Sudan University of Science & Technology

College of Graduate Studies

بسم الله الرحمن الرحيم

جامعة السودان للعلوم والتكنولوجيا

كلية الدراسات العليا

كلية الدراسات العليا

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Thesis title: Range Plants as preferred by Camels in the semi-arid zone at Kalemando Locality, North Darfur State, Sudan

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Declaration

I, the signing here-under, declare that I'm the sole author of the (M.Sc.) thesis entitled Range plant preferred by camels in The Semi Arid Zone at Kalemando Locality - North Dar Fur state - Sudan

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إقرار

أنا الموقع أدناه أُقر بأننى المؤلف الوحيد لرسالة الماجستير المعنونة .....

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وهى منتج فكري أصيل . وباختياري أعطى حقوق طبع ونشر هذا العمل لكلية الدراسات العليا - جامعه السودان للعلوم والتكنولوجيا، عليه يحق للجامعه نشر هذا العمل للأغراض العلمية .

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Range Plants preferred by camels in Semi-AridZone atKalemando Locality -North DarfurState –Sudan

نباتات المراعى المفضلة للابل فى المنطقةشبه الصحراوية فى محلية كليمندو – ولاية شمال دارفور –السودان

A thesis Submitted in fulfillment for the Requirements for the Degree of Master ofScience (M.SC) in Range Sciences

By

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Supervisor: Professor Babo Fadlalla Mohamed

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November 2015

Dedication

To my mother and father

To my brother and sisters

For all those I dedicate this humble work.

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Abstract

There was growing pressure on natural resources, especially rangelands, in the last three decades due to an increase in human population and in animal numbers. The rangelands were also impacted by climate change, desertification, agricultural expansion and overgrazing. Decreased amounts of rainfall and its fluctuation from one year to the other as well as its uneven distribution within the same year have impoverished the natural rangelands. Intensive grazing early in the plant lifecycle before seed set exacerbated the situation. Camels are capable of grazing on semi-desert regions that are characterized by low rainfall and scarcity of grazing resources. Therefore, there is a need to evaluate the range resources found in these areas both qualitatively and quantitatively so as to trace the change in the condition of the rangeland as well as managing it, so as to preserve and improveit through appropriate interventions such as reseeding. In the present study, the condition of rangeland at Kalemando Locality in the Northern Darfur State has been evaluated through carrying out some measurements of rangelands in the years 2013 and 2014 during the seed set stage. Data were collected, on some household attributes, the number of livestock, the favorite plans to camels and the diseases that affect camels, as well as the socio-economic condition of herders within the Locality. Measurements of plants were conducted in the rainy season of 2013 while a questionnaire was distributed to (50) respondents from herder communities. In addition three focused groups' discussions were held. The main objectives of this study were to find out the natural rangeland plants that are preferred by camels. In order to achieve this objective, the study was divided into two main areas namely: the rangeland south and north of Umkadoya. These areas were chosen in order to collect enough information needed for

evaluation such as the density, frequency of plant species, condition of vegetation cover, carrying capacity, rangeland productivity in addition to an indicator of the camel's preference of the rangeland plants. The results revealed that there were no wide variations in the vegetation cover between the southern and the northern rangelands. Cover was 78.75% and 79.91% in the southern area for 2013 and 2014 respectively whereas in the northern area it was 81.75% and 76.09% respectively. Plant species composition in the southern area was dominated by *Dactyloctenium aegyptium* which accounted for (35.66%, 16.0%) and *Aristidamutabilis* (18.14%, 10.54%) in 2013 and 2014 respectively. In the northern area the species with highest presence were *Dactyloctenium aegyptium* (18.94%,10%), *Schoenfeldia gracilis* (11.7%,11.06%), *Eragrostis diplachnoides* (11.60%,10%), *Echinocloa colona (9.74%,2.08%), Justica kotschyi*(7.24%, 2.08%),*Tripogon minmus*(5.66%,13.47%),*Brachiria eruciformis*(6.75 % , 8.64%) and *Tribulus terresttris(5.06%,11%)*in 2013 and 2014 respectively.

Plant density for the two seasons 2013 and 2014 in the southern area was 449 and 206 plant/m^2 respectively; while the plant average density in northern area during seasons 2013 and 2014 was 300 and 150 plants/m^2 respectively. Plant species showing highest frequency in the southern area in 2013 and 2014were *Dactyloctenium aegyptium* (77.5%), *Aristidamutabilis* (57.5%),*Eragrostis tremula* (44.17%),*Alycicarpus glumaceus* (40%),*Eragrostis diplachnoides*(40%) and *Echinocloa colona* (38.34%).In the northern area the highest frequency of plant species were shown by: *Eragrostis diplachnoides*(86%), *Dactyloctenium aegyptium* (83.5%), *Tripogon minimum* (54.17%), *Schoenfeldia gracilis* (56%),*Brachiria eruciformis*(45%) and *Tribulus terresttris* (34.17%).

The productivity in the southern area during the seasons 2013and2014 was 672 and 709 kg/ha respectively with an average of 691 kg/ha for the two years,where as in the northern part, productivity was larger being 710 and 453 kg/ ha for the two seasons respectively with an average of 582 kg/ha. The mean carrying capacity in the southern area was 8.72 ha/tropical livestock unit/year, while in the northern area the meanit was 10.35 ha/tropical livestock unit/year.

The average trees density for the two seasons 2013 and 2014 was 395 and 361 tree/ha for the two sites (north and south) respectively. The prevailing trees in the southern site were *Acacia tortilis, Boscia sengalensis, Acacia nilotica, Acacia mellifera and Balanites aegyptiaca.* The average frequency of these trees in the two seasons was (90%, 40% 17.5%, 17.5% and 15%) respectively. Common trees in the northern area were *Acacia mellifera, Acacia tortilis, Acacia nubica, Boscia sengalensis and Permina resinosa*. The average frequencies of these trees for the two seasons were 65%, 65%, 32.5%, 27.5%, 17.5% respectively. There were wide variations between forage and browse productivities in the study area, which were 691, 63.29 and 581, 73.20kg/ha for the two seasons respectively. The carrying capacity was 7.37 and 8.28 ha/tropical livestock unit/year for the two seasons 2013 and 2014 respectively. Regarding plant preference by camels during season 2013 in the southern site, five species constituted 46.90% of the total plants that were selected by camels. These plants included *Tephrosia uniflora* (21.36%) followed by *Ipomoea sinesisvar*(14.44%),*Corchorus olitorius* (4.31%) ,*Oxygonum atriplicifolium* (4.10%) and *Echinocloa colona* (2.69%).Among the browse species five of the trees and shrubs constituted 40.97% of the total plants that were selected namely *Acacia tortilis*(20%),*Acacia*

nilotica(9.30%),*Acacia mellifera* (5.22%),*Boscia senegalensis*(4.39%) and *Grewia tanex*(2.06%).

In the northern site, three plant species constituted 18.15% of the total plants selected during the grazing period. These were *Justicia kotschyi* (12.69%), *Brachiria eruciformis*(2.84%) and *Tripogon minmus* (2.57%), while four trees and shrubs constituted 66.72% of the total plants selected. They were *Acacia mellifera* (22.64%), *Acacia nubica* (19.20%), *Acacia tortilis* (16.89%) and *Boscia sengalensis* (7.99%).In the southern site in season 2014, five plants constituted 54.33% of the total plants selected during grazing period. These were *Dactyloctenium aegyptium* (18.36%), *Ipomoea sinesisvar* (15.08%), *Cyperus rotundus* (9.2%), *Echinocloa colona* (6.61%), and *Eragrostis diplachnoides* (5.08%). On the other hand four trees constituted 21.53% these were *Grewia tanex* (9.25%), *Boscia senegalensis* (6.1%), *Permina resinosa* (3.08%) and *Acacia tortilis* (3.1%). In the northern site, trees constituted the highest percentage of the selected plants where four of the trees constituted (81.30%) of the total plants selected during the grazing namely *Acacia mellifera* (43.59%), *Perminaresinosa* (14.35%), *Acacia nubica* (12.9%) and *Acacia tortilis* (10.46%). The study concluded that: trees constituted the highest percentage of camel diet (62.87%) followed by forbs. The herbaceous plants that constituted the highest percentage in the diet selected by camels were: *Tephrosia uniflora, Ipomoea sinesisvar, Corchorus olitorius*, *Oxygonum atriplicifolium, Justicia kotschyi, Tripogon minmus*, *and Echinocloa colona.* Trees and shrubs most selected were *Acacia tortilis*, *Boscia senegalensis, Acacia mellifera*, *Permina resinosa*, *Acacia nubica*, *Grewia tanex*, and *Dactyloctenium aegyptium*. These plants are considered the most palatable plants for camels which can be promoted in the range to improve the quality of

grazing lands for camels. The study has recommended that efforts should be exerted towards paying more attention on grazing resources and their management for improving camels' production.

بسم الله الرحمن الرحيم

ملخص البحث

نباتات المراعى المفضلة للأبل فى المناطق شبة الصحراوية

في محلية كلمندو – ولاية شمال دارفور- السودان

ازدادت الحاجة للمواردالطبيعية فى العقود الثلاثة الاخيرة كنتيجة للزيادة فى أعداد السكان والثروةالحيوانية كماتعرضت الموارد للتدهوربفعل تغيرالمناخ والتصحر والتوسع الزراعى والرعوى غيرالرشيد ومن ثم انحسارها . ادى شح الامطار وتذبذبها الى افقارالمراعى الطبيعية وقلة العلف بها واذ ا قرن ذلك بالرعى المكثف والرعى المبكر فهنالك من الاسباب ما يدعو للقلق.

تتميز الابل بقدرتها علي استغلال المناطق شبة الصحراوية التي تتميز بقلة الامطاروشح الموارد الرعوية لذلك لابد من تقويم مواردها من حيث الكم والكيف حتي يمكن رصد السنوي في حالة المرعي وادارته بهدف المحافظة عليه ومن ثم تحسينه بنثر بذوربعض الانواع المفتاحية .

في هذه الدراسة، تم دراسة نباتات المرعى بمحلية كلمندو فى ولاية شمال دارفور باجراء القياسات على نباتات المرعى والغابات على مدى موسمي 2013م و 2014م اثناء فترة تكوين البذورلمعرفة النباتات التي تفضلها الابل.

جمعت معلومات السكان واعداد الثروة الحيوانية والنباتات المفضلة للابل والامراض التى تصيبها كما درست النواحى الاقتصادية والاجتماعية للرعاة داخل المحلية خلال فترة اجراء قياسات النباتات لموسم الامطار 2013م.حيث تم توزيع الاستبانة على 50 فردا من الرعاة بالاضافة الى ثلاث مجموعات نقاش لذلك الغرض.

من الاهداف الرئيسة للدراسة معرفة نباتات المراعى الطبيعية المفضلة للابل. وللوصول لهذا الهدف قسم موقع الدراسة الى موقعين رئيسين هما: منطقة رعوية جنوبا مكدويا ومنطقة رعوية شمال امكدويا .

اختيرت هذه المناطق للحصول على معلومات وافية للتقييم حيث قيست كثافة وترددات النباتات الرعوية والاشجار وكذلك تمت دراسة الغطاء النباتى والحمولة الرعوية وانتاجية المرعى اضافة الى مؤشرتفضيل الأبل للنباتات الرعوية.

أظهرت النتائج عدم وجود اختلافات كبيرة فى الغطاء النباتي بين منطقة الرعى الجنوبية ومنطقة الرعى الشمالية حيث كانت 78.75% و79.91% فى المنطقة الجنوبية للعامين 2013م/2014م على التوالى بينما فى المنطقة الشمالية كانت النتيجة 81.75% و76.09% على التوالى .

أشارت النتائج الى ان التركيبة النباتية فى المنطقة الجنوبية يغلب عليها نبات ابواصابع*Dactyloctenium aegyptium* بنسبة(35.66 و16.0%) ثم القو *Aristidamutabilis* بنسبة (18.14 و 10.54%) ثم الدفرة*Echinocloa colona* (11.16 و9.0%) ثم ام صبيحة*Alycicarpus glumaceus* (5.13 و 5.63 %) المحوى *Eragrostis diplachnoides*(5.60 و5.0%) في عامي 2013م و 2014م على التوالي.

امافى المنطقة الشمالية فالأنواع الغالبة هي ابواصابع *Dactyloctenium aegyptium* (18.94 و 10.0%) ، ضنب الناقة (*Schoenfeldiagracilis*.7 11. و11.06%) ، المحوى *Eragrostis diplachnoides* (11.60 و10.0%) ، الدفرة*Echinocloa colon* (9.74 و 2.08%) ، نعناع *Justica kotschyi* (7.24 و2.08%) ، ام ضفيرتين *Brachiria eruciformis* (6.75و8.64%) ، فرت الارنب *Tripogon minmus* (5.66و13.47%) ، ضريسة *Tribulus terresttris* (5.06و11.0%) للموسمين 2013م و2014م على التوالي.

متوسط كثافة النباتات فى المنطقة الجنوبية للعامين2013 م و2014 م كانت 449 و 206 نبات فى المترالمربع على التوالى امافى المنطقة الشمالية فإن متوسط كثافة النباتات فى المترالمربع خلال العامين 2013 م و2014 م كانت 300 و 150 نبات /متر^2 على التوالى .

