0
Female	0	0	0

Fig (5): Gender of households



4.1.1.2. Education:

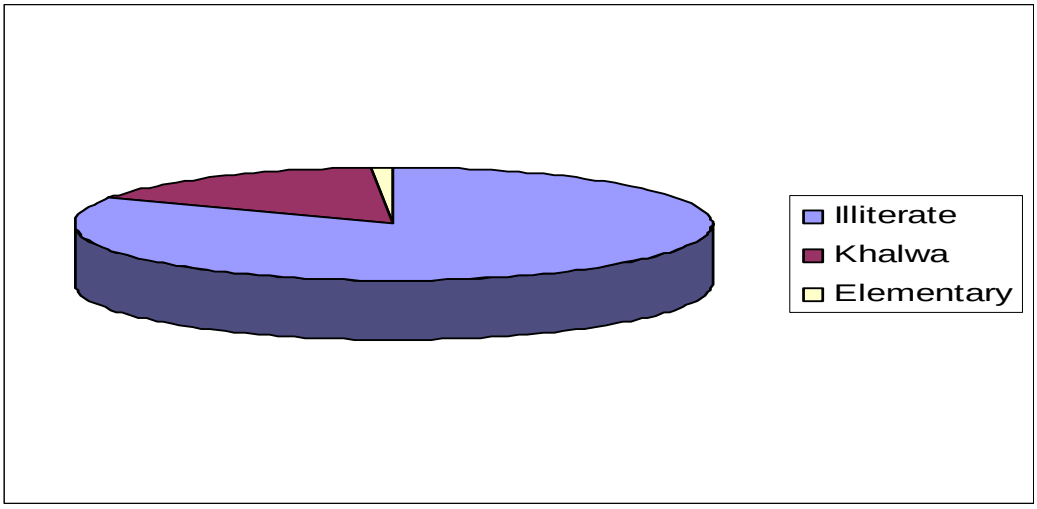
Table (30) and Figure (6) show level of cattle owner's education. Of the 200 livestock owners 165 (82.5%) were illiterate and 33 (16.5%) had

Khalwa education, while only 2 (1.0%) owners were educated to Elementary school level.

Table (30): Education levels of cattle owner's.

Education level	Frequency	Percent
Illiterate	165	82.5
Khalwa	33	16.5
Elementary education	2	1.0

Fig (6): Livestock owner's education level



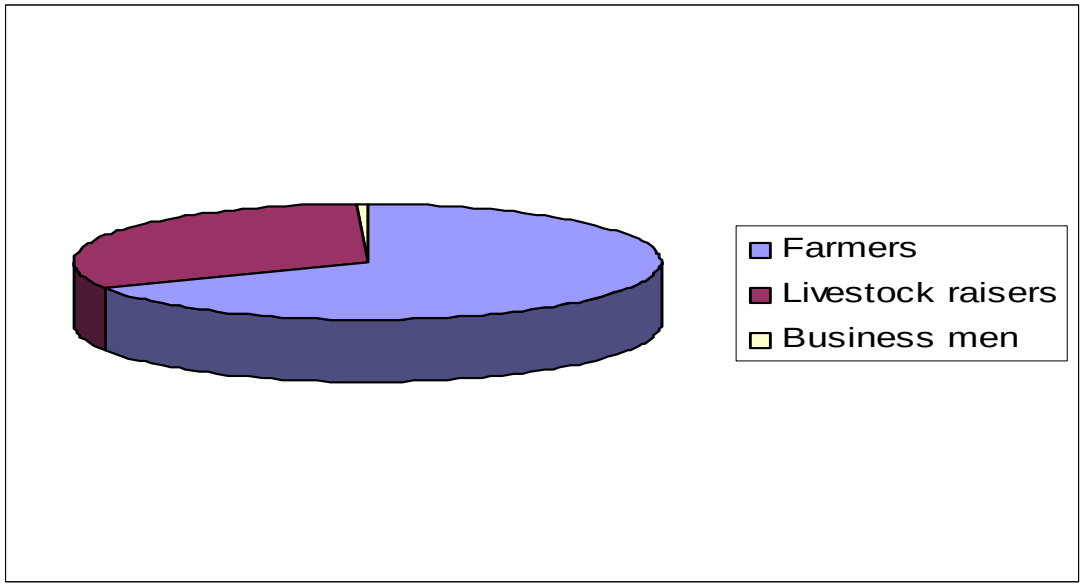
4.1.1.3. Respondent Occupation:

Of the 200 owners, 135 (67.5%) were farmers, 64 (32%) were livestock raiser and (1.5%) owner were businessmen (Table 31 and Figure 3).

Table (31): Respondents Occupation

Occupation	Frequency	Percent
Farmers	135	67.5
Livestock raisers	64	32.0
Business men	1	0.5
Total	200	100.0

Fig (7): Respondent Occupation



4.1.2. Land ownership, size and livestock

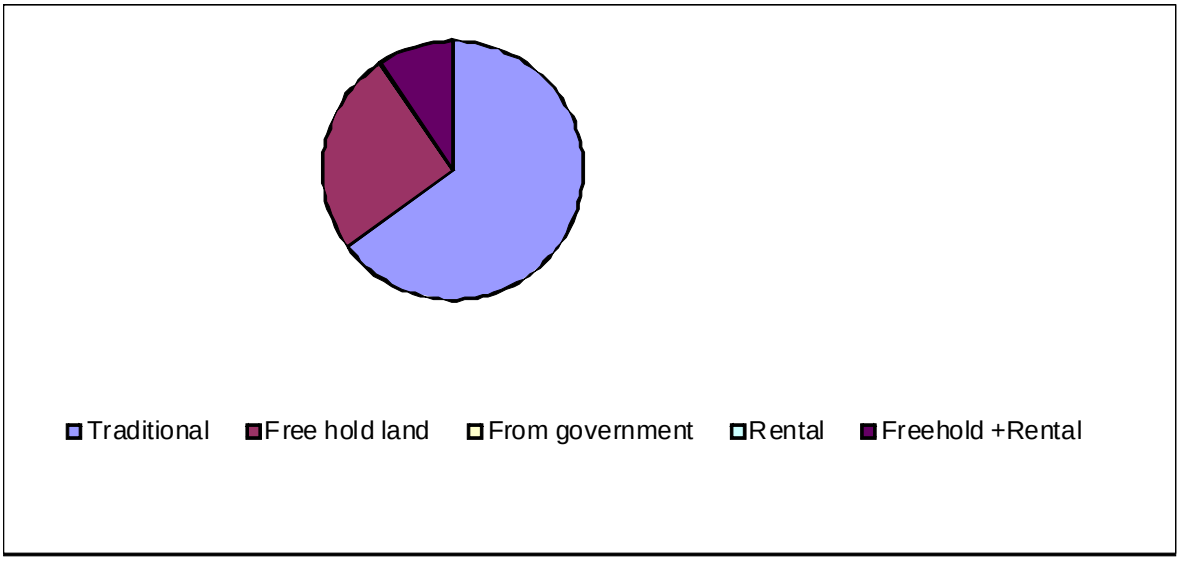
4.1.2.1. Land tenure

Table (32) and Fig (8) Show the proportions of households with land ownership under various land tenure systems. Sixty five percent of the households investigated owned traditional land, followed by those owned free hold land (25.5%), and 9.5% owned by Freehold and Rental land tenure

Table (32): Proportions of households with land ownership under various land tenure systems

Type of land	Frequency	Percent
Traditional		65
Free hold land		25.5
From government		0
Rental		0
Freehold & Rental		9.5

Fig (8): Proportions of household with land ownership under various land tenure systems



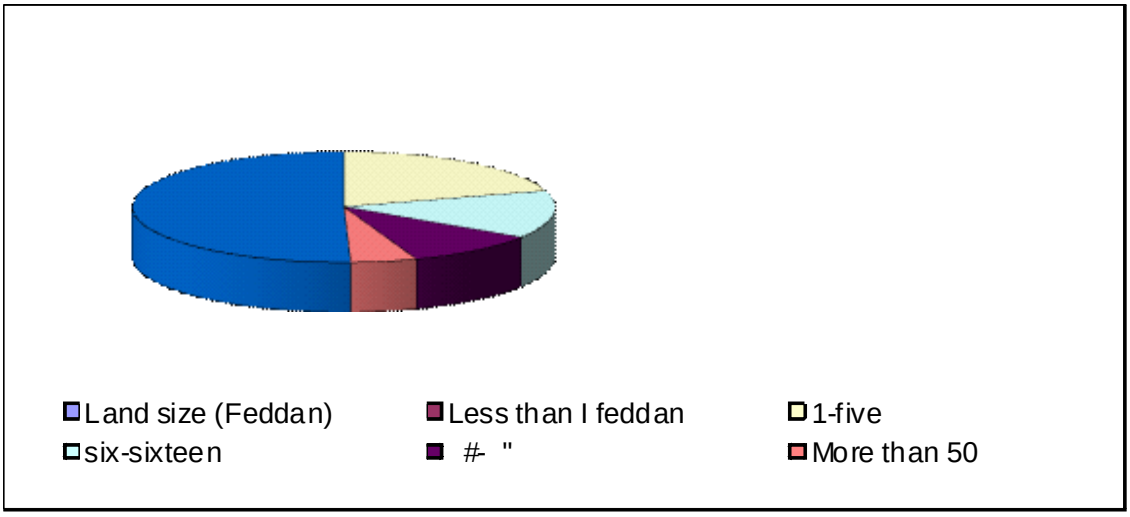
4.1.2.2. Land size

Table (33) and Fig (9) Show the percent of households with different land size. Results showed that 40.2% of households had 1 to 5 feddan, followed by those had 6 to 15 fedan (27.6%); then those had 16 to 50 feddan (20.2%), while the lowest percent (0.0%) for those had less one feddan.

Table (33): The percent of households with different land size

Land size (Fedan)	Frequency	%
Less than one feddan		0
1-5		40.2
6-15		27.6
16-50		20.2
More than 50		10.0
Total members of households		100.0

Fig (9): Percent of households with different land size



4.1.2.3. Ownership of livestock:

Of the 200 livestock owners 100% of the households investigated in the study area, owned all species, cows, sheep and goats (Table 34). The dominant cattle types found in Blue Nile area, Kenana cattle, the Umbararo cattle and Angsana cattle (dwarf type).

Table (34): Percent of livestock ownership

Type of livestock	Frequency	Percent
All species	200	100.0
Cows	200	100.0
Sheep	200	100.0
Goats	200	100.0

4.1.2.4 Herd size and composition

Animal herd size is outlined in Table (35). Sheep are the most frequently kept animals with a total herd size of 125 head. Cows and calves are kept with 86 and 34 heads respectively.