كما وجد ان اعلى متوسط نسبة تردد نباتى سجلت للنباتات فى المنطقة الجنوبية فى العامين 2013م و2014 م كانت ابواصابع *Dactyloctenium aegyptium* (77.5%) ، القو*Aristidamutabilis* (57.5%)، البنو *Eragrostis tremula*(44.17%) ،ام صبيحة *Alycicarpus glumaceus* (40.0%)، المحوي *Eragrostis diplachnoides* (40.0%) ، ثم الدفرة *Echinocloa colona* (38.34%) .

امافى المنطقة الشمالية فكان اعلى متوسط نسبة تردد نباتى فى الانواع التالية :المحوى*Eragrostis diplachnoides* (86%) ،ابواصابع *Dactyloctenium aegyptium* (83.5 %) ، ضنب الناقة الناقة *Schoenfeldia gracilis* (56%) ،

فرت الارنب *Tripogon minmus* (54.17%) ،ام ضفيرتين *Brachiria eruciformis* (45 %) ، ثم الضريسة *Tribulus terresttris*(34.17%) .

اظهرت الدراسة بان انتاجية المنطقة الجنوبية خلال الموسمين 2013م و 2014 م كانت672 و 709كجم/ هكتار على التوالي وبمتوسط 691كجم/هكتار للعامين .امافى المنطقة الشمالية فقد كان الفرق في الانتاجية كبير حيث كانت 710و 453 كجم/ هكتار فى الموسمين على التوالي بمتوسط 582 كجم .

بلغت متوسط حمولة المرعى مقدرة من العلف العشبي بالمنطقة الجنوبية 8.72 هكتار/وحدة حيوانية مدارية /السنة بينما بالمنطقة الشمالية كانت10.35هكتار/وحدة حيوانية مدارية / السنة

أشارت الدراسة كذلك الى ان متوسط كثافة الاشجارفى الموسمين 2013م و2014م كانت 395 و 361 شجرة /هكتارللمنطقتين (جنوب وشمال) على التوالى وكانت الاشجار السائدة فى المنطقة الجنوبية هي السيال *Acacia tortils*والمخيط *Boscia sengalensis* والسنط *Acacia nilotica* والكتر *Acacia mellifera* والهجليج *Balanites aegyptiaca* .كما كان متوسط نسب التردد فى الموسمين هو (90% و 40% و 17.5% و 17.5 % و15%) على التوالي بينما الاشجار السائدة فى المنطقة الشمالية تشمل الكتر *Acacia mellifera* والسيال *Acacia tortils* واللعوت *Acacia nubica* والمخيط*Boscia sengalensis* والسعات *Permina resinosa* وكان متوسط نسبة التردد فى الموسمين هو (65% و65% و32.5 و27.5 % و17.5%)على التوالي .

من خلال الدراسة وجدان هنالك فروقات كبيرة بين انتاجية العلف العشبى والعلف الشجرى فى منطقة الدراسة حيث كانت (691 و63.29)و(581 و 73.20)كجم /هكتار على التوالى للعلف العشبى والعلف الشجرى فى الموسمين . والحمولةالرعوية كانت 7.37و 8.28هكتار /وحدة حيوانية مدارية /سنة للموسمين2013 م و2014م على التوالى .

اما فيما يختص بتفضيل الابل لأنواع النباتات خلال موسم 2013 م فى منطقة الرعى الجنوبية فإن خمس انواع من النباتات العشبية شكلت 46.90% من جملة النباتات التى اختيرت اثناء عملية الرعي وشملت هذه النباتات نبات العرقانة *Tephrosia uniflora*(21.36%) يليه الحنتوت*Ipomoea sinesisvar* (14.44%) ثم الملوخية*Corchorus olitorius*(4.31%) ثم امحميميدا *Oxygonum atriplicifolium*(4.10%) ثم الدفرة*Echinocloa colona* (2.69%) .بينما شكلت خمس من الاشجار و الشجيرات الرعوية 40.97% من جملة النباتات

التى اختيرت وشملت شجرة السيال*Acacia tortils* (20%) يليها السنط*Acacia nilotica* (9.30%) والكتر*Acacia mellifera* (5.22%) والمخيط *Boscia sengalensis* (4.39%) والقضيم *Grewia tanex*(2.06%) .

وفى المنطقة الشمالية نجد ان ثلاث انواع من النباتات العشبية شكّلت 18.15% من جملة النباتات التى اختيرت اثناء عملية الرعي وشملت هذه النباتات نبات النعناع *Justicia kotschyi* (12.69%) وام ضفيرتين *Brachiria eruciformis*(2.84%) وفرت الارنب *Tripogon minmus* (2.57%) بينما شكلت اربع من الاشجار والشجيرات الرعوية 66.72% من جملة النباتات التى اختيرت وشملت شجرة الكتر*Acacia mellifera* (22.64%) واللعوت *Acacia nubica*(19.20%) والسيال *Acacia tortils* (16.89%) ثم المخيط *Boscia sengalensis* (7.99%).

اما فى موسم 2014م فى المنطقة الجنوبية نجد ان خمس من النباتات العشبية شكلت 54.33% من جملة النباتات التى اختيرت اثناء عملية الرعى والنباتات هى ابواصابع *Dactyloctenium aegyptium* (18.36%) والحنتوت *Ipomoea sinesisvar*(15.08%) وسعدة *Cyperus rotundus* (9.2%) والدفرة *Echinocloa colona* (6.61%) والمحوى *Eragrostis diplachnoides* (5.08%) .بينما اربع من الاشجار شكلت 21.53% وهى القضيم *Grewia tanex* (9.25%) والمخيط *Boscia sengalensis* (6.1%) والسعات *Permina resinosa* (3.08%) والسيال *Acacia tortils* (3.1%) .

بينما فى المنطقة الشمالية الاشجار والشجيرات شكلت النسبة الأكبر من النباتات المختارة حيث ان اربع من الاشجارشكلت (81.30%) من جملة النباتات التى اختيرت اثناء عملية الرعى والاشجار هى الكتر *Acacia mellifera* (43.59%) والسعات *Permina resinosa* (14.35%) واللعوت *Acacia nubica* (12.9%) والسيال *Acacia tortils* (10.46%).

خلصت الدراسة الى ان الاشجارتشكل النسبة الاكبر من الوجبة التي تختارها الابل اثناء الرعي حيث بلغت هذه النسبة 62.87% مقارنة بالاعشاب. من بين النباتات العشبية كانت التباتات ذات الاوراق العريضة اكثر تفضيلاً من الحشائش. وعليه لا بد من المحافظة علي الاشجار الرعوية التي توفر غذاءآ هاما للابل وذلك بالتقليل من ازالتها للاغراض المختلفة وخاصة لحطب الوقود ومواد البناء وذلك عبر التوعية والتشريع وادخال بدائل للطاقة واستخدام مواد بناء غير الاشجار كالرمل والجير.

Chapter One

Introduction

1.1 General

Natural rangelands are vast ground spaces dependent on rain in growing the plants without direct human interference. They are one of the most important renewable natural resources contributing to the food needed for livestock and wildlife and are repository for biodiversity. They sometimes provide humans with food in times of famine. They also contribute to reducing the rate of water and soil drift and resisting desert creep and maintenance of watersheds.

The decline in the role of this resource in the area was due to factors that affect productivity such as external environmental factors and human activities. Sudan livestock population amounts to about 104 million heads of which32 million are in Darfur or about 31%. Camels contribute 4.6 million heads to Sudan livestock of which1.15 million or 25% are in Darfur (MARFR, 2011).Camels in Darfur region are commonly raised under nomadic conditions. The annual migrations of nomads vary from year to year to exploit the seasonally abundant forage depending on the amount of rainfall (Abu Sin, 1990). Camels depend on pasturelands to obtain their nutrient requirements, but rarely forage can satisfy these requirements (Adam, 2012a). The camel is a multi-purpose animal .It is an important component of the arid and semi-arid ecosystems, where it makes optimal utilization of the major vegetation and limited water resources better than any other domestic animal species. It has a unique physiological system adapted to desert environments (Higgins, 1985).

Camels spread mostly in the arid and semi-arid parts of Sudan in a belt extending across the country from west to east. Camels are characterized

by their ability to live in harsh environmental conditions such as high temperature; water scarcity and scarce pasture .They are also able to utilize shrubs and halophytes. Camels did not receive adequate attention compared to other animals like cows and sheep, but in recent years there is increased interest in camels from many scientists and specialists after knowing its economic importance as hardy animal that produces under hot and dry conditions and that has the ability to exploit natural resources That otherwise remain underutilized (Zaid*et al*., 1991*)*.

1.2The study area:

1.2.1Location

North Darfur State is located between latitudes 12° -20° N and longitudes 24° - 27°E and Kalemando Locality is located in the southeastern part of the State, 19 km from the State capital El Fashir.

1.2.2 Climate

The climate prevailing in the State is arid and semi-arid, hot in summer and cool in winter .The mean minimum and maximum temperatures are 17.7℃ and34.7℃, respectively and average rainfall ranges between75-287mm/year (El Fashir Meteorological Station, 2013). Rinfall in the years 2010 – 2014 is shown in Figure (1).

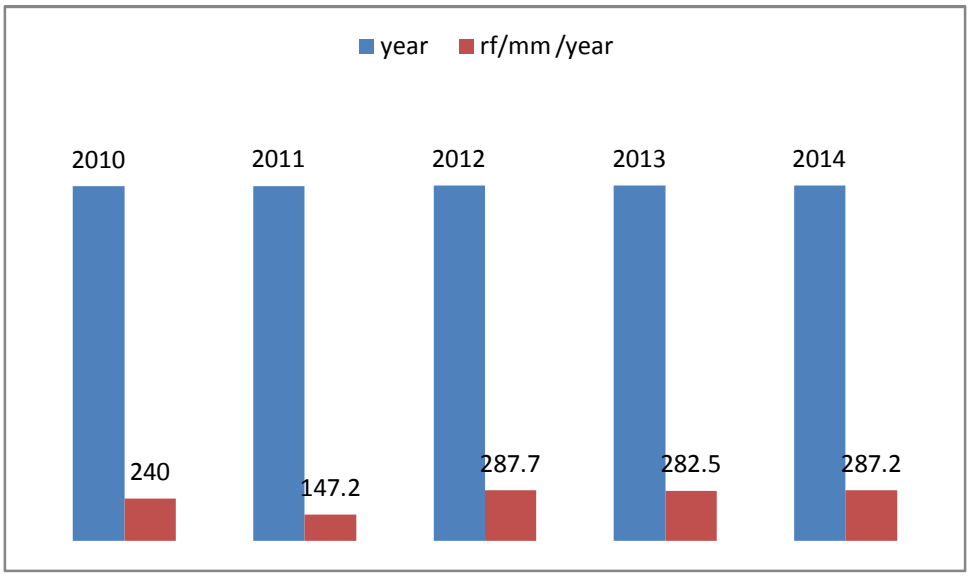


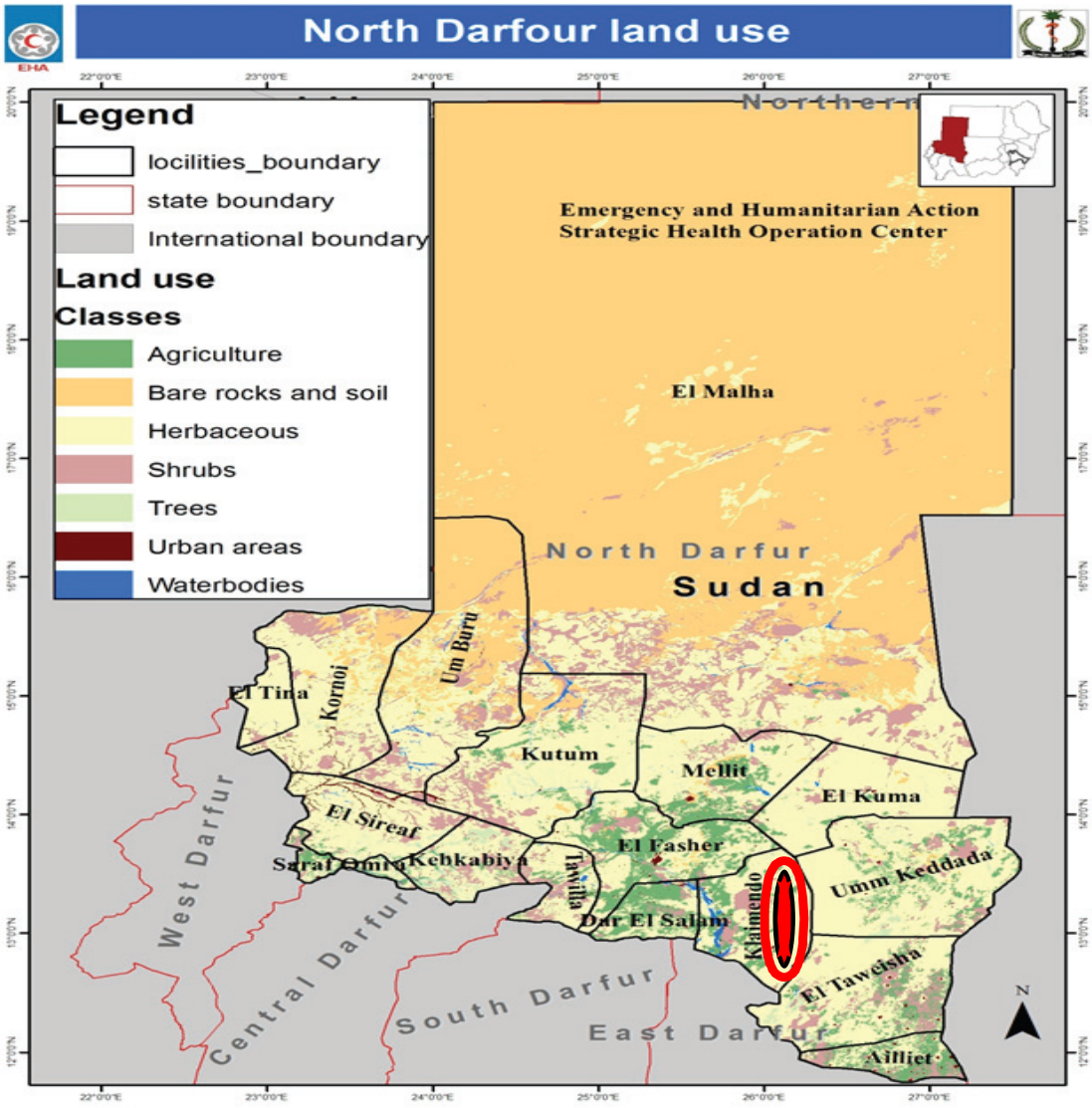
Figure 1.the mean rainfall for five year in study area (E.Meteorological 2013).

1.2.3Vegetation

The study area is characterized by fluctuating rainfall from one season to another resulting in the prevalence of many plant communities and plant species (Harrison and Jackson, 1958).

1.2.4Population

Population of North Darfur State consists of different tribes such as Bertie, Mima, Zaghawa, Rizaigat, Zayadia and other tribes. The population is estimated at about 2.1 million, and those who work in agriculture and pastoralism represent 85%of the total population. The population ofKalemando Locality is about114thousand people, mostly living on grazing, agriculture and other work like government jobs, trade and handcrafts (Sudan national census, 2010).



Figuer2.Map of North Darfur Sudan (EHA, 2013).

1.3 Research problem and justification

North Darfur State suffers from drought, fluctuation of rainfall, environmental degradation and overgrazing events that led to a decrease in range resources base and ultimately to competition over these resources and conflict in many parts of the region. Due to the large number of herds and the fragility of the semi-desert ecosystem, the study area is exposed to intensive grazing particularly by sheep, camels and goats in addition to seasonal grazing by cattle during their movement into the area in the rainy season.Furthermore, there are seasonal fire out

breaks and excessive cutting of trees and shrubs for use as firewood, charcoal and agricultural land .These led to deterioration of vegetation cover manifested in the disappearance of some adapted palatable plant species and invasion by other species from adjacent environments. Information is needed on the effect of these stress factors on rangeland quantity and quality attributes and knowledge of plants most preferredby camels and their nutritional value. Camels have the ability to take advantage of the natural grassland impoverished in semi-desert, where rainfall is less than 50-180 mm / year leading to the growth of annual plants.Camels can exploit these arid lands with high efficiency (Elaine, 2003).

1.4Hypotheses

Camels are classified as browsers that prefershrubs and trees rather than forbs and grasses.

1.5 Objectives

This study aimed to assess the effect of stress factors stated above on some attributes of range quality and quantity in Kalemando Locality North Darfur State.

1.5.1 Specific objectives

a-To Determine range botanical composition, diet selection by camels, plant preference indices of herbaceous plants for camels and carrying capacity.

b. To Suggest better management practices for the rangeland and livestock especially camels.

c. To Study the negative activities of the local population that harm the range.

Chapter two

Literature Review

2.1Conceptsof rangelands

Rangeland resources include both tangible products such as grazable forage, wildlife, water, natural beauty, recreational opportunities, mineral, energy supplies, and areas for the ecological study of natural systems (Busby, 1987).Rangeland though produces a variety of these important natural resources, perhaps the most important of these is the vegetation which is used as forage and cover for livestock and wildlife species. Also rangelands provide open space ,water, wood fuel and numerous other products (Tuller, 1991).The use of rangeland is generally coupled with the use of other types of grazing land and most range livestock and many big game animals use multiple sources of grazing capacity to meet their requirements (Vallentine,1990).

2.2Vegetation sampling:

Sample plots vary in size depending mainly on the kind of vegetation studied. Tree and shrub stands require larger plots than herbaceous vegetation. The most effective sampling of an area can be obtained by the use of numerous small plots, rather than fewer and larger plots, but the plots chosen must be large enough to encompass individual plants of the large number of species present. Spacing of individual plants and the number and distribution of species are important in determining plot size (Peter, 1995).

The plot size required increases both as distance between plants and the number of species increase. Plots commonly used in range analyses are $1m^2$(Frischknecht and Plummer, 1949).

Permanent plots commonly are called quadrats especially when the position and area of each plant are mapped.In the case of alien transect, a circular plot maybe reduced to such a size that no significant area is represented e.g. a19mm diameter loop (Parker, 1951)

2.2.1. Land cover

Cover means the projection of plants or plant parts on to the soil surface. Measurements of cover can be expressed either as the percentage of the soil surface covered by the plants or plant parts or can be broken down into the species or groups of species ***present*** ***(Whalle, and Hardy, 2000).***

2.2.2 Plant Density concepts

Density is defined as the number of either individual species or groups of species of plants per unit area (Cooper, 1959). In some cases, it is difficult to identify an individual plant for sod-forming species. In these situations, it may be necessary to use plant unit such as an individual shoot. Density can be determined by counting the number of plants in quadrats, but quadrat size is critical. Large quadrats serve well for vegetation with low density but may be too time-consuming for areas with high density (Dix, 1961).

2.2.3*Plant Frequency concepts*

Frequency is the percentage of total quadrats containing at least one rooted individual of a given species. Relative frequency of one species is the percentage of that species relative to total plant frequency. Frequency is affected by quadrat size and may be less meaningful than other measurements (USDA, 1996).

*2.2.4*Forage biomass productionof herbaceous plant

The term biomass usually refers to the weight of organisms present at the time of measurement (Society for Range Management, 1989). Biomass of grassland vegetation refers to above-ground herbaceous material, commonly referred to as 'dry matter (DM) yield'. Research workers and managers of grassland vegetation are interested in this to determine the amount of available forage for animals or to measure the effects of management (e.g. fertilization, grazing, and cutting) on the vegetation, whether the vegetation is for agricultural or amenity purposes. Vegetation biomass is important also for assessment of grassland or rangeland condition and for evaluation of new germplasm and cultivars (Mannetje, 2000).One of the best methods to estimate biomass is direct harvest method which may not be suitable in the case of inventory of large areas and where quadrat is used to measure fodder cut inside it and weighed to estimate productivity.

2.2.5 Carrying capacity

It is the maximum stocking rate possible which is consistent with maintaining or improving vegetation or related resources. It may vary from year to year on the same area due to fluctuating forage production. The carrying capacity is determined on the basis of total forage biomass production and amount of feed requirement per animal unit. Carrying capacity is sometimes determined using the proper use factor (PUF) of 50% in which only one half of forage biomass produced is considered as available for grazing (Darrag, 1996).

2.3 Range condition and trend

Smith (1949) and Holechek (2004), consider that the concept of range condition and trend is perhaps the most important one in range management. Condition may be broadly defined as the status of a grazing

site, in terms of its vegetation and soil characteristics, relative to its potential. Trend is the detectable movement of such parameters. Two basic approaches to measurement of range condition have been employed: the first is an ecologically based approach in which condition is relative to inferred climax or pristine vegetation for the site while the other is a productivity based approach in which condition is judged on the sites, present productivity and is rated relative to its potential for a particular use. Also range condition can be assessed by examining population shifts in indicator species (increasers and decreases) as measure of change in condition (Stoddart*et al*.1975).Range can be classified as having excellent condition when it produces more than 75% of potential capacity of climax vegetation. It is in good condition when it produces between 51-75% of potential capacity of the area. Although the better perennial forage plants predominate, many sub-climaxes, less desirable forbs are contained and fewer seedlings are becoming established than on range in excellent condition. This is so despite the fact that abundant viable seeds are produced. Range is considered in fair condition when it produces from 26-50% of potential capacity of the area, the cover consists of early maturing medial succession stage of low value for livestock and low seeds production. Poor condition range usually produces from 0-26% of the potential capacity of the area. It has sparse and unstable forage with week resistance to run-off and erosion .The cover is largely composed of unpalatable forbs, the better forage plants occurring mainly under bushes and other protected places (Darrag,1986).

2.4 Browsing

Browsing refers to the consumption of edible leaves and twigs from woody plants (trees and shrubs) by the large-hoofed animals (Holechek *et al.* 2004). Browse refers to the part of a woody plant which is used by range herbivores for forage. It usually includes leaves and young stems

(Nichols *et al*. 1987). Trees and shrubs have potential value as sources of feed for domestic livestock and wildlife (Kaitho *et al*. 1997).

Browse plays a significant role in providing fodder for ruminants in many parts of the world. Most browse species have the advantage of maintaining their greenness and nutritive value throughout the dry season when grasses dry up and deteriorate both in quality and quantity. Tree fodder is generally richer in protein and minerals and is used as a dry season supplement to poor quality natural pasture and/or fibrous crop residues (Kibon and Orskov 1993). The notion of browse is a complex issue that depends on plant species, animal species, forage availability and accessibility and the nutritional state of the animals (LeHouerou, 1980). Browse plants constitute a major source of food for goats and camels in arid and semiarid regions of the world (Ramfrez *et al*. 1990).

2.4.1Browse productivity assessment

Forage declines in quality and quantity as the dry season progresses. The inadequacy of range plants increases with the advance of the dry season leading to more dependence of animals especially camels and goats on perennial vegetation such as leaves, twigs and fruits (Abdelgabbar, 1986).

2 .5 Animal diet preference

Preference is defined as the relative consumption of one plant over another by a specific class of animal when given free choice at a particular time and place (Frost and Ruyle, 1993). It is defined in terms of free choice by an animal, and is often considered an " animal characteristic". It refers to selection by the animal and is essentially behavioral. Relative preference indicates proportional choice among two or more foods (Heady, 1964).

2.5.1 Preference index:

Preference index was defined as percentage composition of a plant species in the diet compared to percentage composition of that species in available herbage (Rosiere *etal.* 1975).

Diet frequency measurement is important in determining relative preference of animals for specific plants because the index then includes not only the quantity of a plant the animal consumes but also the consistency with which it selects the plant. Consistency of selection may be influenced by plant distribution, i.e., uniformly distributed plants might be more frequent in the diet than plants with irregular distribution. Allowance can be made for this by using frequency of the plant on the range as a part of the availability factor (Krueger, 1972).

2.5.2Plant preference classification

There are five plant classifications used in the grazing land application (GLA) according to NRC (2003).

-Preferred plant –composition of a plant species is greater in the diet of the target animal than found in the area being grazed by this animal.

-Desirable plant: composition of plant species is approximately the same in the diet of the target animal as that found in the area.

-Undesirable plant: composition of the plant species is lower in the target animal than is found in the area being grazed by this animal.

- Toxic plant: rare occurrence in the diet of the target animal and if consumed in any tangible amounts, will result in death or severe illness in the animal.

-Non-consumed plant: plant species that would not be eaten under normal extremes in forage conditions, but if no other forge is available, the target animal will attempt consumption although at greatly reduced rates.

2.5.3 Measurement of diet selected:

A number of methods can be used to measure the diet selected by herbivores. These include direct observation of animals (Holechek *et al*. 1982), oesophageal fistula (Theurer *et al*.1976), rumen fistula (Jarrett 1948), micro histological analysis of faecal samples and near infrared spectroscopy.

2.5.3.1 Direct observation of animals

Bite count technique, as a direct observation method, was usuallyused to assess camels' diet. The advantages and disadvantages of this technique were reported by Holechek *et al*. (1982). Simplicity, minor equipment requirements and ease of use are major advantages of direct observation. Difficulty in species identification and quantification of how much of a plant was consumed are important problems associated with the procedure.

Quantitative information from direct observation has been obtained from the bite-count and feeding minute's approaches. When the feeding minutes approach is employed, time spent grazing each species is quantified and assumed to be proportional to the importance of the species in the diet (Bjugstad *et al*. 1970).

The bite-count procedure differs in the number of bites taken from each species, rather than the length of grazing time, is recorded (Reppert 1960).

Wild animals are often difficult to locate and approach closely enough for accurate observation. These problems are reduced or eliminated with tamed animals. However, only one animal can be observed at a particular time even with tamed animals. In addition, it may be difficult to differentiate between mere nibbling and active grazing (Bjugstad *et al*.

1970). Diet selection is a complex behavioral act that is influenced by several factors. Physiological condition, degree of hunger, topography, other animals present and past grazing experience all influence which and how much of individual plant species are consumed (Krueger *et al*. 1974).