Table (35): Mean, minimum and maximum of livestock herd size

	N	Minimum	Maximum	Mean	SD
Adult cows	200	15	300	85.78	58
Calves	200	6	100	34.32	23
Sheep flocks	200	10	400	124.84	81.87

Fig (10): Mean of livestock herd size

4.1.3. General management

4.1.3.1. Type of farming system:

Table (36) shows the percent of grazing type. The results found that the main type of grazing system in the study area was extensive grazing type.

Table (36): The percent of grazing type

Type of grazing	Frequency	Percent
Extensive grazing	200	100.0

4.1.3.2. Husbandry techniques

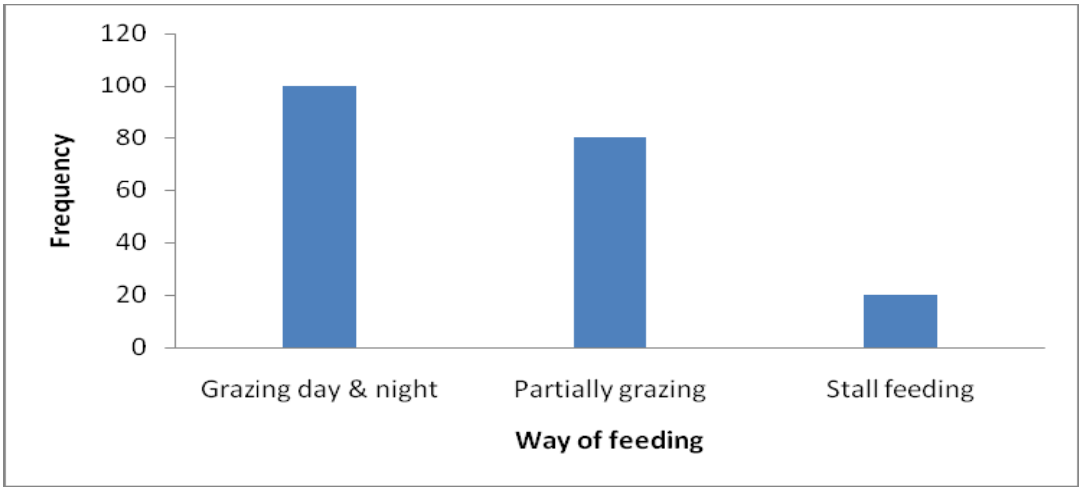
4.1.3.2.1. Feeding

Free grazing of communal rangelands is the most common feeding system. Results showed that animals were grazing during the day and night, especially during the wet season. On the other hand farmers supplement range grazing with stored hay, farm grown crop residues, agro-industrial by-product, irrigated fodder and purchased concentrates to supplement the lactating cows during the dry season table (37) and fig (11). They also add salt minerals and household remains and waste in feeding.

Table (37): Way of feeding

Way of feeding	Frequency	Percent
Grazing day & night	100	50.0
Partially grazing	80	40.0
Stall feeding	20	10.0

Fig. (11): Ways of feeding:



The study showed that all households or respondents (100%) use remains and waste in animal feeding (Table 38) and also they used mineral as salts (Table 39). On the other, all households (100%) use supplementary feeds for milking and weak animals as well as in dry season (Table 35).

Table (38): Use of household remains and waste in feeding

Using remains & waste in feeding	Frequency	Percent
Yes	200.0	100.0
No	0.0	0.0

Table (39): Use minerals salt

Using minerals salt	Frequency	Percent
Yes	200.0	100.0
No	0.0	0.0

Table (40): Use of supplemented feed

Using supplemented feed or nutrients	Frequency	Percent
Yes	200.0	100.0
No	0.0	0.0

4.1.3.2.2. Reproduction

4.1.3.2.2.1. Access to breeds improvement

Table (41) shows access to breeds improvement services. The results explained that all respondents (100%) have access to breed improvement. However; Table (42) shows the methods of insemination used in the breed improvement. The study indicated that all interviewers (100%) used natural services for genetic improvement of animals.

Table (41): Access to breeds improvement services

Access to breeds improvement	Frequency	Percent
Yes	200.0	100.0
No	0.0	0.0

Table (42): Methods of breed improvement

Method of services	Frequency	Percent
Natural services	200.0	100.0
Artificial services	0.0	0.0

Table (43) shows the type of breeds used for inseminating females. The results indicated that all interviewed households in Blue Nile region (100%) use only indigenous animals, no one of them use exotic animals.

Table (43): Type of breeds used by households

Type of breed	Frequency	Percent
Indigenous	200.0	100.0
Exotic	0.0	0.0

Table (44) shows taking dry cows to be conceive, the study pointed that the all respondent (100%) taking dry cows to be conceive.

Table (44): Taking dry cows to be conceive

Taking dry cows to conceive	Frequency	Percent
Yes	200.0	100.0
No	0.0	0.0

4.1.3.3. Veterinary care, veterinary services and vaccination

Table (45) shows the frequency of households who deal with veterinary services and vaccination. The study showed that all of respondents (100%) were dealing with veterinary services e.g. vaccination and diseases treatment. The households explained that annual vaccination has been carried against the infectious diseases such as haemorrhagic septicaemia, contagious bovine pleuropneumonia, black quarter, Rinder pest and anthrax.

Table (45): Frequency of households dealing with veterinary services

Dealing with veterinary services	Frequency	Percent
Yes	200.0	100.0
No	00	0.0

Table (46) shows dominant disease of livestock in the study area. The study indicated that the most prevalent livestock diseases found in the region are: Trypanosomiasis, Pneumonias, Sheep pox, Babesiasis and Heart water.

Table (46): shows dominant disease of livestock in the study area

Disease	Local Arabic names
Trypanosomiasis	الدبان
Pneumonias	التهاب
Sheep pox	جدرى
Babesiasis	بول دم
Heart water	الخدر
Mastitis	التهاب الضرع

The most common drugs used by livestock herders in the area of study are antihelmintics for internal parasites, worms and haemonchus contratus; quinapyramine for treating trypanosomiasis disease; in addition ivomec injection is also used as injection for internal and external parasite according to information obtained from veterinary pharmacies in Sinnar and The Blue Nile Towns. The most dominant drugs used by livestock herders in the area shown in table (47).

Table (47): Common drugs used in the study area

Anti-biotics	Anti-helmentics	Anti-diaherria	Others
Oxyteteracycline	Benzole 2.5%	Sulphadimidine 33.33%.	Udderoid
Enrofldxacin	Teteramizole powder 10%	Enrol 20	Ethedium bromide
Penicllin	Nil vet plus	Diaclen	Diminazlne Diaceturate (Berranil)
Quinapyramine	Ivermactine	Sulfamethoxazol	Mast. Injection
Tylosine	Cyper vet	Enrofloxacin-oral	Cypermethrin

4.1.4. Markets for animals and animals products

There are many livestock markets in the Blue Nile State. The largest markets are found in Eldamazeen town and Dandaro market. The last one is a largest for Watish sheep and cross Fulani sheep. On the other hand Bout market is the largest one for Kenana cattle. Table (48) shows the different locations of markets in the Blue Nile state; the marketing days among every week and the trading season.

Table (48): Different locations of markets in the Blue Nile state

Market	Day	The best season
Eldamazein	Daily	All seasons
Bout	Daily	Summer
Wad abook	Sunday	Summer
Roro	Monday	Summer
Baw	Wednesday	Harves season
Elkormok	Daily	Summer
Dandaro	Thursday	Summer
Elrouseris	Daily	All seasons
Elrougeyba	Wednesday	All seasons
Ganees	Daily	All seasons
Senga nabag	Thursday	Summer
Bakori	Saturday	Summer
Galgani	Thursday	All seasons
Elkhartoum bellail	Friday	Summer
Amoura	Monday	Summer
Elgari	Thursday	Summer
Gesan	Sunday	Summer
Badoos	Tuesday	All seasons

Source: Field data Eldamazeen state (2008)

Animal owners have to sell when they go to the market even if they are offered prices that are lower than their expectations because of their need for the cash money. In case prices are lower than anticipated price. Some of them take their animals back and incur additional costs; while others might wait for the following market-day. In Sinnar State livestock markets found in all towns was Sinnar, Singa,Abuhugar, Wadelnail, Dindir. Also there is important camels market in Doupa in East Sinnar city.

4.1.4.1. Livestock prices:

Livestock prices depend on many factors such as age, sex, function, breed and local taxes. Kenana cattle type are aged breed is usually more valuable than other breeds because of the high demand for this type in the Blue Nile area. On the other hand Umbororo cattle and Watish sheep were found with a large numbers.

4.1.4.2. Kinds of output produced

Table (49) shows the kind of output produced by livestock owners. The results explained that the all respondents (100%) produced meat and milk as same as manure, however; all respondent revealed that they could not produce eggs, chicken, skin and hides; and also did not use animal for draft power.

Table (49): Kinds of output produced

Kinds of Output	Frequency	Percent
Meat	Yes	100%
Milk	Yes	100%
Eggs	No	100%
Chicken	No	100%
Skin& Hides	No	100%
Manure	Yes	100%
Work force	No	100%

4.1.4.3. Items on which income from livestock production is used

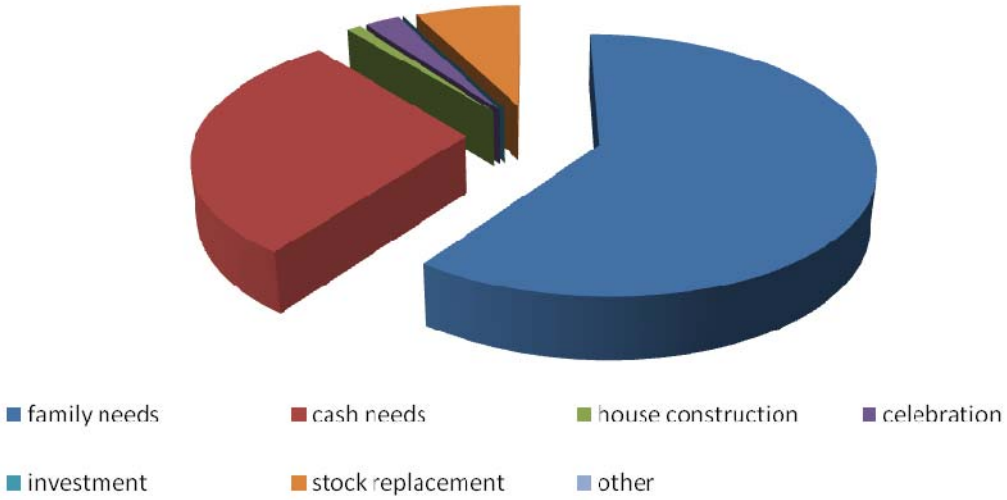
Table (50) and Fig (12) Show the contribution of the livestock to household welfare of the small commercial farmers during the past 12

months. Sixteen percent of the households interviewed used their income from livestock on family needs (food clothes, marriage, medical treatment etc), 29% on Cash needs (animals feed, medicines & vaccination; salt, water, taxes, travel, herding cost, education), 1% on house construction or furnishing, 2% on Celebrations (Eids, Ramadan, marriage ceremonies, etc.) and 7 % on stock replacement.

Table (50). Contribution of livestock to household welfare of the animal owners during the last 12 months.

Use of income from livestock	Frequency	Percent
Family needs: (food, clothes, marriage, medical treatment etc.)	120	60%
Cash needs: (animals feed, medicines &vaccination, salt, water, taxes, travel, herding, cost, education fees)	58	29%
House construction or furnishing	2	0.1%
Celebrations (Eids, Remadan, marriage ceremonies, etc.)	5	0.2%
Investing in business	0	0.0%
Stock replacement	15	0.7%
Others	0	0.0%

Fig (12): Contribution of livestock to household welfare of the animal owners



4.1.5. Production constrain

Water supply during the dry season is the most important constrain to the livestock herders in the study area.

4.1.6. Future goals for livestock keeping

The investigated households in the study area said they would like to expand their herd size and improve their breeds.

4.1.7. Purpose of keeping cattle

All animal owners consider that the primary reasons for keeping animals to generate income from the sale of milk and animals, in addition to milk for home-consumption or as insurance against financial problem.

4.1.8. Trees, shrubs, grasses and herbs browsed or grazed by dromedary:

Table (51): List of grass species preferred by dromedary during the dry and wet seasons in the study of area.

Scientific Name	Arabic Name
Cymbopogon nervatus	النال
Sorghum perpureo Screcium	انيس
Brachiaria Spp.	أم كويعات
Rottboellia Spp.	رزا
Ipomoea Spp.	التبر
Echinochloa Pyramidatis	أم جر
Dactlyocteniem Spp.	ابو اصابع
Seltaaria Spp.	ضنب الكديس
Ennisetum Vamsum	البعشوم
Ischaemum Afrum	أنكوج
Esmodium Spp.	أبو عريضة
Danebere Spp.	أم ماملیحة
Pennisetum polstachion	أم خميرة

Table (52): List of tree species preferred by dromedary during the dry and wet seasons in the area

Scientific Name	Arabic Name
Acacia meltifera	الكتر
Balanites aegyptica	الهجليج
Acacia nubica	اللعوت
Acacia seyal	*الطلح*
Acacia Senegal	الهشاب
Tamarindus indica	العرديب
Hyphaene ihebacia	الدوم
Adansonia digitata	التبلدى
Acacia nilotica	السنط
Zizyphus spina-chtisti	السدر
Boswellia papyrifea	الطرق طرق
Commijera Africana	القفل

Plate (2): Hay

Plate (3): Botab

4.1.9: Water points:

The study area is characterized by the largest water resources in northern Sudan. They are comprised of the Blue Nile that extends from the Ethiopian borders to the Rosairis Dam Lake and water resources between the Dam and the borders of Sinnar state in the north. Water resources in the area are available and sufficient for human consumption, as well as crop and animal production. Surface water from excessive rain fall collects in seasonal Khors (water runways) and "wadies" (valleys) within or outside the area. The estimated total drainage of "Khor" reach within the area is 700 million cubic meters, while annual drainage of some Khors reached 80 million cubic meters. Under ground water supply is available in the Blue Nile basin to depth of 10 to 50 cubic meters. The Blue Nile water, in addition to the high rain fall, marks the area as the richest in water resources. The nomadic people depend for their water needs on more than one source, while the semi-nomadic and sedentary systems depend for their water need on hafeirs. The main sources of water for livestock in the study area were showed in Table (53).

Table (53): Main sources of water for livestock in the study area.

Water resources	No.
River	2
Hafeir	57
Khors	12
Irrigation canal	35

4.1.10. Labour division

The results showed that the long term labours were found major contributed in household involved in grazing, cut, carry feed, caring for the animals and in milking. Only (5%) of adult males involved in purchase or search for feed and watering drugs. On other hand the most household head (95%) involved in purchase or search of feed and veterinary drugs. The study showed that, the adult female have not any significant role in livestock breeding activities(Table 54).

Table (54): Labour division in the study area

	% of HHs involved in grazing	% of HHs involved incut & carryfeed	% of HHs involved infeed, watering, caring for the animals	% of HHs involved in purchase or search for feed and veterinary drugs	% of HHs involved in milking	% of HHs involved in selling milk	Manging large stock
HH head	0	5%	0	95%			
Adult males	5%	0	5%	5%	5%	75%	5%
Adul females	0	0	0	0	0	3%	0
Any HH member	0	0	0	0	0	2%	0
Children	0	0	0	0	0	0	
Long term labour	85%	85%	85%	0	85%	0	85%
Causal labour	10%	10%	10%	0	10%	0	10%

Plate (4): Kenana cattle

Plate (5): The Blue Nile as a main source of watering livestock

4.2 Survey results derived from questionnaire of sheep owner's:

Sheep which found in the Blue Nile and Sinnar states are dominated by Watish breed of sheep. Watish breed of sheep are owned mainly by Rufaa and Kenana tribes. In Sinnar state the major concentration of these tribes are found around Umbanien, Wadelnail, Aldinder, Almazmom and Kenana.

4.2.1 Herd structures:

Herd structure of Watish sheep was showed in table (55). Results revealed that 32.00 heads were old ewes (in their 4^{th} to 6^{th} birth), while an average of 17.25 heads for ewes ranging from 1^{st} and second birth. In this study the average male and female accounts to 38.25 to and 23 heads, respectively..

Table (55) Shows herd structure of watish sheep in the studied area.

Item	Mean	SD	Minimum	Maximum
Ewes (4-5 birth)	32.0	18.60	15	90
Ewes(1-2 birth)	17.25	11.75	5	60
Male lambs	38.25	31.01	13	150
Female lambs	23.00	9.93	12	50

4.2.2 Historyof herd:

Table (56) shows the herd of history. The majority of interviewers (65%) indicated that their herd had been purchased before 1-5 years, while 35% indicated that the herd comes to them from ancestor

Table (56): History of herd

Type	Frequency	Percent
1-5 years	13	65%
Inherited	7	35%

4.2.3 Herd type:

Table (57) shows the kind of herd in the studied areas. Results revealed that all sheep owners breed permanent herd, no one of them have flying herd.

Table (57): The kind of herd

Kind of herds	No.	Percent
Permanent	20	100%
Flying	0	0%

4.2.4 Herd size:

Herd size of Watish sheep in the studied area was shown in table (58). The majority of sheep owners (60%) had herd size ranging between 21-50 heads, followed by those ranging from 51-100 heads. While the lowest percentages were recorded for those ranging from 10 to 20 and 101 to 200 heads.

Table (58): Herd size of Watish sheep

Herd size	No.	Percent
10-20	1	5%
21-50	12	60%
51-100	6	30%
101-200	1	5%

4.2.5 Objective of sheep breeding:

Table (59) shows the objectives of sheep breeding. All sheep owners (100%) indicated that they breed sheep for production of meat.

Table (59): Objective of sheep breeding

Production	No.	Percent
Meat	20	100%
Milk	0	0

4.2.6 Feeding of Watish sheep:

Watish sheep depend on natural range in summer season. The owner offered sometimes green fodder and agricultural residues. However, in rainy season the animal depend on grazing of natural range.

There are constraints hindering sheep production in study area which includes a number of factors: extending of mechanize crop farming, high and duplicated taxes, shortage of water in summer season, and far distances between water points and grazing areas. Lambs start their feeding on grasses at one of month after birth. Herd graze all the day about 12 hours. Sheep owners preserved and stored the roughages and feed on dried form (hay). Some owners use the (Lubia, Adass and Dura) in feeding of ewes as flushing to increase rate births and fertility of animals.

4.2.7 Milk production:

Table (60) shows milk production of Watish ewes. Results showed that 75% of interviewers reported that the ewes produce 0.5-1.5 litre of milk /day. While 25% of them explained that the milk production varied between 2-2.5 litre ./ day.

Table (60): Daily milk production of Watish ewes

Milk production (Kg.)	No.	Percent
0.5-1.5	15	75
2.0-2.5	5	25

4.2.8 Importance of sheep milk:

All respondents explained that they perfer sheep milk and also they used the milk to feed childern. However, the sheep milk was used for spleen disorder therapy in human. The respondents revealed that the milk is more perferred than goat milk. All the interviewers revealed that they did not profit change the breeding of sheep to cattle grazing because the sheep breeding is easiest, more profitable and shortest production duration.

4.2.9 Weaning and reproductive traits:

4.2.9.1 Age at weaning:

Age of lambs at weaning was shown in table (61). Majority of investigated households (85%) indicated that weaning age of lambs was 3.5-5 months, followed by (10%) weaned their animals at age of 5.5-7 month, while few of them (5%) weaned lambs at more than 7 month.

Table (61): Age at weaning

Age	Frequency	Percent
1-5 month	17	85%
5.5-7 month	2	10.0%
More than 7 month	1	5.0%

4.2.9.2 Puberty ages:

Table (62) shows puberty age of males. 40 % of interviewers explained that the male lambs reached maturity at age of 10.5-12 months, followed by 6-8 month, then by 8.5-10 month, while lowest percent (15%) for those reported age of full sexual maturity as reached at the age of one year and more. On the other hand; the interviewers explained that, the average age at first lambing was 12 months, lambing interval of 6.7 months and the gestation period was 5 months, while the percentage of lambed ewes was 80%.

T able (62): Puberty age of males

Age	Frequency	Percent
6-8 months	5	2.5.0%
8.5-10 months	4	20%
10.5-12 months	8	40%
More than year	3	15%

Productive ages of rams and ewes were found in table (63). Results showed that rams reach full productive life at the age of 7 years with standard deviation of o,86 year, while the full productive life of ewes may reach 9.90 years with standard deviation of 1-02 year. On other hand, all interviewers explained that they adopt selection program for their lambs. They select best to best ewes, rams and lambs to be kept for breeding. All respondents expressed that the season of breeding usually starts at 15 August, then the lambing season at 15 January. No one of the respondents used hybrid ram for service. All breeders use pure rams from Watish type. Moreover all respondents breed pure ewes of Watish breed.

Table (63) Productive age of male & females sheep

Sex	No.	Mean	SD	Minimum	Maximum
Ram	20	7.00	0.86	4	8
Ewes	20	9.90	1.02	8	12

4.2.10 Health care:

Sheep herds were yearly vaccinated against sheep pox and Rinder pest. Common diseases in the studied area are rinder pest, sheep pox and pneumonia. Governmental veterinary services are lacking, however herders seek veterinary services from private veterinarian and drug suppliers. All herd men revealed no extension programs in the studied area, practices applied on the herds are due carrying fleece shaving, drinking antihelimenths and practice spraying against external parasite.

Plate (6): El Bahla (local breeding season).