Factors influencing the accuracy and precision of the direct observation procedure include the degree of training of the observer, complexity of the plant community present, and/or phonological development of individual plants. Plant identification is much less of a problem on desert rangelands where plants are widely spaced than on prairie ranges where plants are close together. As plants mature, they also become easier to identify (Holechek *et al*. 1982).

2.6 Camels in Sudan

The type of camel found in Sudan is the one-humped camel (*Camelus dromedarius*) which belongs to the Order Artiodactyla, Suborder Tylopoda. The family Camelidae consists of the genus Lama, to which all the new world Camelidae belong, and the genus Camelus. The genus Camelus is represented by the two-humped Bactrian camel (*Camelus bactrianus*) and the one-humped dromedary camel (*Camelus dromedarius*) (Wilson, 1984). According to FAO (2004), there are about 19 million camels in the world, of which 15 million are found in Africa and 4 million in Asia. About 79% of the world's camel population is found in Africa, and all are one-humped. Camel populations are more concentrated in North East Africa. The population of camels in Sudan is estimated to be 4.7 million distributed between Kordofan, Darfur, Eastern, Northern and the Central States and the country owns 25 percent of the world camels (SCC, 2013).The Sudanese pack camel is the heavy

type which makes up the majority of the camels maintained by nomads. The pack camels include Arab camel together with several pack camel types raised mainly in NorthDarfur, North Kordofan and West Kordofan States. The heavy camels also include Rashaida camel which is slightly shorter than the Arab camel and is found mainly in eastern Sudan (Zaid *et al*., 1991). The riding camel, the kind which was developed for riding and selected for speed in the east of the country includes Anafi and Bishari camel (Wardeh, 2004). Camels are multipurpose animals specifically important in the dry and semi dry eco-systems where they utilize the meager vegetation and limited water resources better than any other domestic animal species. The survival of the pastoralists is dependent on camels especially during severe prolonged drought during which it is difficult for other animals to produce or live (Darosa, 2000).

2.6.1. Economic importance of camels

Camels produce milk, meat, wool, hair and hides. They serve for riding, and as draft animals in agriculture and short-distance transport (Schwartz and Dioli, 1992).Camel milk is one of the most important components of the diet of nomads in the Sudan. It is consumed by the owners and herders and is not exploited commercially (El Amin, 1984) though some farms around Khartoum are now selling camel milk. Milk production is an important factor in the nutrition of nomadic people. In many places, dromedary milk is regarded as an important protein-rich food with therapeutic properties attributed to relatively high mineral and vitamin C contents (Madani, 1996).Dromedary camels are maintained for meat production and as baggage carriers. Furthermore, camel hair is an important by-product for nomads, where it is frequently used for making (ropes, tents, saddle girths, blankets, clothes and carpets (ElAmin, 1984).Asmall number of heavy camels are exported to neighboring

African States, whereas the bulk of camel export-trade goes to Egypt. Most of these camels are drawn from western Sudan (Babiker, 1984).Racing camels are also exported to Saudi Arabia and other Gulf States (Schwartz and Dioli, 1992).

2.6.2Camel production systems in Sudan

For the nomads who inhabit the desert and semi desert regions in Sudan camel has important cultural, economic and social roles in the lives of these communities. In these marginal lands, stricken by recurrent droughts the camel is usually the sole survivor when all other types of livestock have succumbed. In Sudan, three main types of production systems for camel rising prevail. These are nomadic production system in the western side of the Nile, semi nomadic production system in the eastern side of the Nile, and semi settled production system in the agricultural areas and around cities .The majority of camel herders adopt the nomadic system of production.

2.6.2.1The nomadic system

Camel herds form the basis of a subsistence economy for pastoral nomads in the same way as do sheep, goats and cattle. Camels are kept for their meat, milk, hair and transport. Cash revenue is generated by the sale of surplus animals locally and abroad like all nomads. Some of the tribes practicing this system are the Kababish tribe in Northern Kordofan State, the Maharia, Um Gallol and other tribes in northern Darfur. These tribes are on the move continuously, seeking water and good grazing (Al-Khori and Majid, 2000).

2.6.2.2. Semi nomadic production system (Transhumant)

This system is found in eastern and southern regions of the camel belt and is practiced by semi-nomadic tribes (Al-Khori and Majid, 2000). In this system a degree of settlement prevails during the rainy season where rain fed agriculture is practiced for food production and the crop residues provide feed for camel populations (Bakheit, 1999). Several tribes in Eastern Sudan practice a transhumant mode of range utilization (Abbas *etal*, 1992). They move from one area to another following certain migratory routes, e.g. 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 the Butana plain during the rainy season, either to the south (Gadaref) or to the southeast along the RiverAtbra (Al-Amin, 1979).

2.6.2.3. Sedentary or Semi-Sedentary System

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-Khori and Majid, 2000)

2.6.3 Obstacles to Camel Production in Sudan

Camels' breeding is faced by many obstacles. In the desert and semi-desert areas water becomes scarce or completely absent. Consequently, camels do not find water to drink and the pastures recede. The camels are forced to feed on desert shrubs that do not meet their feed requirements. They have to walk long distances in search of water and better pastures. They become emaciated, skinny and their meat and milk production drops. In these areas many harmful insects (flies; mosquitoes; ticks) are

prevalent. These insects feed on the blood of camels and disseminate serious diseases among them. The camels become weaker and their ability to produce milk for their calves and owners diminish. The camels' herders live in remote areas that are difficult to access and lack paved roads. These Bedouins suffer from neglect and lack of governmental services. In these areas there are no permanent veterinary health services to treat and vaccinate the herds of camels against epidemic diseases. In addition to these obstacles that limit the camels' production, there is danger of robbery that leads to the loss of camels and sometime seven human lives. If these obstacles are not curbed this enormous wealth will vanish and the owners of camels will be displaced. Eventually they will be obliged to live in the outskirts of cities (Elsheikh and El Amin, 2014).

2.6.4 Feeding behavior of Camels

Nutrition of domestic ruminants in the tropics is mainly based on the exploitation of rangeland resources which are subject to high quantitative and qualitative variations over the year. Fodder trees and shrubs are an integral part of the diet of these animals and constitute the main source of proteins, minerals and vitamins during the dry season. Selection and intake of diet depends not only on the available plant resources but also on the feeding behavior of the animals. Better understanding of feeding behavior allows the development of management strategies aimed at maximizing the use of ecosystems for increased animal production (Dicko and Sikena, 1991).

Different kinds (species) and classes (heifer, steer, lactating, growing, etc.) of grazing animals utilize range and pasture systems differently. Specifically, the foraging behavior of a given kind or class of animal determines how it moves across the landscape and selects different

forages. In the process of grazing, an animal progresses through levels of instinctive responses and behaviors that lead to the consumption of a plant (Stuth, 1991). These responses and behaviors are driven by sensory signals and the physiological needs of the animal. These vary across the landscape and through time. Factors that influence foraging behavior can be divided into factors that affect spatial choice, and those that affect forage species choice. Spatial choice is a function of landscape features, plant community characteristics, and grazing patch attributes (Thorne *et al*. 2007).

Among domestic ruminants, camels are classified as browsers, goats as intermediate selective feeders with preference for browse, sheep as nonselective intermediate feeders with preference for grasses and Buffalos, cattle and donkeys as grazers (Schwartz and Schafft, 1988). Camels are predominantly raised on semi-arid to arid ranges. Despite the sparseness of feed in these ranges, the preference of certain plant species and feed intake mainly depends on the eco-system. Camels prefer to browse rather than graze and need time not only to consume their feed but also to ruminate. Their mobility and lesser dependence on drinking water allow them to forage over far grazing areas than any other domestic animal. As a general rule, when feed is easily obtained, 6hours is the minimum time that should be allowed for foraging .The digestibility of nutrients varies according to diet composition. Camels digest dry matter, as well as other nutrients; especially crude fiber (Gihad, 1995) .Camels are also the most capable animal species in utilizing marginal areas and in survival and production under harsh environmental conditions (Knoess, 1977; Gauthier-Pilters and Dagg, 1981; Hjort and Hussein1986).

Many pastoral groups and communities in diverse eco-zones throughout the world are depending on camels for their livelihood. This dependence

consists of utilization of camel meat, milk, leather and wool. Exportation of live camels, uses as an important sport and tourism resource in Arabian Gulf countries and lastly the use of camel as animal for packing transport and riding (Snow *et al*., 1992).Camels by nature prefer trees and shrubs but sometimes accept the long herbaceous plants (Mohammed, 2003). Gauither-pitters and Dag (1981) reported that camels select plants according to type where shrubs and trees form the larger portion of their diet amounting to 90% followed by broad leaved plants (forbs) which contribute 8% and then grasses amounting to 2%. Camels also prefer salty plants in areas where there is shortage in water. Camels also select more of the young tender parts of trees that contain about 80% moisture during the dry season. It is worth noting that, camels can graze on pastures with short plants that do not exceed 1cm in height, although theycannot consume more than5kg of their total daily diet, which ranges from30-40kg (Bulliet, 1975).Camels have high ability to choose their diet so as to avoid grazing exotic weeds and toxic plants (leitz, 1929).

Chapter Three

Materials and Methods

3.1. Vegetation attributes measurement of herbac

3.1.1Sampling design

Sampling was done by locating a1/2km^2 plot in each of two sites of open rangeland, the first site was south of Umkadoya and the other site was north of Umkadoya. The study was conducted in 2013and 2014 during late rainy season (seed set stage). In each plot, four transects of 500m length were constructed

3.1.2Botanical composition of rangeland

The loop method (Parker and Harris, 1959) was used to measure Botanical composition of the range. At each one of the eight transects, plant species, litter, rock, bare soil, and animal pellets were recorded at every 1m interval using 0.75" loop. Data were recorded in a specified sheet (Appendix3). Plant composition %, bare soil %, litter % and camel pellets %, were calculated as follows

$$\text{Plant composition \%} = \frac{\text{The total hits of plant}}{\text{The total number of all hits}} \times 100$$

$$\text{Bare soil \%} = \frac{\text{The total hits of bare soil}}{\text{The total number of all hits}} \times 100$$

$$\text{Litter \%} = \frac{\text{The total hits of litter}}{\text{The total number of all hits}} \times 100$$

$$\text{Camel pellets \%} = \frac{\text{The total hits of camel pellets}}{\text{The total number of all hits}} \times 100$$

3.1.3 Density and frequency of range plants:

Density is the number of plants within each quadrat, while frequency is the percentage of total quadrats that contain at least one rooted individual of a given species. Forty quadrats from the two sampling plots were used to measure density and frequency (Appendix 4).

The density of each species was determined by summing up their numbers in all quadrats and dividing by the total number of quadrats

$$\text{The average plant density in quadrat } (m^2) = \frac{\text{No. of plant in all quadrats}}{\text{No of all quadrats}}$$

$$\text{Frequency} = \frac{\text{Number of the quadrats containing the species} \times 100}{\text{Total number of quadrats}}$$

3.1.4 Biomass estimate:

At each of the transects, 5 quadrats of one m^2 were placed at 100 m intervals, giving a total number of 40quadrats. Samples were cut in grazing level 2.5cm and air dried in the field, labeled and then oven dried at75°C for 48 hours and their dry weight recorded (Plate 1).

Plate (1): samples after oven drying2013.

3. 1.5. Carrying capacity

According to Mustafa *et al.*, (2000), the proper use factor is (0.5). That means half of the forage production was used for determining the carrying capacity.The carrying capacity was calculated according to the daily requirement of a Tropical Livestock Unit (TLU) which is equivalent to (7.5 kg/day) as reported by (Mustafa *al.,* 2000).In this study10% was added to the annual requirement to cater for walking and has thus annual Consumption was 3012kg / year. Carrying capacity can be determined as hectare/ animal unit/ year (ha/Au/Y) according to (FAO, 1980). Carrying capacity was calculated as follows:

Carrying capacity = the desirable production / requirement of TLU

3.2 Browse assessment

3.2.1 Density and frequency of Trees:

Density is the number of trees within each sampling unit, while frequency is the percentage of total quadrats that contain at least one rooted individual of a given species. Twenty quadrats within each sampling plot were used to measure density and frequency (Adam, 2012).

Average plant density in quadrat ($10m^2$) =

No. of plants in all quadrats / No. of all quadrats

Tree density in hectare = average tree density in ($10m^2$) ×100

$$\text{Frequency\%} = \frac{\text{Number of quadrats containing the species}}{\text{Total number of quadrats}} \times 100$$

3.2.2Estimation of Browse Productivity:

Browse productivity was assessed according to Michael *etal,*(1987)who adopted the diameter at browsing point (d.b.p) and browsing level. These authors reported 3mm and 2.5m for (d.b.p.) and browsing level respectively. Densities for trees were obtained by sampling of an area of $10m^2$. One line transect of 100-meter long was selected across the plot. Twig count method was applied for estimating available browse and total browse (Gaiballa*et al*., 2003 and Lazim, 2001). For estimating available browse, all twigs between the ground level up to camel browsing level (2.5m) with diameter equal to or less than diameter at browsing point (8mm) for selected trees were counted, and material cut was labeled, dried in the field and later on oven dried at 75°C for 48 hours and their dry weight recorded. Sheets used are found in (Appendix5).