Plate (7): Gabali goat

Plate(8) Fodder production

4.3 Survey results derived from questionnaire of camel owner's:

4:3:1 General household information:

Table (64) presents the education level of camel owners. The results revealed that 95.8% of camel owners were illiterate and 0.0% completed primary school, while only 4.2% of them were university graduates.

Table (64): Education levels of camel owners in study area.

Level of education	N	%
Illiterate	23	95.8
Primary	0	0.0
Graduated	1	4.2
Total	24	100

Table (65) shows the numbers and percentages of the different livestock species in study area. Of the 24 camel owners interviewed 4.2% owned only camels, 4.2% camels and cattle, 4.2% camel and sheep.

Table (65): Livestock species for camel owners in the study area

Livestock species	N	%
Camel	1	4.2
Camel, cattle	1	4.2
Camel, sheep	1	4.2
Camel, goat	0	0
Camel, cattle, sheep	2	8.3
Camel, sheep, goat	5	20.8
Camel, cattle, sheep, goat	14	58.3
Total	24	100

Table (66) shows the importance of livestock and crop farming in the surveyed area. The majority of camel owners (91.7%) indicated that their

main activity was livestock breeding, and 7.8% had both livestock breeding and farming as the main activity.

Table (66): The importance of livestock and crop farming in surveyed areas

Main activities					
Livestock		Farming		Livestock & farming	
N	%	N	%	N	%
22	91.7	0	0.0	2	8.3

Table (67) shows the numbers and percentages of respondents who had grown and sold crops within the past 12 months. The questionnaire survey showed that 54.20% of respondents in study area grew crop. Only 38.5% of respondents reported that they sold crops within the past 12 months.

Table (67): Crop growing and selling in study area within 12 months prior to time of survey

Crop growing				Crop sold			
Yes		No		Yes		No	
N	%	n	%	N	%	N	%
13	54.2	11	45.8	5	38.5	8	61.5

4.3.2 Management systems and migrations during past year:

Camel management systems adopted by owners in studied area are shown in Table (68). The majority of camel owners (66.7%) adopted a sedentary management system, 33.3% of owners adopted a nomadic system, while only 8% of them adopted a transhumant system.

Table (68): Camel management system

Management system					
Nomadic		Transhumant		Sedentary	
N	%	N	%	N	%
8	33.3	0	0	16	66.7

Table (69) showed camel migration during the past 12 months prior to the conduct of the survey in study area. Most camel owners (95.8%) migrated with their animals during the last 12 months; in search of pasture and water and escaping from insects in the rainy season. All camel owners moved to the north in the wet season and returned to their original areas in the dry season. 95.8% of camel owners migrated during the last 12 months. Those owners remain in the dry season (Nov. to June) in southern Sinnar state and north Blue Nile state; then they move to the northern approaches of Dweim town (White Nile state) in the wet season.

Table (69): Camel migration in surveyed area

Migrated		Not-migrated	
N	%	N	%
23	95.8	1	4.2

4.3.3 Livestock herd size and camel herd

The livestock herd size in study area is presented in Table (70). The average camel herd size in surveyed areas was 63.71 heads, the average sheep flock size was found to be 207.00 heads. The results revealed that the average goat flock size in studied areas was 42.47 head.

Table (70): Livestock herd size in study area,

Species	Study area	
Camel	N	Mean
Cattle	24	63.71
Sheep	14	25.50
Goat	20	207.00
	17	42.47

The camel herd composition in surveyed area is shown in Table (71). The percentage of she-camels in this study was 76.8% in study area. The young male and female calves (< 1 year) have almost similar percentages (6.0 and 6.8%, respectively). The percentage of growing females (< 4 years) was greater than the percentage of growing males

Table (71): Camel herd composition in study area

Item	No	%
Mature females	26.7	41.9
Females <4	13.6	21.4
Females <1	6.8	10.7
Mature males	1.8	2.8
Males <4	8.8	13.8
Males <1	6.0	9.4
Castrated males	0.0	0.0

4.3.4 Camels sold, bought and died:

Numbers and percentages of camel owners who sold and bought camels are presented in Table (72), while, the numbers of camels sold and

bought are reported in Table (73). Fifty percent of camel owners in study area sold animals within the 12 months proceeding the survey period, The camels were sold for various reasons; in the study area the camels were sold in order to buy sorghum residues after harvesting (straw), pay taxes and to cover family needs, solve agricultural financial problems and buy breeding females (after selling male camels) and buy sorghum residues. In addition to the previous reasons, management cost of animals and covering cost of camel herder

Table (72): Percentages of camel owners who sold or bought camels within the past 12 months

Camel sold				Camel bought			
Yes		No		Yes		No	
N	%	N	%	N	%	N	%
12	50.0	12	50.0	2	8.3	22	91.7

Table (73): Numbers of sold and bought animals

Sold animals:	
Both sexes	5.33
Males	2.42
Females	2.92
Bought Animals:	
Both sexes	1.50
Males	0.00
Females	1.50

The majority of camel owners (91.7%) did not buy animals within the last 12 months preceding the survey period. The percentages of camel

owners, who bought animals in study area, were 8.3. The number of animals bought was (1.50). Generally, breeding purposes were the main reasons for buying camels in all the studied areas (numbers of female camels bought more than males).

The results showed that 70.8% of respondents reported that some of their camels died within the last 12 months (Table 74). Diarrhea of young calves (1-12 months) was the main cause of losses in camel herds in the studied areas. However, other diseases e.g. trypanosomiasis, internal worms, bloat and pneumonia were also important. Fractures, wounds and snake bites were also reported in study area as a common factor in camel losses.

Table (74): Percentages of camel owners having dead camels within 12 months and numbers of dead camel

Incidence of camel death				No. of dead camel		
Yes		No				
N	%	N	%	Males	Females	All
17	70.8	7	29.2	1.65	2.76	4.41

4.3.5 Breeding practices:

91.7% of camel owners in study area kept breeding camels. (Table75). The results also revealed that the average number of breeding camels was 1.41 camels per herd, (Table 75). Camel owners who did not keep breeding camels reported the small size of herd and death of breeding camel as the main reasons for absence of a breeding camel. Two breeding seasons were identified in the surveyed area, one in autumn (July - Oct.) and the other in winter (Nov. - Feb.). In herds with two breeding camels, the first was activated in the autumn breeding season and the other was used in the winter breeding season. The majority of breeding camels belonged to the

pack type (Arabi camel and Rashaidi). However, in study area breeding camels belonged to the riding type (Anafi and Bishari) were also observed.

Table (75): Percentages of camel owners keeping breeding camel and numbers of breeding camels

Keeping of Breeding camel				No. of breeding camels		
Yes		No		Minimum	Maximum	Mean
n	%	n	%			
22	91.7	2	8.3	1	3	1.41

Table (76): Source of breeding camels, age of selection and age at end of herd life

Sources of breeding camel						Ages of	
Own herd		Other herd		Purchased		Selection	Keeping
N	%	N	%	N	%	Years	Years
19	86.4	0	0.0	3	13.6	4.14^{b}	17.38^{b}

a,b means with the same letters were insignificantly ($P < 0.05$) different.

The results in Table (77) showed that 41.7% of camel owners sold male camels that were not selected for breeding purposes, 33.3% of owners sold males as castrate camels, while 25.0% were camels used for various purposes such as packing, droght power and riding.

Table (77): The fate of male camels not selected for breeding purposes

Castrate		Kept in herd		Sold		Other	
N	%	N	%	N	%	N	%
8	33.3	0	0.0	10	41.7	6	25.0

Table (78) shows the source of replacement breeding camels. The majority of camel owners (91.7%) reported that they select replacement breeding camel from their own herd, 8.3% of owners selected them from other herds. 100.0% of interviewees explained that they select the son of former breeding camel to become the new replacement breeding camel. Dam reproduction and milk performance, sire performance, body size, conformation of animal selected, grazing behavior, health and vigor were the most important characteristics for camel owners when selecting breeding camels of pack types (Arabi and Rashaidi camel). However, dam and sire performance, shape of animal selected and racing ability were the most important properties for camel owners when selecting breeding camels of the riding types (Anafi and Bishari).

Table (78): Source of replacement of breeding camel

Source of replacement breeding camel						Son of former breeding camel			
Own herd		Other herd		Purchased		Yes		No	
n	%	n	%	N	%	n	%	N	%
22	91.7	2	8.3	0	0.0	23	100.0	0	0.0

The goals of camel improvement were presented in Table (79). The study showed that the improvement of camel for milk and meat production ranked first (54.2% of respondents), followed by improvement for meat (29.2%) and for meat and racing (16.7%).

Table (79): Goals of camel improvement

Goals of improving camels											
Milk		Meat		Racing		Milk, meat		Milk, racing		Meat, racing	
n	%	N	%	N	%	N	%	N	%	N	%
0	0.0	7	29.2	0	0.0	13	54.2	0	0.0	4	16.7

Table (80): Percentage of camel owners having plans for camel improvement and method of improvement

Have plan				Method of improvement					
Yes		No		Selection		feeding		Selection & feeding	
n	%	n	%	N	%	N	%	N	%
24	100.0	0	0.0	21	87.5	0	0.0	3	12.5

All camel owners in study area stated that they have plans to improve their camels. (Table 80). 87.5% of respondents reported that they improve camel production by selection of the best breeding camel, no one of them improve camels by feeding, while 12.5% of them improve their camels by selection and feeding together.

4.3.6 Milk production and reproductive performance:

Milk production performance is outlined in Table (81). Results showed that the average milk yield was 1508 liter. The camel owners reported that camels produced the highest milk yield in autumn because of the abundance of lush pastures and sufficient water. Rashaidi tribe milked their camels twice a day. However, other tribal groups milked their camels 3-4 times a day. The results of this study showed that the average lactation length in Sudanese camels was 10.54 months.

Table (81): Milk production performance of camels breeds of Sudan

Milk production (liter)				Lactation length (month)
Beginning	Middle	End	Total	
7.38 ± 2.19^{a}	4.63 ± 1.37^{a}	2.18 ± 0.84^{a}	1508 ± 533^{a}	10.54 ± 1.64^{a}

a,b means with the same letters were insignificantly ($P > 0.05$) different.

Statistics of reproduction traits of camels are given in Table (82). The results revealed that the age at first calving and calving interval were 5.18' 20.83 months, respectively.

Table (82): Reproduction performance (mean ± SE) of camel breeds

Age at first calving (years)	Calving interval (months)	No. of services per conception	Age keeping she camel (years)
5 ,18 ±1.05[bc]	20,.83 ±2.88[a]	1.56 ± 0.31 [a]	16,.71 ± 4.56 [a]

a,b,c means with the same letters were insignificantly (P > 0.05) different.

Table (83): Production objectives of camel keeping

Drought		Low cost		Way of life		Save money		Social	
n	%	n	%	N	%	N	%	N	%
8	33.3	7	29.2	7	29.2	2	8.3	0	0.0

4.3.7 Purposes of keeping camels:

Table (83) shows production purposes of camel keeping. 29.2% of interviewees said that the keeping of camels is a way of life; 29.2% of them said they keep camels because they cost little and their revenues are high; 33.3% reported that they keep camels because they are drought tolerant and perform well in extremely dry years. Income from sale of animals, milk for home consumption, insurance against financial crises and investment opportunity were also reported as reasons of camel keeping.

4.3.8 Feeding and watering:

The majority of camel owners (87.5 and 75.0%) considered that the feeding and water supply respectively were important constraints to their herd production (Table 84). The camels depend mainly on grazing and

browsing. Minerals (salt) were commonly used as a nutritional additive in surveyed areas.

Table (84): Feeding and water supply

Feed is a constraint				Watering is a constraint			
Yes		No		Yes		No	
n	%	N	%	N	%	N	%
21	87.5	3	12.5	18	75.0	6	25.0

The duration between every two consecutive watering times and distances between water points and grazing areas are shown in Table (85). The duration between every two waterings ranged between 4.9 and 7.9 days in the summer season. The duration between waterings is very variable in the winter and autumn seasons among the studied areas. Also results showed the great variability in distances between water points and grazing areas in different seasons. The sources of drinking water for camels were rivers.

Table (85): Duration between every two watering times and distance between water points and grazing areas

Duration (day)	Autumn	26.6[a]
	Winter	7.9[b]
	Summer	4.9[b]
Distance (km)	Autumn	9.6[a]
	Winter	26.1[a]
	Summer	29.0[a]

a,b means with the same letters were insignificantly (P > 0.05) different.

Data revealed that only 87.5, 87.5, 91.7 of respondents had access to free water supply for their animals in summer, autumn and winter seasons. Trees, shrubs, grasses and herbs which were browsed or grazed by camels are showed in(table 51 and 52).

Table (86): Percentages of camel owners had free charge or paid of water supply

Seasons					
Summer		Autumn		Winter	
Free	Paid	Free	Paid	Free	Paid
87.5	12.5	87.5	12.5	91.7	8.3

4.3.9 Animal health and camel production constraints:

Data in Table (87) shows the incidence of diseases during the past 12 months and sources of veterinary help available. 79.2% of respondents reported the incidence of diseases within the 12 months proceding the survey. Results also revealed that the majority of camel owners (87.5%) in surveyed areas use veterinary help from drug suppliers, while 12.50 % found help from private services.

Table (87): reports of diseases during preceding 12 months and sources of veterinary services

Report any disease during past 12 month				Veterinary help from							
Yes		No		Government services		Private services		Drug suppliers		Others	
n	%	n	%	N	%	N	%	N	%	N	%
19	79.2	5	20.8	0	0.0	3	12.5	21	87.5	0	0.0

Important diseases in studied area are shown in Table (88). Mange, ring worms, pneumonia, trypanosomiasis, anthrax, external parasites (ticks

and lice), internal parasites (worms) and calf's diarrhea were prevalent diseases in the studied areas. Trypanosomiasis was reported as the most important disease by 91.7% of camel owners in study area.

Table (88): Important camel diseases in studied areas

Disease	N	%
Contagious skin necrosis	1	4.2
Calf Diarrhea	0	0.0
Dermatomycosis	0	0.0
Wry neck syndrome	0	0.0
Mange	1	4.2
Pneumonia	0	0.0
Anthrax	0	0.0
Ticks	0	0.0
Trypanosomiasis	22	91.7

Production constraints which were defined by camel owners are presented in Table (89). 20.8% of camel owners in study area mentioned the lack of feeds as a constraint. Disease was the second most important constraint, but it ranked as the most important constraint in study area. Water shortage was also considered as a constraint by camel owners in study area (4.2%). A small portion of camel owners in the surveyed areas mentioned that labour, capital, taxes and lack of security were important constraints.

Table (89): Serious constraints to camel production

Serious constraint	N	%
Diseases prevalence	13	54.2
Lack of feeding	5	20.8
Shortage of water	1	4.2
Labour	2	8.3
Lack of security	1	4.2

Plate (10): Sudanese Camels (Arabian Types)

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5–DISCUSSION

Livestock play important roles in human life, in the tropics as well as elsewhere. They are especially essential in semi-arid and arid zone, since they provide a wealth resource to the farmers (FAO, 2006). In mixed crop-livestock farming system, the land used for growing crops in the wet season can, after harvest, be grazed by the livestock (Sudanimals, 2006). In the dry part of the year, farmers in these areas have no other income than what they can get from their animals in terms of milk, meat and skins, both for subsistence and commercial use. By using livestock as draft power, the land available for cropping can be considerably increased. Improved crop production can give more income for the family, as well as potentially increasing the storages for the dry season of vegetable foods for humans as well as fodder for livestock.

Pastoralism and livestock are significant in Sudanese history as well as in present. Several sources interviewed for this project estimated that 80 to 90 percent of Sudanese households own livestock, with perhaps one third to one-half of all households reliant upon livestock for their livelihood. Despite of importance of livestock for Sudanese rural and urban they are poor populations.

As shown in table (29) 100% of those responsible for livestock keeping were males. The reason behind this could be attributed to the fact that in the study area, traditionally investment in livestock is male business. This result is in agreement with the findings reported by Elniema (2008). The middle aged (31-60 years) was the most numerous group of the livestock keepers in the study area. For some older people livestock keeping provides a coping strategy for retirement. This result is in agreement with the findings reported by DFID (2002) in East Africa. 82.5% of livestock

owners were illustrated (16.5%) had Khalwa education, while only (1%) visited elementary schools.

In the present study about (67.5%) farmers, (32%) were livestock breeders and (0.5%) were small businessmen. The land tenure system in the study area showed that (65%) owned traditional land, followed by (25%) had freehold and rental land tenure. On the other hand, the land size showed that from 1-5 feddan (40%0), followed by those had 6-15 fedan (27%), then those had 16-50 feddans (20%). In this study, it is shown that there had been a clear trend in terms of the livestock types and species kept by farmers in the study area. The most common ruminant types were cattle, followed by sheep and goats. This result goes in line with the findings reported by DFID (2002) in east Africa who observed the same trend in livestock types and species kept by farmers. Cattle are one of the most important species of livestock in the world, due to their ability to provide milk, meat and draft power (Payne &Wilson, 1999). The high nutritional value of milk is of considerable impossible to humans particularly in poor communities. As a highly palatable source of protein, energy, vitamins and calcium, it makes a significant difference in the diet for especially women of reproductive age and children (Gebre-Medhin, 1996). To the farmers, milk production constitutes a continuous source of income, while the livestock can be used for other purposes (draft power, producing calves and ect.) at the same time. Sheep are most kept animal with a total herd size of 125 heads. Cows and local calves are kept with 86 and 34 head, respectively.

The results of this study showed that the main type of farming system was extensive grazing system, this because the study area is reputed for its rich and extensive natural vegetation cover, which is available for natural grazing. This cover is present in the herd grazing routes, Khors and reserved forests. There are eighty grazing routes, 1380 km long and 4 km wide, which

occupy 1000 Fedan. The grazing routes are generally secure. There are also twelve Khors with an average width of 6 km. The available grazing area in forests is about 4 million Fedans. The vegetation cover varies with amount and distribution of rains, soil type and elevation above sea level. Further more, the area is characterized by a thick cover of trees which constitute 75% of the total area. The species vary depending on amount of rains and predominant environmental conditions. The area is, there fore, the richest in tree cover compared to other States in the Sudan.

The results showed that 50% of the cattle owners were grazing day and night. Two main types of feeding methods were identified. These are extensive grazing and partial grazing. Table (36) shows that 10 % adopted stall feeding. Livestock kept for mainly subsistence purposes is often encountered scavenging and foraging supplemented with household waste. It is also shown that farmers use wild grasses collected from agricultural and empty plots and or obtained as a result of grazing or partial grazing, were incorporated in the rations. This could have been due to the farmers decision to reduce feed cost. Farmers supplement range grazing with stored hay, farm crop residues, agro-industrial byproducts, irrigated fodders and purchased concentrates for lactating cows during the dry season. The study showed that all the respondents use remains and waste farm products as well as salt as minerals in animal feeding. Free grazing of rangelands is the most common feeding system. During the short wet season grasses grow rapidly producing abundant biomass. The body condition of the grazing animals is at its best during this period , but with the onset of the dry season both quality and quantity of the pasture herbage decline and fail to support any performance demand. In fact, in most cases livestock catabolise body reserves and loose body weight during this period to meet maintenance requirements, and then compensate body weight during the next rainy season. (Ryan, 1990 and

Barash, 1994). However, with a market oriented dairy production system opportunities for investing in active forage production and conservation methods can be an option. Such methods can be pursued for forages adapted to the prevailing ecological conditions. Elsewhere, legumes and fodder trees have been developed and tested by ILRI; similar work can be done in Sudan. All these feed sources can be integrated into improving crop-residue utilization and for complementing dry season rations. Additional use of agro-industrial by-products available in the region (e.g. Molasses and Sugar cane residues) can also be considered as a major component of the agro-pastoral systems in arid and semi arid zones, in addition to other species (sheep, goat and cattle).

Most of the farmers were engaged in dairy farming and tended to keep improved breeds of cattle. The productivity of an animal depends on genetic potential as well as nutrition and management, including protection against disease. The latter comprises dipping, vaccination and preventing the animals from meeting the infectious agent, for example by keeping the herds closed. The performance of Kenana in this study clearly indicated the effect of feeding management and the possible scope for performance potential exploitation of Kenana cattle with the improvement of the production systems. The main production objective of Kenana cattle owners is directed to award production as a source of regular cash income and home consumption. Therefore, any management measures to improve the performance level must take into account the selection of best performing bull and dams and this will go along way to improve the economic condition, and also this will lead to food security of the people in this area. The average level performance *of Bos indicus cattle is generally lower than that of B. Taurus cattle (McDowell, 1972).* The choice of breed for dairy production must be related to management system and available nutrition

(Payne &Wilson, 1999). One policy is to use indigenous breeds that, although with low productivity, are well adapted to the environment. Another is to use imported breeds with high productive potential genes and a third way is to use crossbreeds. The average lactation milk yield in the Sudanese local cattle breeds Kenana (*B. indicus*) was found to be 1405+_695 kg adjusted to 305 days (Ageeb& Hillers, 2000b). However, the authors suggested that with improvements on management, feeding and breeding, the Kenana breed has a lot of potential as a milk producer under hard climatic conditions. It is shown in table (43) that livestock production in the study area was characterized by the diversification of species 100 % of the HHs owned (cattle, sheep and goats). This may be attributed to the fact that livestock owner with rich resources do that keep different animals for economic reasons and as a coping strategy in case of market failure in this product or that.