3.3 Measurement of the diet selected by grazing camel

3.3.1 Diet selection by grazingcamel

Diet botanical composition was estimated using the bite-count technique (Van Dyne, 1968) .This technique was used in camels by Kayongo (1986) and Kurin *et al* 2005). Five camels were observed for 5 days.Observation times was between 10:00am and 12:30 pm, and 4:00 - 6:30pm. Each camel was observed for atotal of 60minutes/day (Plate2 and Appendix2).The numbers of bites made by the camel on various forage species, with species of plant ingested / bite were recorded for each animal (Plate3).

3.3.2 Relative preference index (RPI)

The accurate determination of the botanical composition of the diet of grazing animal is essential for proper evaluation and management of grazing lands (Rice et at. 1970).RPI is used to classify plants according to their preference and it is obtained from the relationship:

RPI% = species in diet (%) ÷ species botanical composition (%).

The range plants are classified according to their relative preference index into five forage value categories (NRC, 2003):

PP = Preferred plant (RPI more than 1.0)

DP = Desirable plant (RPI about 1.0)

UP = Undesirable plant (RPI less than 1.0)

NCP = Non –consumed plant

TP = Toxic plants

In this study the following indicators were adopted:

PP = Preferred plant (RPI more than 1.50), DP = Desirable plant (RPI about 0.70 to 1.49), UD = Undesirable plant (RPI less than 0.70)

NCP = non-consumed plant (plant appeared in range, not eaten by camels).

Plate (2): Five camels selected for observation for diet selection

Plate (3) Recording of range plants selected by grazing camel

3.4 Socio-economic aspects and plant species preferred by camels

To analyze and investigate the socio-economic factors and plant preference by camels as perceived by herders' descriptive statistical analyses was used. A questionnaire was used to collect information from 50 livestock raisers randomly chosen for contribution to the questionnaire. For the purpose of the study the respondents were asked separately and their answers were recorded in a form (Appendix1).

3.5Data analysis:

The Statistical analysis was done using (SPSS). T-Test was used to estimate significance of differences between means (Steel and Torrie, 1980).

Chapter Four

Results and discussion

This chapter reports the results obtained during the study for the various angeland attributes and camel behavior investigated. It describes camel utilization patterns and addresses the interaction between animals and plants and tackles the socio-economic aspects of the internally displaced people in two sites(Umkadoya, Kalemando Locality) North Darfur, Sudan.

4.1Herbaceous vegetation measurements:

Table (4.1) shows percent cover as determined by loop method for two sites during seasons 2013 and 2014. There was high percentage of plant cover in southern site(S) (79.33%) and northern site (N) (78.92%), while the mean bare land in the two range sites (S) and (N) was14.84% and16.54%respectively. The variation within site (N) in percent cover between seasons could be attributed to fluctuation in rainfall from one year to another and to early grazing.

Table 4.1: Percent cover for two sites of the range

Parameter measured %	Southern site			Northern site		
	2013	2014	Mean	2013	2014	Mean
Plant %	78.75	79. 91	79.33	81.75	76.09	78.92
Bare soil (B.S)%	16.5	13.17	14.84	11.25	21.83	16.54
Litter (L) %	4.74	5.42	5.08	7.00	1.83	4.42
Animal pellets	0.00	1.00	0.5	0.00	0.25	0.13
Total	100	100	100	100	100	100

Botanical composition (%) for the two range sites during seasons 2013 and 2014 is presented in Table (4.2). The highest percent for the grasses during season2013in site (S) was shown by*Dactyloctenium aegyptium*

(35.66%), *Aristida mutabilis* (18.14%) and *Echinochloa colona* (11.16%). Insite (N) the highest percent for the grasses was shown by*Dactyloctenium aegyptium* (18.94%), *Eragrostis diplachnoides* (11.60%) and *Schoenfeldia gracilis* (11.7%).The highest percent for forbs during season2013 in site(S) was for *Alycicarpus glumaceus* (5.13%), *Tripogon minmus* (1.98%) and *Mollugo noduavlis (1.58%)* while in site (N) *Justicia kotschyi* (7.24%)*, Tripogon minmus* (5.66%) and *Tribulus terrestris* (5.06%) showed highest percent botanical composition.

Grasses of highest contribution to botanical composition during season 2014were *Dactyloctenium aegyptium* (16%) , *Aristida mutabilis* (10.54%) and *Echinochloa colona* (9%). Insite (N) the highest percent for grasses was *Schoenfeldia gracilis* (11.06%), *Dactyloctenium aegyptium* (10%) and *Eragrostis diplachnoides* (10%). For forbs the highest percent during season2014in site(S) were *Zalya pentandra* (7%), *Trigonella hamosa* (6.47%) and *Alycicarpus glumaceus (5.63%)*. In site (N) *Tripogon minmus* (13.47%), *Tribulus terrestris* (11%) and *Mollugo noduavlis (4.05%)* dominated the botanical composition.

Table 4.2 Botanical composition (%) of herbaceous plant species in the two sites during seasons 2013and 2014

No	Latin name	Vern name	S site			N site			Type
			2013	2014	Mean	2013	2014	Mean	
1	*Aristida mutabilis*	Gaw	18.14	10.54	14.34	1.86	5.00	3.43	Grass
2	*Alycicarpus glumaceus*	Umsabiha	5.13	5.63	5.38	0.75	0.55	0.65	Forbs
3	*Echinocloa colonum*	Defra	11.16	9.00	10.8	9.74	2.08	5.91	Grass
4	*Eragrostis tremula*	Banw	2.90	5.32	4.11	0.47	4.27	2.37	Grass
5	*Dactyloctenium aegyptium*	Abuasabi	35.66	16.00	25.83	18.94	10.00	14.47	Grass
6	*Indigofera spp.*	Sharaya	0.41	0.10	0.26	1.21	0.00	0.61	Forbs
7	*Trigonella hamosa*	Umgreen	0.00	6.47	3.24	0.00	0.76	0.38	Forbs
8	*Justica kotschyi*	Nana	1.58	0.94	1.26	7.24	2.08	4.66	Forbs
9	*Cyperus rotundus*	Seida	2.07	4.59	3.33	2.99	0.55	1.77	Grass
10	*Tripogon minmus*	Fart elarnab	1.98	2.09	2.04	5.66	13.47	9.57	Forbs
11	*Mollugo noduavlis*	Semel agrab	1.58	2.09	1.84	2.80	4.05	3.43	Forbs
12	*Eragrostis diplachnoides*	Mohoya	5.60	5.00	5.30	11.60	10.00	21.6	Grass
13	*Indigofera aspera*	Lesan tair	0.16	0.41	0.29	0.00	0.11	0.06	Forbs
14	*Tribulus terresttris*	Derassa	0.17	2.00	1.09	5.06	11.00	8.03	Forbs
15	*Commelina kotschyi*	Iberge elfaki	00	1.04	0.52	0.00	0.00	0.00	Forbs

16	*Oxygonum atriplicifolium*	Umhamid	0.00	0.63	0.32	0.00	0.43	0.22	Forbs
17	*Ipomoea vagans*	Han toot	0.42	3.34	1.88	1.75	1.42	1.59	Forbs
18	*Corchorus olitorius*	Molukhia	0.29	1.25	0.77	2.57	3.00	2.79	Forbs
19	*Portulaca oleracea*	Regla	0.00	1.57	0.79	0.00	0.00	0.00	Forbs
20	*Brachiria eruciformis*	Umdefertain	0.00	1.04	0.52	6.75	8.64	7.70	Grass
21	*Trianthema portulacastrum*	Tarba	0.00	3.00	1.5	0.29	1	0.65	Forbs
22	*Schoenfeldia gracilis*	Danabelnaga	9.85	0.94	5.40	11.7	11.06	11.38	Grass
23	*Fimbristyls dichotomo*	Umfesisiyat	0.00	2.72	1.36	0.00	0.00	0.00	Grass
24	*Unidentified*	Zeraelbaoda	0.00	0.10	0.05	0.00	0.11	0.06	Forbs
25	*Alycicarpus yaginalis*	Umngigirh	0.75	5.42	3.09	0.00	0.11	0.06	Forbs
26	*Parkin Sonia aculata*	Sesaban	0.00	0.21	0.11	0.00	0.00	0.00	Forbs
27	*Zalya pentandra*	Rabaa	0.00	7.00	3.5	0.15	0.33	0.24	Forbs
28	*Zornia glochidiata*	Sheliniy	0.00	0.31	0.16	0.68	1.64	1.16	Grass
29	*Aristida adscensionis*	Umhiraibu	0.14	0.00	0.07	0.72	4.17	2.45	Grass
30	*Euphoebia aegyptiaca*	Umlibaina	0.00	0.00	0.00	0.00	0.55	0.28	Forbs
31	*Trianthema portulacastrum*	Tarbahamra	0.00	0.00	0.00	0.00	1.97	0.99	Forbs
32	*Cenchrus biflorus*	Haskaneet	0.42	0.00	0.21	3.00	1.08	2.04	Grass
33	*Solanum dubium*	Jebain	0.29	0.21	0.25	1.28	1.21	1.25	Forbs
34	*Cucumis sativus*	Ajour	0.00	0.00	0.00	0.00	0.11	0.06	Forbs
35	*Vignas un hum*	Tagtaga	0.00	0.00	0.00	0.00	0.22	0.11	Forbs
36	*Polygala erioptera*	Merikh	0.00	0.53	0.27	0.00	0.22	0.11	Forbs
37	*Cassia acutifolia*	Senamka	0.00	0.00	0.00	0.00	0.11	0.06	Forbs
38	*Unidentified*	Basal	0.00	0.73	0.37	0.00	0.00	0.00	Forbs
39	*Amarannthus graecianis*	Tamalika	0.00	0.10	0.05	0.00	0.00	0.00	Forbs
40	*Tephrosia uniflora*	Argana	0.00	0.21	0.10	0.28	0.00	0.14	Forbs
41	*Farsetialon gisiliqua*	Aboadefir	1.35	0.00	0.68	0.00	0.00	0.00	Forbs
42	*Unidentified*	-	0.13	0.00	0.07	0.00	0.00	0.00	Forbs
43	*Urochloa trichopus*	Hochst	0.00	0.00	0.00	2.52	0.00	1.26	Grass
Total			100%	100%	100%	100%	100%	100%	

Figure (3) shows botanical composition by plant class (%). Grasses during two seasons 2013 and 2014 in range site (S) formed (55.17%) while forbs were (44.83%). Also in site (N) the mean percent of grasses was (51.11%) and that of forbs was (48.90%). The range appears closely balanced between grasses and forbs.

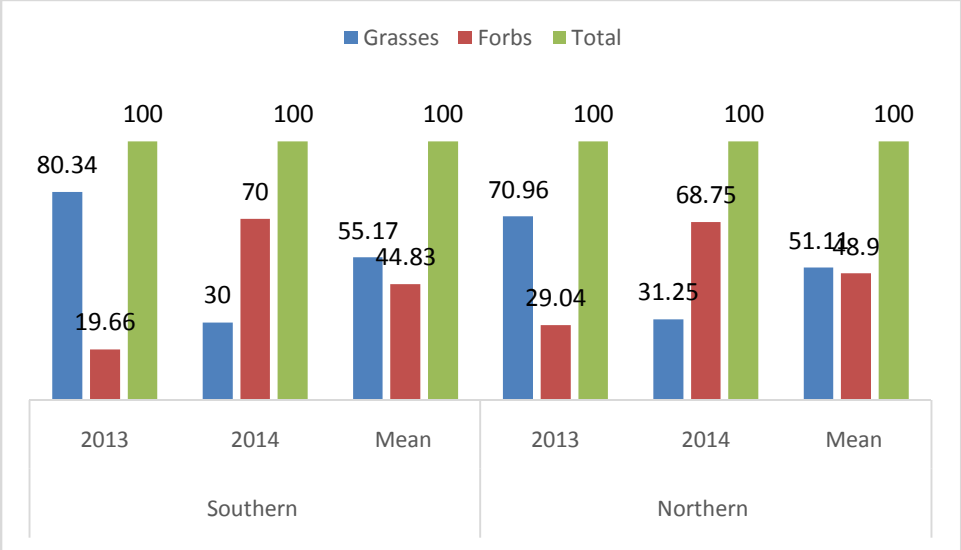


Figure 3 Botanical compositions by plant class (%) for the two sites during seasons 2013 and 2014

Plant density (plant/m^2) for the two range sites (S) and (N) during seasons 2013 and 2014is shown in Table (4.3).The mean density was327and 225plants/m^2 for the two sites respectively.

The species with highest density for site (S) were *Dactyloctenium aegyptium* (124), *Aristida mutabilis* (94), and *Cyperus rotundus* (30) plants/m^2. Plant species with highest mean density for site (N) were *Dactyloctenium aegyptium* (59), *Eragrostis diplachnoides* (58) and *Schoenfeldia gracilis* (34) plant/m^2.