There are 26 states in Sudan, 10 in Southern Sudan and 16 in the North Sudan. Each state government has an executive branch (Governor and Council of Ministers). The livestock sector primary falls under the state level Ministry of Agriculture, Animal Resources, and Irrigation, which has responsibility for range and pasture lands and coordinates veterinary services with the fedral MARF. Farmers in the study area, had listed a wide range of diseases Table (46) shows that the most important disease in the study are e.g. Mastitis, Trypanosomiasis, Hart water, Sheep pox, Babesiasis and pneumonia. These findings are partly in line with these reported by (Musa *et al*., 2006).

The most common drugs used by livestock herders in the study area are antihelmintics for internal parasites, worm and haemonchus controtus. Quinapyramine for treating trypanosomiasis; in addition ivomec injection which is used as injection for internal and external parasite according to

information obtained from veterinary pharmacies in Sinnar and the Blue Nile states. Oxytetracycline, Enrofldxacin, Penicllin, Benzole 2.5%, Tetramizole powder 10%, Nile vet plus, Ivermactine, Cyper vet, Quinapyramine, Tylosine, Sulphadimidine 33.33%, Enrol 20, Diaclen, Sulfamethoxazol, Enrofloxacin-oral and others are the most dominant drugs used by livestock herders in the study area (Table 47).

El Damazeen market is the largest market in the study area, followed by Dandaro which is a largest for Watish sheep and cross Fullani sheep. Bout market is the largest one for Kenana cattle. Table (48) shows the different locations of markets in the study area; the marketing days in every week and the marketing seasons. Animal owners have to sell when they go to the market even if they are offered prices that are lower than their expectations because of their need for the cash money. The implications of improved market facilities, open auctions, and increased exports for poor livestock owners have been inadequately studied. Overall the changes in the livestock marketing system appear designed to give the government increased control over markets and transactions. More exports mean more revenue for the government. In addition, the control of the marketing system by a few firms adversely affects poor livestock producers. Pro-poor initiatives could include legislation to break the monopoly of the few trading firms currently controlling the domestic and export markets. Another initiative could be the establishment of communication networks that could provide rural populations with information about prices at secondary or terminal mark, the value of the stock itself was the major benefit from livestock keeping. The farmer benefited from this amount of money when forced to sell animals to finance specific occasions e.g. festival, build a house or pay school fees. This agreed with the findings of Hanyani-Mlambo et al (1998) who reported that dairying is an income supplementing to

households in African countries. The reasons why farmers complemented dairying may be attributed to its immense contribution as a source of income and regular flow of cash and milk for household consumption.

In the present study, livestock owners stated that the reasons for selling and buying livestock is to increase herd size , make new sheds and own land. This finding is in line with Musa *et al*. (2006) who reported that the primary reason of Butana and Kenana breeders for keeping cattle is to generate income from the sale of milk, meat, and milk for home-consumption or as insurance against financial problems. It is evident from this study that farmers in the study area vary widely with regard to diversification of farming activities beside livestock production. All of them grew cash crops such as sorghum and sesame and use them residues as fodder for their animals. On the other hand, no one grew fodder for sale. This meant that the stall system feeding is used in the study area. Concentrate feeds were purchased from markets for dairy cattle in addition to fodder grown by farmers. This is agreed with the findings of Hanyani-Mlambo *et al* (1998) who reported that concentrates are mainly used as supplements for dairy animals in East African countries. The sources of agricultural and industrial by-products such as molasses, baggass, hays and sorghum stalks were used for livestock production in the study area.

In the present study shows that livestock contribute very well to welfare of the small farmers (Table 50). Income from livestock was used on family needs (food, clothes, marriage, and medical treatment etc...) . The contribution was also indicated by types of products sold during the same year. Farmers pointed that the long distance of water sources from the pastures in summer, is the most important limiting factor for productivity of livestock. However, some breeders tend to transport water by trucks to where pasture is abundant. Poor breeders tend to prolong watering intervals

(once per day or longer). Nicholson and Sayers (1987), cited from Doerfler (2005), investigated the body condition of lactating and dry cows watered every 24, 48 and 72 hours by scoring.

In the present study 85% of HHs employed long-term labour and only 10% of the HHs employed causal labour. Family labour was only 5% (Table 54). The tendency to recruit more long –term labour is attributed to the fact that off-farm activities close to urban markets are available. This agreed with the findings of Swai *et al* (2005) who studied the socio-economic characteristics of smallholders dairy production system in coastal humid region of Tanga, Tanzani.

Sheep which found in the Blue Nile and Sinnar states are dominated by Watish breed of sheep. Watish breed of sheep are owned mainly by Rufaa and Kenana tribes. Herd structure of Watish sheep was showed in table (55). Results revealed that 32.00 heads were old ewes (in their 4^{th} to 6^{th} birth), while an average of 17.25 heads for ewes ranging from first and second birth. In this study the average male and female accounts to 38.25 and 23 heads respectively. The percentage of ewes (4-5 birth) was 65% and ewes (1-2 birth) were 35%. Table (57) shows the type of herd in the studied areas. Results revealed that all sheep owners breed permanent herd, no one of them have flying herd .Herd size of Watish sheep in the studied area was shown in table (58). The majority of sheep owners (60%) had herd size ranged between 21-50 heads, followed by those ranging from 51-100 heads. While the lowest percentages were recorded to those have herd size varied between 10 to 20 and 101 to 200 heads. Table (59) shows the objectives of sheep breeding. All sheep owners (100%) indicated that they breed sheep for production of meat.

Sheep are well known for feeding on a wide spectrum of plants, and are said to possess some degree of nutritional wisdom which enables them to

select foods that meet their nutritional needs and avoid those that cause toxicosis (Provenza et al, 1994a, b). In the studied area, Watish sheep depend on natural range in summer season. The owner offered sometimes green fodder and agricultural residues. However, in rainy season the animal depend on grazing of natural range.

There are constraints hindering sheep production in study area which includes a number of factors: extending of mechanized crop farming, high and duplicated taxes, and shortage of water in summer season, and far distances between water points and grazing areas. Lambs start their feeding on grasses at one of month after birth. Herd was grazing all the day about 12 hours. Sheep owners preserved and stored the roughages and feed on dried (hay). Some owners use the (Lubia, Adass and Dura) in feeding of ewes as flushing to increase rate births and fertility of animals.

Table (60)shows milk production of Watish ewes. The results showed that 75% of interviewers revealed that the ewes produced 0.5-1.5 Kg milk / day. While 25% of them explained that the milk production varied between 2-2.5 Kg./ day. The respondents revealed that the milk is more importance to shorten the age of puberty. For this reason the owners did not milking the dams and let them for their kids only.

Age of lambs at weaning was shown in table (61). Majority of investigated households (85%) indicated that weaning age lambs was 3.5-5 months, followed by (10%) 5.5-7 month, while few of them (5%) weaned lambs at more than 7 month.

Table (62) shows puberty age of males. 40 % of interviewers explained that the male lambs reached maturity at age of 10.5-12 months, followed by those by 6-8 month, then by 8.5-10 month, while lowest percent (15%) for those reported age of full sexual maturity as reached at the age of one year and more. On the other hand; the interviewers explained that, the

average age at first lambing was 12 months, lambing interval of 6.7 months and the gestation period was 5 months. Productive ages of rams and ewes were found in table (63) Results showed that rams reach full productive life at the age of 7 years with standard deviation of o,86 year, while the full productive life of ewes may reach 9.90 years with standard deviation of 1-02 year.

On other hand, all interviewers explained that they adopt selection program program to improve their herds. They select best to best ewes, rams and lambs to be kept for breeding. All respondents expressed that the season of breeding usually starts at 15 the August, then the lambing season at 15 the January. No one of the respondents used hybrid ram for service, they use Watish breed for breeding purposes.. Moreover all respondents breed pure ewes of Watish breed.

Sheep herds were yearly vaccinated against sheep pox and rinder pest. Common diseases in the studied area are, Rinder pest, sheep pox and pneumonia. Governmental veterinary services are lacking, however herders seek veterinary services from private veterinarian and drug suppliers. All herd men reported no extension programs in the studied area, practices applied on the herds are fleece shaving, drinking antihelimenths and spraying against external parasite.

In the northern part of the camel belt in Blue Nile and Sinnar State the annual rainfall is relatively low (semi desert) and limited cultivation is practiced to meet all or part of the family requirements, while in the southern part of the camel's belt the annual rainfall is relatively moderate (poor savannah).

This study showed that the interviewees bred mixed species of animals in surveyed areas. Only 4.2% of them breed camel only, while the majority (58.3%) bred camel with cattle, sheep and goat. The variety of species raised

allows for optimum use of the available scant vegetation. Sheep and goats thrive in years of good rainfall while camels are the mainstay in years of poor or below average rainfall. The study showed that 91.7% of camel owners considered livestock grazing to be their main activity, 8.3% considered both livestock and farming as their main activity, while no one of them said that farming was their main activity. On the other hand; 54.2% of camel owners cultivated crops during the 12 months preceding the conduct of the survey, and 38.5% of them sold crops in the same period. The shortage of rainfall might be the reason behind the small percentage of camel owners who sold crops. These findings indicate that camels are kept in a mixed crop-livestock production system and that they are the most important component of the agro-pastoralist system in Sudan. The nomadic system was the system adopted by (33.3%) of respondents, while 66.7% adopted sedentary system in Blue Nile area. Al-Khouri and Majid, (2000) explained that the nomadic system was dominant in the geographical zone between 13-16◦ N (Northern part of the camel's belt), while the sedentary system was practiced in agricultural areas in the middle and south of the camel belt. The results of this study revealed that 95.8% of respondents migrated with their herds during the past year in response to availability of grazing and water supplies and escaping from insects. Similar findings were also reported by Al-Khouri and Majid, 2000; Wardeh, 1989; Abbas *et al.* 1992 and Agab and Abbas, 1993.

The average camel herd size in this study was found to be 63.71 heads. The female camels contribute about 74% of the total herd size. This result is similar to that reported for camel herds in the Butana plain in Sudan (Ali, 1998). It is also similar to that reported for Tuarig herds in northern Mali. However, it is higher than that recorded for Kenya Rendille and Gabbra herds (Wilson, 1984). Where mature females contribute 41.9% of

total herd size; this value was relatively smaller than that recoded in Sudan (Ali, 1998) and Suadia Arabia (Algayli et al., 1998). The percentage of breeding camels in this study was similar to that observed by Algayli *et al.* (1998) in Saudia Arbia. Differences in camel herd size and herd structure are probably a reflection of the differences between regions in the availability of feed and water.

The results showed that 50.0% of respondents sold camels during the 12 months preceding survey time. However; only 8.3% of respondents bought camels during past year, the majority of camels bought being females for breeding purposes, herd replacement and to build up herd size. The results also showed that 70.3% of interviewees reported camel death during the past 12 months.

The selection of breeding camels at a young age before maturity was noted in this study. The majority of respondents selected the replacement male breeding camels from their own herd and they also select the sons of former breeding camels.

Results of this study showed that the majority of respondents improved their camels for both meat and milk production. These findings are not different from the findings of Algayli *et al.* (1998) who reported that the camel owners in Saudi Arabia kept camels for milk and meat production. The majority of camels in Blue Nile area belong to the pack type (Arabi camel); the Arabi camel has a wide geographic distribution in the Sudan due to its good performance for meat and milk. Wardeh (2004) in his new classification of camels placed the Arabi camel in the class of dual purpose animals (meat and dairy production). In this study, most camel owners had plans to improve their camels' production but this planned improvement did not have any scientific basis.

The statement that camel raising was a way of life was the manner in which most owners explained the purpose of camel keeping in this study, The low cost of camel keeping and the fact that camels are drought tolerant animals able to survive in severe conditions compared to other livestock were also offered as reasons for keeping camels. None of the respondents stated the sale of camel milk as an objective of camel keeping, but camel milk was used for home-consumption.

. The camel owners in the study area solve the shortage of feed and water by adopting a long migration route to the south. Most respondents in all studied areas reported disease incidence during the past 12 months. Trypanosomiasis was found to be the important camel disease in Sinnar state. Trypanosomiasis is an endemic disease in the southern part of the camel belt. The migration pattern of camel owners maintain the transmission cycle between the parasite and vector. On the other hand, the study revealed a deficiency in government veterinary services in comparison with private veterinary services and drug suppliers.

The study area is reputed for its rich and extensive natural vegetation cover, which is available for natural grazing. This cover is present in the herd grazing routes, Khors and reserved forests. There are eighty grazing routes, 1380 km long and 4 km wide, which occupy 1000 Feddan. The grazing routes are generally secure. There are also twelve Khors with an average width of 6 km. The available grazing area in forests is about 4 million Fedan. The vegetation cover varies with amount and distribution of rains, soil type and elevation above sea level. Further more, the area is characterized by a thick cover of trees which constitute 75% of the total area. The species vary depending on amount of rains and predominant environmental conditions. The area is, there fore, the richest in tree cover compared to other States in the Sudan.

According to estimates of range forages nutritive value (1979). The dry matter of range forage amount is 95% and the total Digestible Nutrient amount to 31.4% of the dry matter. The average production Ton/Fedan of the total forage production of central region was 0.64. If the year long requirement of TDN per Au is estimated as 1.044 Ton/au/year (Range Ecology1965).Then the total TDN from usable range and the proper stocking rate can be determined as follow:

TDN from usable range = 31x95%x31.4% = 9.24 million Ton (TDN)

Proper stocking rate = (Tot. au/yr) = 9.24/1.044 = 8.88

It is a clear indication that the proper stocking rate is 9.24 million au which is for upper the actual livestock population (7 million au). The actual livestock population decreased the proper stocking rate by almost 2 million au. This situation indicates that amount of pasture and agricultural by-products is more adequate for livestock in the area comparatives with the numbers of the animals found in the area.

The general herd population in the study area of the study between years 2002-2006 given by official authorities of animal resources shows continuous increasing in livestock population due to the security, the adequate pasture and crop by- products in the study area.

In addition to extensive natural vegetation, there are a plenty of agricultural and industrial by-products in Blue Nile area (sorghum stover, wheat stover, cotton by-products, oil cakes, baggass, molasses, guar by-products, wheat bran and fodder production. In the study area also found different markets for various livestock, some markets specialized for sheep and other for camels and cattle. These markets offered livestock animals for local need, and export. On the other hand, the majority of human resources in Blue Nile area work livestock breeding or crop farming.

From the finding recorded from study during 2002 -2006 one can confirm that the Blue Nile area has an excellent potential for investment in livestock production to the degree that no other State in the Sudan can compete with the Blue Nile area in that issue.

6-Conclusion and Recommendations

The results obtained seem to justify the following conclusion

Results of this study showed that all the livestock owners are male (100%) while female own nothing. (82.5%) of livestock owners were illustrated (16.5%) had Khalwa education, while only (1%) visited elementary schools. About (67.5%) were farmers, (32%) were livestock breeders and (0.5%) were small businessmen. Sixty five percent of households livestock investigated owned traditional land, followed by (25.5%) for those who had free hold land and (9.5%) for freehold and Rental land tenure. (40.2%) of household had from 1 to 5 feddan, followed by those had 6 to 15 fedans (27.6%), then those had 16 to 50 fedans (20.2%). All the investigated livestock owners in the study area, own the following species, cow, sheep and goats. Sheep are most kept animal with a total herd size of 125 heads. Cows and local calves are kept with 86 and 34 head, respectively.

The results of this study showed that the main type of farming system was extensive system type and 40% partial grazing while 10% use stall feeding. 50% of livestock owner were grazing day and night. Farmers supplement range grazing with stored hay, farm crop residues, agro-industrial byproducts, irrigated fodders and purchased concentrates for lactating cows during the dry season. The study showed that all the respondents use remains and waste farm products as well salt as minerals in animal feeding.

Results explained that all respondents have access to breed improvement and use natural breeding for genetic improvement of animals. (100%) of the breeders are only breed indigenous local breed. Non of them breed exotic breeds.

This study showed that all the livestock owners (100%) uses veterinary services like vaccination and diseases treatment. Annual vaccination was usually carried against the infection diseases such as hemorrhagic septicaemia, contagious bovine pleuri pheumonia, black quarter, rinderpest and anthrax. This study showed that the most prevalent diseases in the region study are trypanosomiasis, pneumonia, sheep box, babesiasis and heart water.

The largest markets are found in Eldamazeen and Dandoro towns. Dandoro is the largest for Watish sheep and cross Fulani sheep, while Bout market is the largest for Kenana cattle. All the respondents produce meat, milk and manure while egg, chicken, skin and hides are not produce and livestock owner did not use animals for work force. Sixteen percent of the interviewed livestock owners use their income on family needs (food, clothes, marriage, medical treatment etc). 29% from income for animal feeds, medicine vaccination, salt, water taxes, ravel herding cost and education, 1% for house construal or furnishing, 2% on celebration and 7% for stock replacement. Sheep which found in the Blue Nile and Sinnar states are dominated by Watish breed of sheep. Watish breed of sheep are owned mainly by Rufaa and Kenana tribes. In Sinnar state the major concentration of these tribes are found around Umbanien, Wadelnail, Aldinder, Almazmom and Kenana. 40 % of interviewers explained that the male lambs reached maturity at age of 10.5-12 months, followed by those by 6-8 month, then by 8.5-10 month, while lowest percent (15%) for those reported age of full sexual maturity as reached at the age of one year and more. On the other hand; the interviewers explained that, the average age at first lambing was 12 months, lambing interval of 6.7 months and the gestation period was 5 months. Productive ages of rams and ewes reach full productive life at the age of 7 years with standard deviation of 0.86 year, while the full productive

life of ewes may reach 9.90 years with standard deviation of 1-02 year. On other hand, all interviewers explained that they adopt selection of in their lambs program. They select best to best ewes, rams and lambs to be kept for breeding. All respondents expressed that the season of breeding usually starts at 15 August, then the lambing season at 15 January.

This study showed that, the camels are a major component of the agro-pastoral systems and kept in a mixed livestock-crop production system.

The livestock considered as the main activity in Blue Nile area. Camels bred with other species (cattle, sheep and goat). The sedentary management system was adopted then traditionally nomadic system; while transhumant system was not adopted in the studied area. The camels were found, have seasonal north-south movements in search of water and pasture. Camels are kept in their respective production systems due to their appreciated multi-productive adaptability. Diseases prevalence found to be the most important constraint limited factor for productivity of their camels. However, Lack of feeds is another important to production and almost respondents reported incidences of diseases. The water supply also considered as serious constraint jeopardize the productivity of camels.

Recommendations

The potential of livestock in Blue Nile and Sinnar areas should be utilized. The existing situation must be improved, and this can be achieved in a number of ways, each adding to successful production of livestock in Sudan.

(1) Breeding management should be improved. Proper records should be kept of births, mating and possibility of production. Where the local population is incapable of doing this, outside inspection and help should be given.

(2) Breeding practices should be modernized and improved. Collection, storage and transport of semen should be used and improved to reach the remotest corner in Blue Nile area. It would be of value to have central sperm bank to serve all Blue Nile area. The local population must be educated to recognize signs of heat in the female animals.

(3) In addition to range feeding, stall feeding should be introduced as far as possible. This will guarantee more efficient use of feed and water, improved chances of introducing selection techniques, better health control and easier observation and control.

(4) An efficient system of marketing of meat, milk and other animal products should be establish to insure efficient operations both during peak production periods and during periods of drought when animal products becomes vitally important.

(5) A veterinary advisory program should be drawn up to decide how to control and prevent prevalent diseases. Deworming and spraying or dipping is essential. Regional laboratories for serological research should be set-up.

(6) Cattle grazing can be combined with sheep, goats and camel raising. Actually, if cattle are stall-fed, sheep; goats and camels will be much easier and will increase the profitability of herds. The different habits and often

different preferences in feed make the combined husbandry an attractive proposition. Also in this case diseases and parasite control are of importance.

(7) Research into various fields of interest is imperative. It is a challenge to our society that we can combine our knowledge and skills to help make livestock a popular and profitable to breed. This is an obvious solution to improving human nutrition in Blue Nile and Sinnar State.

(8) The main objective is to help the local population to become independent of foreign aids and capable of providing their own food source in time of drought.

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The Questionnaire to cattle breeders in Sudan

Date of the survey

General information :

Province :
Unit :
Hay /Village :
Distance from city center :
Respondent name or code number :
Original home land :
Address :
Enumerator name or cod number :

Section 1 house hold characteristics

1.1 Age of respondents

(1) 31- 40
(2) 41 - 50
(3)51 – 60
(4) 61 – 70
(5)over70

1.2 Gender of household

(1) Male (2) Female

1.3 Number of family members : Males ( ) Females ( )

1.4 Education

(1) Illiterate
(2) Khalwa
(3) Elementary
(4) Intermediate
(5) Secondary
(6) University
(7) Higher
(8) Adult education

1.5 Respondent occupation

(1) Farmer
(2) Live stock…….
(3) Formal employment (salaried labor)
(4) Informal employment (salaried labor)
(5) Business (merchant/trader)
(6) Technician
(7) Remittance
(8) Other(specify)

Section2: Livestock &Agro-Production

2.1 Land ownership and size

2.1.1 Land tenure :

(1) Traditional land
(2) Freehold
(3) Leasehold land
(4) Rental land

2.1.2 Land size:

(1) Do you grow animal feed mainly for your animals?
Yes…..NO…….
(2)Do you also grow animal feed for sale /trade ?
(3)What is the primary use of your land?
(4)What is the total number of fedans?

Total area :

Farmed for animal feed……(fedans)
Used for other purposes……(fedans)

2.2 Ownership of livestock
(1) Do you own live stock?
(2) Do you own cattle?
(3)Do you own camels?
(4)Do you own sheep?
(5)Do you own goats?
(6) Do you own chickens?
(7)Do you own any other livestock?
2.3 livestock herd size composition

How many these animals do you currently own?