Table 4.3 Plant density (plant/m^2) in the two range sites (S) and (N) during seasons 2013 and 2014

No	Latin name	Vern name	Ssite			N site		
			2013	2014	Mean	2013	2014	Mean
1	*Aristida mutabilis*	Gaw	140	47	94.0	11.00	2.00	7.00
2	*Alycicarpus glumaceus*	Umsabiha	3	3	3.00	0.00	0.00	0.00
3	*Echinocloa colonum*	Defra	44	9	27.00	31.00	2.00	17.00
4	*Eragrostis tremula*	Banw	6	4	5.00	0.00	1.00	0.00
5	*Dactyloctenium aegyptium*	Abuasabi	208	40	124	87.00	31.0	59.00
6	*Indigofera spp.*	Sharaya	0.00	0.00	0.00	0.00	0.00	0.00
7	*Trigonella hamosa*	Umgreen	0.00	2	1.00	0.00	0.00	0.00
8	*Justica kotschyi*	Nana	0.00	3	2.00	10.00	4.0	7.00
9	*Cyperus rotundus*	Seida	5.00	54	30.00	3.00	3.0	3.00
10	*Tripogon minmus*	Fart el arnab	0.00	3.0	2.00	3.00	15	9.00
11	*Mollugo noduavlis*	Semel a grab	0.00	5.0	2.00	0.00	6.0	3.00

12	*Eragrostis diplachnoides*	Mohoya	35.0	22	29.0	93	23.0	58
13	*Indigoferaaspera*	Lesan tair	0.00	0.0	0.00	0.00	0.00	0.00
14	*Tribulus terresttris*	Derassa	0.00	0.00	0.00	0.00	2.00	1.00
15	*Commelina kotschyi*	Ibrrg elfaki	0.00	1.0	0.00	0.00	0.00	0.00
16	*Oxygonum atriplicifolium*	Umhamid	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ipomoea vagans*	Han toot	0.00	2.0	1.00	0.00	0.00	0.00
18	*Corchorus olitorius*	Molukhia	0.00	1.0	0.00	2.00	1.00	2.00
19	*Portulaca oleracea*	Regla	0.00	2.0	1.0	0.00	0.0	0.00
20	*Brachiria eruciformis*	Umdefertain	0.00	0.00	0.00	15.00	13	14
21	*Trianthema portulacastrum*	Tarba	0.00	0.00	0.00	0.00	1.00	0.00
22	*Schoenfeldia gracilis*	Danabelnaga	5.00	0.00	3.00	39.00	28	34.00
23	*Fimbristyls dichotomo*	Umfesisiyat	0.00	1.0	0.00	0.00	0.00	0.00
24	*Unidentified*	Zeraelbaoda	0.00	0.00	0.00	0.00	0.0	0.00
25	*Alycicarpus yaginalis*	Umngigirh	0.00	3.0	2.00	0.00	0.00	0.00
26	*Parkin Sonia aculata*	Sesaban	0.00	0.00	0.00	0.00	0.00	0.00
27	*Zalya pentandra*	Rabaa	0.00	2.0	1.0	0.00	0.00	0.00
28	*Zornia glochidiata*	Sheliniy	0.00	0.00	0.00	0.00	0.00	0.00
29	*Aristida adscensionis*	Umhiraibu	0.00	0.00	0.00	4.00	15	10.00
30	*Euphoebia aegyptiaca*	Umlibaina	0.00	0.00	0.00	0.00	0.00	0.00
31	*Trianthema portulacastrum*	Tarba hamra	0.00	0.00	0.00	0.00	1.0	0.00
32	*Cenchrus biflorus*	Haskaneet	0.00	0.00	0.00	0.00	0.00	0.00
33	*Solanum dubium*	Jebain	0.00	0.00	0.00	0.00	0.00	0.00
34	*Cucumis sativus*	Ajour	0.00	0.00	0.00	0.00	0.00	0.00
35	*Vigna sun hum*	Tagtaga	0.00	0.00	0.00	0.00	0.00	0.00
36	*Farsetia longisiliqua*	Aboadefir	0.00	0.00	0.00	0.00	0.00	0.00
37	*Polygala erioptera*	Merikh	0.00	0.00	0.00	0.00	0.00	0.00
38	*Unidentified*	Areghalamey	0.00	0.00	0.00	0.00	0.00	0.00
39	*Tephrosia uniflora*	Arcane	0.00	0.00	0.00	0.00	0.00	0.00
40	*Cassia sena*	Senamka	0.00	0.00	0.00	0.00	0.00	0.00
41	*Urochrus trichopus*	Hochst	0.00	0.00	0.00	0.00	0.00	0.00
Total			446	204	327	298	148	224

Table(4.4) shows plant relative density for the two range sites (S) and (N) during seasons 2013 and 2014.Plant species with highest mean relative densityin site (S) were *Aristida mutabilis* (27.05%), *Dactyloctenium aegyptium* (32.94%) and *Cyperus rotundus* (13.69%) while in site (N) *Dactylocteniumaegyptium* (24.94%) *Eragrostis diplachnoides* (23.11%) and *Schoenfeldia gracilis* (16.02%) were dominating.

Table4.4Plant relative density (%) at seed set stage of plant growth in the two range sites during seasons 2013 and 2014

No	Latin name	Vern name	S site			N site		
			2013	2014	Mean	2013	2014	Mean
1	*Aristida mutabilis*	Gaw	31.28	22.82	27.05	3.54	1.32	2.43
2	*Alycicarpus glumaceus*	Umsabiha	0.56	1.46	1.01	0.03	0.09	0.06
3	*Echinocloa colonum*	Defra	9.48	4.37	6.93	10.44	1.32	5.88
4	*Eragrostis tremula*	Banw	1.37	1.94	1.66	0.00	0.66	0.33
5	*Dactyloctenium aegyptium*	Abuasabi	46.45	19.42	32.94	28.88	21	24.94
6	*Indigofera spp.*	Sharaya	0.00	0.16	0.08	0.00	0.00	0.00
7	*Trigonella hamosa*	Umgreen	0.00	0.97	0.49	0.00	0.24	0.12
8	*Justica kotschyi*	Nana	0.00	1.46	0.73	3.23	3.0	3.12
9	*Cyperus rotundus*	Seida	1.17	26.21	13.69	1.10	2.0	1.55
10	*Tripogon minmus*	Fart el arnab	0.03	1.46	0.75	0.82	10.0	5.41
11	*Mollugo noduavlis*	Semel a grab	0.06	2.43	1.25	0.12	4.0	2.6
12	*Eragrostis diplachnoides*	Mohoya	7.86	10.68	9.27	30.98	15.23	23.11
13	*Indigofera aspera*	Lesan tair	0.03	0.06	0.05	0.00	0.00	0.00
14	*Tribulus terresttris*	Derassa	0.03	0.05	0.04	0.13	1.32	0.73
15	*Commelina kotschyi*	Ibrrg elfaki	0.00	0.49	0.25	0.00	0.00	0.00
16	*Oxygonum atriplicifolium*	Umhamid	0.02	0.16	0.09	0.05	0.09	0.07
17	*Ipomoea vagans*	Han toot	0.07	0.97	0.52	0.13	0.22	0.18
18	*Corchorus olitorius*	Molukhia	0.09	0.49	0.29	0.65	0.66	0.66
19	*Portulaca oleracea*	Regla	0.00	0.97	0.49	0.00	0.00	0.00
20	*Brachiria eruciformis*	Umdefertain	0.06	0.19	0.13	4.92	9.00	6.96
21	*Trianthema portulacastrum*	Tarba	0.00	0.11	0.06	0.00	0.66	0.33
22	*Schoenfeldia gracilis*	Danabelnaga	1.05	0.19	0.62	13.03	19	16.02
23	*Fimbristyls dichotomo*	Umfesisiyat	0.02	0.49	0.26	0.00	0.02	0.01
24	*Unidentified*	Zeraelbaoda	0.00	0.03	0.02	0.00	0.07	0.03
25	*Alycicarpus yaginalis*	Umngigirh	0.07	1.46	0.76	0.00	0.04	0.02
26	*Parkin Sonia aculata*	Sesaban	0.08	0.15	0.11	0.00	0.00	0.00
27	*Zalya pentandra*	Rabaa	0.00	0.97	0.48	0.00	0.00	0.00
28	*Zornia glochidiata*	Sheliniy	0.00	0.00	0.00	0.03	0.09	0.06
29	*Aristida adscensionis*	Umhiraibu	0.00	0.00	0.00	1.40	10	5.7
30	*Euphoebia aegyptiaca*	Umlibaina	0.00	0.00	0.00	0.00	0.04	0.02
31	*Trianthema portulacastrum*	Tarba hamra	0.00	0.00	0.00	0.00	0.66	0.33
32	*Cenchrus biflorus*	Haskaneet	0.00	0.00	0.00	0.03	0.28	0.15
33	*Solanum dubium*	Jebain	0.00	0.00	0.00	0.00	0.22	0.11
34	*Cucumis sativus*	Ajour	0.00	0.00	0.00	0.00	0.02	0.01
35	*Vigna sun hum*	Tagtaga	0.00	0.00	0.00	0.00	0.22	0.11
36	*Farsetia longisiliqua*	Aboadefir	0.18	0.00	0.9	0.00	0.00	0.00
37	*Polygala erioptera*	Merikh	0.03	0.00	0.01	0.00	0.00	0.00
38	*Unidentified*	Areghalamey	0.01	0.00	0.005	0.00	0.00	0.00
39	*Tephrosia uniflora*	Arcane	0.00	0.00	0.00	0.8	0.00	0.4
40	*Cassia italica*	Senamka	0.00	0.00	0.00	0.03	0.00	0.01
41	*Urochloa trichopus*	Hochst	0.00	0.00	0.00	0.25	0.00	0.13
Total			100	100	100	100	100	100

In terms of relative density grasses formed (92.55and 87.27%) while forbs were (1.45% and 12.73%) at the southern and northern range sites respectively.

Plant frequencies (%) for the two range sites (S) and (N) during seasons 2013 and 2014 are given in Table (4.5). Plant species showing the highest mean frequency in range site (S) were *Dactyloctenium aegyptium* (77.5%), *Aristida mutabilis* (57.5%) and *Eragrostis tremula* (44.17%).

In range site (N) plants with highest frequency were *Eragrostis diplachnoides* (86%), Dactyloctenium *aegyptium* (83.5%) and *Schoenfeldia gracilis* (56%).

Table 4.5Plant frequency (%) in the two range sites during seasons2013and 2014

NO	Latin name	Vern name	Ssite			Nsite		
			2013	2014	Mean	2013	2014	Mean
1	*Aristida mutabilis*	Gaw	55	60	57.5	20	37	28.5
2	*Alycicarpus glumaceus*	Umsabiha	50	30	40	5.0	6.67	5.84
3	*Echinocloa colonum*	Defra	20	56.67	38.34	40	23.33	31.67
4	*Eragrostis tremula*	Banw	55	33.33	44.17	0.00	23.33	11.67
5	*Dactyloctenium aegyptium*	Abuasabi	85	70	77.5	80	87	83.5
6	*Indigofera spp.*	Sharaya	0.00	3.33	1.67	0.00	0.00	0.00
7	*Trigonella hamosa*	Umgreen	0.00	56.67	28.34	0.00	6.67	3.34
8	*Justica kotschyi*	Nana	0.00	16.67	8.34	45	20	32.5
9	*Cyperus rotundus*	Seida	10	33.33	21.67	15	10	12.5
10	*Tripogon minmus*	Fart el arnab	10	23.33	16.67	45	63.33	54.17
11	*Mollugo noduavlis*	Semel a grab	15	40	27.5	5.0	70	37.5
12	*Eragrostis diplachnoides*	Mohoya	30	50	40	85	87	86
13	*Indigofera aspera*	Lesan tair	5.0	6. 67	5.84	0.00	0.00	0.00
14	*Tribulus terresttris*	Derassa	5.0	10	7.5	15	53.33	34.17
15	*Commelina kotschyi*	Ibrrg elfaki	0.00	6.67	3.34	0.00	0.00	0.00
16	*Oxygonum atriplicifolium*	Umhamid	5.0	3.33	4.17	5.0	3.33	4.17
17	*Ipomoea vagans*	Han toot	5.0	23.33	14.17	20	6.67	13.34
18	*Corchorus olitorius*	Molukhia	10	16.67	13.34	30	27	28.5
19	*Portulaca oleracea*	Regla	0.00	20	10	0.00	0.00	0.00
20	*Brachiria eruciformis*	Umdefertain	5.0	13.33	9.17	60	30	45
21	*Trianthema portulacastrum*	Tarba	0.00	13.33	6.67	0.00	20	10
22	*Schoenfeldia gracilis*	Danabelnaga	30	10	20	65	47	56
23	*Fimbristyls dichotomo*	Umfesisiyat	5.0	13.33	9.17	0.00	3.33	1.67
24	*Unidentified*	Zeraelbaoda	0.00	6.67	3.34	0.00	3.33	1.67
25	*Alycicarpus yaginalis*	Umngigirh	15	30	22.5	0.00	6.67	3.34
26	*Parkin Sonia aculata*	Sesaban	5.0	6.67	5.84	0.00	0.00	0.00
27	*Zalya pentandra*	Rabaa	0.00	20	10	0.00	0.00	0.00
28	*Zornia glochidiata*	Sheliniy	0.00	0.00	0.00	5.0	13.33	9.17

29	*Aristida adscensionis*	Umhiraibu	0.00	0.00	0.00	5.0	27	16
30	*Euphoebia aegyptiaca*	Umlibaina	0.00	0.00	0.00	0.00	6.67	3.34
31	*Trianthema portulacastrum*	Tarba hamra	0.00	0.00	0.00	0.00	10	5.0
32	*Cenchrus biflorus*	Haskaneet	0.00	0.00	0.00	5.0	13.33	9.17
33	*Solanum dubium*	Jebain	0.00	0.00	0.00	0.00	6.67	3.34
34	*Cucumis sativus*	Ajour	0.00	0.00	0.00	0.00	3.33	1.67
35	*Vigna sun hum*	Tagtaga	0.00	0.00	0.00	0.00	6.67	3.34
36	*Farsetia longisiliqua*	Aboadefir	25	0.00	12.5	0.00	0.00	0.00
37	*Polygala erioptera*	Merikh	10	0.00	5.0	0.00	0.00	0.00
38	*Unidentified*	Areghalamey	5.0	0.00	2.5	0.00	0.00	0.00
39	*Tephrosia uniflora*	Arcane	0.00	0.00	0.00	10	0.00	5.0
40	*Cassia italica*	Senamka	0.00	0.00	0.00	5.0	0.00	2.5
41	*Urochloa trichopus*	Hochst	0.00	0.00	0.00	5.0	0.00	2.5

Plant relative frequency (%) for the two range sites during seasons 2013 and 2014 is provided in Table 4.6. Plant species with highest mean relative frequency in range site (S) were*Dactyloctenium aegyptium* (14.44%), *Aristida mutabilis* (10.44%) and *Eragrostis tremula* (8.46%). Species showing highest mean relative frequency in range site (N) were *Eragrostis diplachnoides* (13.48%), *Dactyloctenium aegyptium* (13.05%) and *Schoenfeldia gracilis* (8.96%).