(1) Grade cow ……..
(2)Cross cow…….
(3)Local cow ……
(4)Grade bull……
(5) Cross bull……..
(6)Local bull……..
(7)Grade calf……
(8)Cross calf……
(9)Local calf ……
(10)Camel……..
(11)Grade goat…….
(12)Cross goat…….
(13)Local goat…….
(14)Grade buck…….
(15)Cross buck……..
(16)Local buck……..

(17)Sheep……..
(18)Chicken……
(19)Others (specify)……

Section3: General management

3.1 Type of grazing :

(1)Extensive grazing
(2)Feed lot
(3)Partial grazing
(4)Semi-partial grazing

3.2 Husbandry techniques

3.2.1 Feeding

(a) way of feeding :
(1)Grazing during the day and enclosing during night
(2) Grazing day and night
(3) Partially grazing
(4) Stall feeding

(b)Do you use household remains and waste in feeding ?
yes….No……

©Do you normally use salt minerals ? yes…No……

(d)Do you normally use supplemented feed or nutrients (no grown by you) ? yes…….No……..

3.2.2 Reproduction

3.1.3.1Breeds improvement

(1) Have you access to breeds improvement services? Yes……
No……..

If so ,

(2)what method (AI…….natural service …….)
(3)what breed (exotic …../endogenous ……)
(4) where (government centre…….borrowing……..)

(2) Do you take dry cows are taken to the country side to conceive and calve again? Yes…….No……..

3.2.3 veterinary care and veterinary services and vaccination

(1) Have you an access to veterinary services? Yes….. No…..

If so ,

(2)How often,……
(3)What type ……
(4)For which animal……

3.3 Markets for your animals and animals products

(1) List your markets locations :

* Where they are ?.....

(2)How far from your operation ?.....
(3)How often and when you go there ?.....
(4)What you sell or buy ……..

(5)How do markets differ from season to season ?.....
(6)please explain if there are differences in availability ,quality ,or prices of goods bought or sold ,etc…….
(7)To whom do you sell?.....

3.4 Labor division

Who is responsible for?

	Activity	Grazing	Cut& curry feed	Feeding ,watering, caring for the animal	Purchase or search for feed and veterinary drugs	milking	Selling milk/other products	Managing large stock	Managing small stock
1	HH head								
2	Adult males								
3	Adult females								
4	Any HH member								
5	children								
6	Long –term labor								
7	Casual labor								

Section 4:

4.1 kinds of out put produced

Did you produce any of these products over the past 12 mo?(1=yes,2=no)

(1)Meat ( )
(2)Milk ( )
(3)Egg ( )
(4)Chicken( )
(5)Skin &Hides ( )
(6)Manure ( )
(7)Work force( )
(8)Other live stock products ( )

4.2 Item /items on which income from live stock production is used over the past 12 mo :

(1)Family needs (food ,clothes ,marriage, medical treatment, etc)
(2)Cash needs (animals feed ,medicines & vaccines, salt, water, taxes, travel, herding cost ,education fees)
(3)House construction or furnishing
(4)Celebrations (eids ,Ramadan ,marriage , ceremonies ,etc)
(5)Investing in business
(6) Stock replacement
(7)Others

4.3 production constraints

In your opinion what are the major constraints of live stock keeping ?

1.Land
2.Problems of marketing (long distances, low prices)
3.Small / lack of capital to buy in puts
4.Expensive feed concentrates
5.Diseases
6. Feed shortage (seasonal)
7.Poor /limited extension coverage
8.Poor management practice
9.Por genetic make-up of local animals
10.Lackof utilizable technologies / information
11.Pressurs from governmental health authorities
12.High taxes
13.Theft

4.4What are your future goals for live stock keeping ?

(1)
(2)
(3)
(4)
(5)

Appendix 2: Questionnaires to camel breeders in Sudan

1- General household information

Farmer's name: .....
Village: .....
Farmer Number: .....
Level of education: .....
Age: .....

1.1- Labor distribution in camel production

	Dairy production					
	Feeding	Milking	Breeding	Herding	Health care	Housing
Husband						
Wife						
Sons						
Daughters						
Laborer						

1.2- What types and number of livestock do you keep

a) Camel _____b) Cattle _____ c) Sheep:_____ d) Goats _____.e) other _____

1.3- If you have camels, cattle, sheep and goats, could you rank them according to the relative importance to you?

a) Camel _____ b) cattle _____ c) sheep _____ d) goats _____

1.4- How is composition of your herd?

a) Number of she camel _____ b) Number of she camel U. In. _____ c) Number of camel _____ d) Number of female calves _____ e) Number of castrated camel ____ f) Number of male calves __

2- Herd management

2.1- What is type of your management system?

a) traditional nomadic _____ b) transhumant _____ c) sedentary ___

2.2- Did you migrate or move with animal during year? a) Yes b) No

2.3- If yes: where did you move during a) wet season _____ b) Dry season ____

2.4- Did you sell any camel during the past 12 months? Yes No

2.4.1-If yes: How many? *and fill the table for each animal sold*:

No	Sex	Age	Reason why sold	Condition score
(1)				A ( ) B ( ) C ( )
(2)				A ( ) B ( ) C ( )
(3)				A ( ) B ( ) C ( )

Sex: (m/f); Condition score: A+ healthy, B+ strong, C+ good for breeding
A- sick, B- weak, C- infertile

2.5- Did you buy any camel into the herd during the past 12 months? Yes No

2.5.1- If yes: How many? *and fill the table for each animal bought*

	1	2	3	4	5	6	7	8	9
Sex (m/f)									
Age (years)									

2.6- Did any animals die during the past 12 months? Yes No

2.6.1- If yes: How many? *and fill the table for each animal died:*

No	Sex	Age	Reason of dead
(1)			
(2)			
(3)			
(4)			

3- Farming system:

3.1- Did you grow crops? Yes No

3.1.1- If yes: Did you sell any crops during the past 12 months? Yes No

3.1.2- If yes which crop did you sell?

3.2- What do you consider your main production activity?

a- livestock _____ b- farming _____ c- livestock and farming _____

4- Breeding practices

4.1- Do you keep a breeding camel? YES ____ NO ____

4.1.1- If YES: Why do you keep a camel (s)?

_____

4.1.2- How many breeding camels do you have? _____ What is the breed and age of camel (s) you are owning?

No.	Breed	Age
1		
2		
3		
4		

4.1.3If NO: Why do you not have a breeding camel? _____

_____. (*and go on to question no. 5.6)*

4.2- Where is your breeding camel from?

a) own herd ___ b) other herd ___ c) purchased ___ d) other ___

4.2.1- If (a) own herd: At what age do you select your breeding camel? ____years ____months

4.3- What do you do with camels that are not selected for breeding purposes?

a) castrate ___ b) just leave them in the herd ___ c) sell (before mature) ____ d) other ____

4.4- Do you select your own camel? YES ___ NO ____

4.4.1- If YES: How do you choose a breeding camel, what are the characteristics you use to select your breeding camel?

a) _____ b) _____

c)_____ d) _____ e) _____

4.5- How long do you keep a breeding camel for service? ____years

4.6- Where do you take the replacement breeding camel from?

a) own herd ___ b) other herd ___ c) purchased ___ d) other ___

4.7- Can the replacement camel be the son of the former breeding camel? YES ___ NO

4.7.1- If NO: Why not?
_____
4.8- How do you make sure that your breeding camel is fathering the herd? ___
_____

5- Mating organization:
5.1- Do you keep mating records of your camel (s)? If yes how? _____
_____

5.2- What are the mating records you keep (observation of the records)? _____
_____

5.3- In addition to your farm,
5.3.1- For how many farmers do you give service at the moment? _____ farmers
5.3.2- For how many she camels do you give service at the moment? _____ she camels
5.3.3- How many farmers used your camel service last year? _____farmers
5.3.4- What was the total number of she camels served per year per camel last year? _____ she camels
5.4- Do you get a feed back information from the she camels owners about the condition of she camels after service?
a) YES ____ b) NO ____
5.4.1- If your answer yes, what was the number of she camels that got pregnant after serve by your camel last year? _____ she camels
5.5- How much do you charge for one camel service? _____Dinars
(and go to question 5.8)
5.6- If you not using your own camel, do you know the camel serving your she-camel?
a) Yes b) No
5.6.1- If YES: what is the source and breed of the camel you are using for mating
_____

5.7- How much do you pay for one camel service? _____ Dinars
5.8- How long do you keep a she camel for production? ____years
5.9- Do you have a goal to improve your herd? a) milk ____ b) meat _____ c) racing & riding _____
5.10- Do you have plans to improve your herd? a) YES ____ b) NO ____
5.10.1- If YES: how do you want to improve the productivity of your herd?
_____
___
5.11- What improvement in your herd do you expect from the selection of breeding camel, in may be 20 to 30 years?
_____
5.12- Do you record or keep the performances of your breeding camels (males & females)?
a) Yes _____ b) No _____
5.11.1- If yes, how do you record the performance of your herd? _____

6- Production objectives:

6.1Why do you keep camel?_____(first reply given)

6.2- From the following list, could you rank the reasons according to the degree of importance**?**

Reasons	Rank
Income from sale of milk	
Milk for home-consumption	
Income from sale of animal	
Traction (animal for work)	
Manure	
Insurance against financial problems	
Investment (Like a bank)	

7- Feeding Management, Animal health and Production Constrains:

7.1.1- What do you feed your animals?

a) grazing _____ b) hay _____ c) crop residues _____

d) concentrates _____ e) minerals _____

7.1.1.1- If you use hay, which animals do you supplement with it?

_____

7.1.1.2- If you use concentrates, which animals do you supplement with it?

_____

7.1.2- Do you consider that the feeding is a constraint to your herd production?

7.1.3- Do you consider that the water supply is a constraint to your herd production?

7.1.4- How did you secure water supply to your camels? In wet season Free_____ Paid _____

7.1.5- How did you secure water supply to your camels? In dry season Free___ Paid ____

7.2.1- What are the prevalent diseases in your area?

a) _____ b) _____ c) _____

d) _____ e) _____ f) _____

7.2.2- What is the most important one?

_____

7.2.3- Did you report any diseases among your herd during past 12 months? YES __NO __

7.2.3.1- If YES: could you mention them?

a) _____ b) _____ c) _____

d) _____ e) _____ f) _____

7.2.4- If you report any case of disease, where you look for veterinary help from?

a) government veterinary service _____ b) private veterinarians _____

c) drugs suppliers _____ d) others _____

7.3- Could you rank these below constrains according to relative importance?

a) lack of pasture _____ b) security ___ c) lack of water ___ d) diseases _____

e) capital _____ f) labor _____

7.4- What do you consider a more serious constraint to your camel production?