Table 4.6 Plant relative frequency (%) in the two range sites during seasons 2013 and 2014

No	Latin name	Vern name	Ssite			Nsite		
			2013	2014	Mean	2013	2014	Mean
1	*Aristida mutabilis*	Gaw	11.96	8.91	10.44	3.51	5.12	4.32
2	*Alycicarpus glumaceus*	Umsabiha	10.87	4.46	7.67	0.88	0. 92	0.9
3	*Echinocloa colonum*	Defra	4.35	8.42	6.39	7.02	3.23	5.13
4	*Eragrostis tremula*	Banw	11.96	4.95	8.46	0.00	3.23	1.62
5	*Dactyloctenium aegyptium*	Abuasabi	18.48	10.40	14.44	14.04	12.05	13.05
6	*Indigofera spp.*	Sharaya	0.00	0. 49	0.25	0.00	0.00	0.00
7	*Trigonella hamosa*	Umgreen	0.00	8.42	4.21	0.00	0.92	0.46
8	*Justica kotschyi*	Nana	0.00	2.48	1.24	7.89	2.77	5.33
9	*Cyperus rotundus*	Seida	2.17	4.95	3.56	2.63	1.39	2.01
10	*Tripogon minmus*	Fart el arnab	2.17	3.46	2.82	7.89	8.77	8.33
11	*Mollugo noduavlis*	Semel a grab	3.26	5.94	4.6	0.88	9.70	5.29
12	*Eragrostis diplachnoides*	Mohoya	6.52	7.43	6.98	14.91	12.05	13.48
13	*Indigofera aspera*	Lesan tair	1.09	0. 99	1.04	0.00	0.00	0.00
14	*Tribulus terresttris*	Derassa	1.09	1. 49	1.29	2.63	7.39	5.01
15	*Commelina kotschyi*	Ibrrg elfaki	0.00	0. 99	0.50	0.00	0.00	0.00
16	*Oxygonum atriplicifolium*	Umhamid	1.09	0. 49	0.79	0.88	0.46	0.67
17	*Ipomoea vagans*	Han toot	1.09	3.46	2.28	3.51	0.92	2.22
18	*Corchorus olitorius*	Molukhia	2.17	2.48	2.33	5.26	3.74	4.5
19	*Portulaca oleracea*	Regla	0.00	2.97	1.49	0.00	0.00	0.00

20	*Brachiria eruciformis*	Umdefertain	1.09	1.98	1.54	10.53	4.16	7.35
21	*Trianthema portulacastrum*	Tarba	0.00	1.98	0.99	0.00	2.77	1.39
22	*Schoenfeldia gracilis*	Danabelnaga	6.52	1.49	4.01	11.40	6.51	8.96
23	*Fimbristyls dichotomo*	Umfesisiyat	1.09	1.98	1.54	0.00	0.46	0.23
24	*Unsatisfied*	Zeraelbaoda	0.00	0.99	0.49	0.00	0.46	0.23
25	*Alycicarpus yaginalis*	Umngigirh	3.36	4.46	3.91	0.00	0.92	0.46
26	*Parkin Sonia aculata*	Sesaban	1.09	0.99	1.04	0.00	0.00	0.00
27	*Zalya pentandra*	Rabaa	0.00	2.97	1.49	0.00	0.00	0.00
28	*Zornia glochidiata*	Sheliniy	0.00	0.00	0.00	0.88	1.85	1.37
29	*Aristida adscensionis*	Umhiraibu	0.00	0.00	0.00	0.88	3.74	2.31
30	*Euphoebia aegyptiaca*	Umlibaina	0.00	0.00	0.00	0.00	0.92	0.46
31	*Trianthema portulacastrum*	Tarba hamra	0.00	0.00	0.00	0.00	1.39	0.70
32	*Cenchrus biflorus*	Haskaneet	0.00	0.00	0.00	0.88	1.85	1.37
33	*Solanum dubium*	Jebain	0.00	0.00	0.00	0.00	0.92	0.46
34	*Cucumis sativus*	Ajour	0.00	0.00	0.00	0.00	0.46	0.23
35	*Vigna sun hum*	Tagtaga	0.00	0.00	0.00	0.00	0.92	0.46
36	*Farsetia longisiliqua*	Aboadefir	5.43	0.00	2.72	0.00	0.00	0.00
37	*Polygala erioptera*	Merikh	2.17	0.00	1.09	0.00	0.00	0.00
38	*Unidentified*	Areghalamey	1.09	0.00	0.55	0.00	0.00	0.00
39	*Tephrosia uniflora*	Arcane	0.00	0.00	0.00	1.75	0.00	0.88
40	*Cassia italica*	Senamka	0.00	0.00	0.00	0.88	0.00	0.44
41	*Urochloa trichopus*	Hochst	0.00	0.00	0.00	0.88	0.00	0.44
Total			100	100	100	100	100	100

The biomass productivity at two sites during seasons 2013 and 2014 is shown in Table (4.7), There was significant difference between thesites ($P<0.05$) in season 2014. In season 2013the biomass productivity was (672and710 kg/ha) in the range sites (S) and (N) respectively. Productivity in northern site was higher than that of the southern site**.** However, in season2014 the biomass productivity was 709 and 453 kg/ha in the southern and northern range sites, respectively. Biomass productivity was higher in season 2013 than in season 2014. Seasonal differences were not significant.The ecological factors, particularly; precipitation is more than any other factor that determines plant growth in the range land. Rainfall in the study area is erratic in distribution and quantity this phenomenon has reduced biomass production, altered plant botanical composition and reduced seed production, Bunderson (1986) stated that the amount and distribution of rainfall received in any given year has a profound impact on biomass, cover and composition of

vegetation, particularly among the annual species. Also different nomadic groups have practiced communal use of the resource base for a long time which had negative impact on the vegetation cover.

Table 4.7Biomass productivity (kg/ha) in the two range sites during seasons2013and 2014

Season	Site	Biomass(kg /ha)	Mean	Sig
2013	Southern	672	69 1 ± 42.3	Ns
	Northern	710		
2014	Southern	709	581 ± 51.9	*
	Northern	453		
Mean		63 6	636 ± 23.7	Ns

Note: ± = SE (Standard error).

The carrying capacities of herbaceous plants in the two range sites at seed set stage during season 2013and 2014 are presented in Table (4.8). According toMustafa *et al.* (2000) carrying capacity can be defined as the "maximum animal numbers which can graze each year on a given area of grassland for a specific number of days without inducing a downward trend in forage production, forage quality, or soil".

The carrying capacity in this study was determinedaccording toDarrag, (1996), who reported that the Carrying capacity is usually, determined using the proper use factor (PUF) of 50% in which only one half of forage biomass produced is considered as available for grazing. The carrying capacity in southern site was notdifferent during season 2013and 2014. But in northern site the carrying capacity in season 2014 was lower thanthat during 2013.

Margon (1993), Stated that there is no universal formula for determining stocking rate, and the carrying capacity of the pasture is usually imprecisely defined. The determination is more difficult in a region with high variability in rainfall from year to year so that overgrazing is almost inevitable when several years of drought follow in succession.

Table 4.8 Carrying capacity in southern and northern range sites at seasons2013 and 2014

Season	Site	TLU /ha /year	Ha/TLU/year
2013	Southern	0.11	8.96
	Northern	0.12	8.48
2014	Southern	012	8.50
	Northern	0.08	13.30
Mean		0.11	9.47

* (TLU) Tropical livestock Unit = 250 kg live body weight

4-2 Browse vegetation measurements

Trees density (tree/ha) in two range sites (S) and (N) during seasons 2013 and 2014 are shown in Table (4.9). In southern site *Acacia tortils, Boscia sengalensis* and *Acacia nilotica* had the highest mean densityabout (223, 55 and 20 tree/ha) respectively. In the northern site *Acacia mellifera*, *Acacia tortils* and *Acacia nubica* had highest mean density about (103, 100, 55 tree/ha) respectively. These species approximately constituted the majorty of the trees in study area and are the most important species that are to lerant to the prevailing environment. They are also feed and food source for animals and human during famine. They are preferred plants for camels according to (FAO, 2003).

Table 4.9 Trees density (tree/ha) in the two range sites during seasons 2013 and2014

No	Latin name	Vern name	S site			N site		
			2013	2014	Mean	2013	2014	Mean
1	*Acacia tortils*	Seyal	220	225	223	85	115	100
2	*Boscia sengalensis*	Mukheit	65	45	55	20	50	35
3	*Acacia nilotica*	Sunt.garad	30	10	20	0.0	0.0	0.0
4	*Maerua crassifolia*	Sarh	10	15	13	0.0	0.0	0.0
5	*Leptadenia pyrotechnica*	Marakh	5.0	5.0	5.0	0.0	0.0	0.0
6	*Acacia Senegal*	Hashab	0.0	5.0	3.0	0.0	0.0	0.0
7	*Acacia mellifera*	Kitr	15	20	18	115	90	103
8	*Ziziphous spina Christi*	Sidr	5.0	10	8.0	5.0	0.0	3,0
9	*Balanites aegyptiaca*	Heglig	15	20	18	15	0.0	8.0
10	*Capparis sepiara*	Mrdo	5.0	5.0	5.0	0.0	5	3.0
11	*Unidentified*	-	0.0	0.0	0.0	0.0	15	8.0
12	*Permina resinosa*	Saat	10	10	10	5.0	35	20
13	*Grewia tanex*	Gudeim	10	5.0	8.0	20	10	15
14	*Acacia nubica*	Laoat	0.0	0.0	0.0	25	85	55

15	*Commiphora Africana*	Gafal	0.0	0.0	0.0	10	5.0	8.0
16	*Anogeissus leiocarpus*	Sahib	5.0	0.0	3.0	0.0	0.0	0.0
17	*Capparis deciduas*	Tundob	5.0	0.0	3.0	0.0	0.0	0.0
18	*Indigofera spinosa*	Singed	5.0	0.0	3.0	0.0	0.0	0.0
19	*Cordial rothii*	Andrab	0.0	0.0	0.0	5.0	0.0	3.0
Total			405	375	395	305	410	361

Table (4.10) shows trees relative density (%) in the two range sites during seasons 2013 and 2014. In the southern site, *Acacia tortils, Boscia sengalensis, and Acacia nilotica* are had highest mean relative density (57.2%, 14% and5%) respectively. At the northern site *Acacia mellifera*, *Acacia tortils* and *Acacia nubica* are showed highest mean relative density (29.9%, 28%, 14.5%) respectively.

Table 4.10 Tree relative density (%) in the two range sites during seasons 2013 and 2014

No	**Latin name**	**Vern name**	**S site**			**Nsite**		
			2013	**2014**	**Mean**	**2013**	**2014**	**Mean**
1	*Acacia tortils*	Seyal	54.32	60	57.16	27.87	28.05	27.96
2	*Boscia sengalensis*	Mukheit	16.05	12	14.03	6.56	12.2	9.38
3	*Acacia nilotica*	Sunt.garad	7.41	2.67	5.04	0.0	0.0	0.0
4	*Maerua crassifolia*	Sarh	2.48	4.0	3.24	0.0	0.0	0.0
5	*Leptadenia pyrotechnica*	Marakh	1.23	1.33	1.28	0.0	0.0	0.0
6	*Acacia Senegal*	Hashab	0.0	1.33	0.67	0.0	0.0	0.0
7	*Acacia mellifera*	Kitr	3.70	5.33	4.52	37.70	22	29.85
8	*Ziziphous spina Christi*	Sidr	1.23	2.67	1.95	1.64	0.0	0.82
9	*Balanites aegyptiaca*	Heglig	3.70	5.33	4.52	4.92	0.0	2.46
10	*Capparis sepiara*	Mrdo	1.23	1.33	1.28	0.0	1.21	0.61
11	*Unidentified*	-	0.0	0.0	0.0	0.0	3.6	1.8
12	*Permina resinosa*	Saat	2.48	2.67	2.58	1.64	9.0	5.32
13	*Grewia tanex*	Gudeim	2.48	1.33	1.91	6.56	2.43	4.50
14	*Acacia nubica*	Laoat	0.0	0.0	0.0	8.19	20.7	14.45
15	*Commiphora Africana*	Gafal	0.0	0.0	0.0	3.28	1.21	2.25
16	*Anogeissus leiocarpus*	Sahib	1.23	0.0	0.62	0.0	0.0	0.0
17	*Capparis deciduas*	Tundob	1.23	0.0	0.62	0.0	0.0	0.0
18	*Indigofera spinosa*	Singed	1.23	0.0	0.62	0.0	0.0	0.0
19	*Cordial rothii*	Andrab	0.0	0.0	0.0	1.64	0.0	0.73
Total			100	100	100	100	100	100

Tree Frequency (%) in the two range sites during seasons 2013 and 2014 is displayed in the Table (4.11). In the southern site *Acacia tortils, Boscia sengalensis, and Acacia nilotica* are representative of highest mean

frequency (90%, 40%, 17.5%) respectively. In the northern site *Acacia mellifera*, *Acacia tortils* and *Acacia nubica* had highest mean frequency (65%, 65%, 32.5%) respectively. *Boscia senegalensis* was browsed only during the unavailability of other vegetation and it has good natural regeneration and is sensitive to fire (IBGR, 1984). Another reason that assisted in the protection of Boscia tree was that reported by (Adam , 2002), who stated that, the Sultans in Darfur region prohibited cutting and misuse of this tree because it is considered as one of the essential wild food in Darfur and now being an indigenous knowledge all over the area of Darfur.There were clear differences between the frequency of trees for the two range sites,*Acacia tortils*, *Boscia senegalensis* and *Acacia nilotica* dominated the southern range site .also in northern site *Acacia tortils, Acacia mellifera, Acacia nubica* and *Boscia sengalensis*. But some plants in south site such as *Acacia Senegal, Maerua crassifolia, Leptadenia pyrotechnica*, *Anogeissus leiocarpus, Capparis decidua* and *Indigofera spinosa* are not found in the northern site range perhaps may bedue to the lack of heavy clay soil in which to grow those plant species.

Table 4.11Treefrequency (%) in the two range sites during seasons 2013 and 2014

No	Latin name	Vern name	Ssite			N site		
			2013	2014	Mean	2013	2014	Mean
1	*Acacia tortils*	Seyal	85	95	90	60	70	65
2	*Boscia sengalensis*	Mukheit	50	30	40	20	35	27.5
3	*Acacia nilotica*	Sunt.garad	25	10	17.5	0.0	0.0	0.0
4	*Maerua crassifolia*	Sarh	10	15	12.5	0.0	0.0	0.0
5	*Leptadenia pyrotechnica*	Marakh	5.0	5.0	5.0	0.0	0.0	0.0
6	*Acacia senegal*	Hashab	0.0	5.0	2.5	0.0	0.0	0.0
7	*Acacia mellifera*	Kitr	15	20	17.5	75	55	65
8	*Ziziphous spina Christi*	Sidr	5.0	10	7.5	5.0	0.0	2.5
9	*Balanites aegyptiaca*	Heglig	10	20	15	15	0.0	7.5
10	*Capparis sepiara*	Mrdo	5.0	5.0	5.0	0.0	5.0	2.5
11	*Unidentified*	-	0.0	0.0	0.0	0.0	15	7.5
12	*Permina resinosa*	Saat	5.0	10	7.5	5.0	30	17.5
13	*Grewia tanex*	Gudeim	10	5.0	7.5	20	10	15
14	*Acacia nubica*	Laoat	0.0	0.0	0.0	25	40	32.5
15	*Commiphora Africana*	Gafal	0.0	0.0	0.0	10	5.0	7.5

16	*Anogeissus leiocarpus*	Sahib	5.0	0.0	2.5	0.0	0.0	0.0
17	*Capparis deciduas*	Tundob	5.0	0.0	2.5	0.0	0.0	0.0
18	*Indigofera spinosa*	Singed	5.0	0.0	2.5	0.0	0.0	0. 0
19	*Cordial rothii*	Andrab	0.0	0.0	0.0	5.0	0.0	2.5

Relative frequencies (%) of trees in the two range sites during seasons 2013 and 2014 are shown in table (4.12). In the southern site *Acacia tortils, Boscia sengalensis and Acacia mellifera* are representative of highest mean relative frequency (38.4%, 17.0%, 7.5%) respectively. Where as in the northern site *Acacia mellifera*, *Acacia tortils* and *Acacia nubica* had highest mean relative frequency (26.13%, 25.71%, 12.8%) respectively.

Table 4.12 Tree relative frequency (%) in the two range sites during seasons 2013 and 2014

No	Latin name	Vern name	S site			N site		
			2013	2014	Mean	2013	2014	Mean
1	*Acacia tortils*	Seyal	35.43	41.3	38.37	25	26.42	25.71
2	*Boscia sengalensis*	Mukheit	20.83	13.04	16.94	8.33	13.21	10.77
3	*Acacia nilotica*	Sunt.garad	10.43	4.35	7.39	0.0	0.00	0.00
4	*Maerua crassifolia*	Sarh	4.17	6.52	5.35	0.0	0.00	0.00
5	*Leptadenia pyrotechnica*	Marakh	2.08	2.17	2.13	0.0	0.00	0.00
6	*Acacia Senegal*	Hashab	0.0	2.17	1.09	0.0	0.00	0.00
7	*Acacia mellifera*	Kitr	6.25	8.70	7.48	31.25	21	26.13
8	*Ziziphous spina Christi*	Sidr	2.08	4.35	3.22	2.08	0.00	1.04
9	*Balanites aegyptiaca*	Heglig	4.17	8.70	6.44	6.25	0.00	3.13
10	*Capparis sepiara*	Mrdo	2.08	2.17	2.13	0.0	1.89	0.95
11	*Unidentified*	-	0.0	0.00	0.00	0.0	5.66	2.83
12	*Permina resinosa*	Saat	2.08	4.35	3.22	2.08	11.32	6.7
13	*Grewia tanex*	Gudeim	4.16	2.17	3.17	8.33	3.77	6.05
14	*Acacia nubica*	Laoat	0.0	0.00	0.00	10.42	15.09	12.76
15	*Commiphora Africana*	Gafal	0.0	0.00	0.00	4.16	1.89	3.03
16	*Anogeissus leiocarpus*	Sahib	2.08	0.00	1.04	0.0	0.00	0.00
17	*Capparis deciduas*	Tundob	2.08	0.00	1.04	0.0	0.00	0.00
18	*Indigofera spinosa*	Singed	2.08	0.00	1.04	0.0	0.00	0.00
19	*Cordial rothii*	Andrab	0.0	0.00	0.00	2.08	0.00	1.04
Total			100	100	100	100	100	100

Browse productivity at the two sites during season 2013 and 2014 is presented in Table (4.13).There was a significant difference between sites ($P<0.05$) in season 2014, but in season 2013 no significant difference

between two sites was observed. Browse productivity in season 2013 was 36.11 and 90.5 kg/ha in southern and northern range sites respectively, but productivity in season2014was 43.754 and 103 kg/ha in the southern and northern range sites respectively. However mean browse productivity in season 2014was higher than that in season 2013 probably due to variability in rainfall (Figures 1).

Table 4.13Browse productivity (kg/ha) forthetwo seasons 2013 and 2014

Season	Site	Biomass(kg /ha)	Mean	Sig
2013	Southern	36	63 ±48.7	NS
	Northern	91		
2014	Southern	44	73 ±54.2	*
	Northern	103		
Mean		69	69±51.5	NS

The carrying capacities of browse in the two range sites during seasons 2013and 2014 are presented in Table (4.14).In southern site the tropical livestock units per hectare per year are lower than those in the northern site.

Table4.14 Carrying capacity in the two range sites during seasons2013 and 2014

Season	Site	TLU /ha /year	Ha/TLU/year
2013	Southern	0.01	84
	Northern	0.03	33.09
2014	Southern	0.02	68.45
	Northern	0.03	29.24
Mean		0.02	44

The combination between herbaceous and browse productivity during seasons 2013 and 2014 is shown in Table (4.15).There was highly significant difference between herbaceous and browse productivity ($P<0.000$) in the two seasons 2013and 2014, while there was no significant difference between the two seasons. The combined productivity of herbaceous and browse species in the two

seasons2013and 2014 was (754.037 and 654.196) ka/ha respectively. Season 2013 witnessed higher combined yields than season 2014.

Table4.15 Productivity (kg /ha) and carrying capacity in two seasons (2013 and 2014) when browse and herbaceous yields recombined

Season	Biomass productivity (kg/ha)			SE	Sig	Carrying capacity	
	Herbaceous	browse	Total			TLU/ha/year	ha/TLU/year
2013	691	63	754	34.466	***	0.14	7.37
2014	581	73	654	34.809	***	0.12	8.29
Mean	636	68	704	24.8	Ns	0.13	7.80

4.3. Measurements of the diet selected bygrazing camels

In the area under study the distribution of trees is scanty. The dominant species at the southern rangeland site were *Acacia tortilis, Acacia mellifera* and *Boscia sengalensis*. The dominant tree species at northern rangeland site were *Acacia mellifera, Acacia tortilis, Acacia nubica* and *Boscia sengalensis*.

Results in Table (4.16) show the diet selected by camel grazing at the southern site during 2013. Browse constituted the largest component of The diet (47.16%) followed by forbs (46.06%) and then grasses (6.78 %).Four forbs were high in the diet; these were *Tephrosia uniflora*(21.36%), *Ipomoea sinesisvar* (14.44%), *Corchorus olitorius* (4.31%) and *Oxygonum atriplicifolium*(4.10%).*Ipomoea* and *Corchorus* also had high relative preference indices of 38.0% and 17.2%, respectively. *Tephrosia* and *Oxygonum* did not appear in the range during sampling but were found to a substantial extent in the diet indicating a high relative preference index. Trees showing high presence in the diet of camels were *Acacia tortilis* (20.0%), *Acacia nilotica* (9.30 %), *Acacia mellifera* (5.22%) and *Boscia senegalensis* (4.39%).Presence of grasses in the diet was meager and among those were *Echinocloa colona* (2.69%) and *Eragrostis diplachnoides* (2.06%).

Table 4.16 Botanical composition of the diets of camels grazing at southern site at seed set stage during 2013

No	Latin names	Vern names	Diet%	Species%	*RPI	**PC	Type
1	*Corchorus olitorius*	Molukhia	4.31	0.25	17.2	PP	Forbs
2	*Ipomoea sinesisvar*	Hantoot	14.44	0.38	38.0	PP	Forbs
3	*Dactyloctenium aegyptium*	Abuasabi	1.44	28.25	0.05	UP	Grass
4	*Aristida spp*	Gaw	0.14	14.37	0.00	UP	Grass
5	*Eragrostis tremula*	Bano	0.03	2.25	0.01	UP	Grass
6	*Echinocloa colona*	Defra	2.69	8.75	0.30	UP	Grass
7	*Justicia kotschyi*	Nana	0.35	1. 58	0.22	UP	Forbs
8	*Schoenfeldia gracilis*	Danab elnaga	0.08	7.5	0.01	UP	Grass
9	*Eragrostis diplachnoides*	Mohoya	2.06	4.125	0.49	UP	Grass
10	*Tripogon minmus*	Fart arnab	0.14	1.625	0.08	UP	Forbs
11	*Polygala erioptera*	Marikh	0.03	0.00	--	-	Forbs
12	*Cyperus rotundus*	Seida	0.38	1.38	0.28	UP	Grass
13	*Parkin Sonia aculata*	Sesaban	0.63	0.00	-	-	Forbs
14	*Alycicarpus yaginalis*	Umngigirh	0.05	0.38	0.13	UP	Forbs
15	*Oxygonum atriplicifolium*	Umhamid	4.10	0.00	-	-	Forbs
16	*Anticharis linearis*	Ndiana	0.12	0.00	-	-	Forbs
17	*Alycicarpus glumaceus*	Umsabiha	0.30	4.5	0.06	UP	Forbs
18	*Tephrosia uniflora*	Arcane	21.36	0.00	-	-	Forbs
19	*Acacia mellifera*	Kitr	5.22	-	-	-	Trees
20	*Acacia tortils*	Seyal	20.0	-	-	-	Trees
21	*Boscia sengalensis*	Mukheit	4.39	-	-	-	Trees
22	*Grewia tanex*	Gudeim	2.06	-	-	-	Trees
23	*Balanites aegyptiaca*	Heglig	1.65	-	-	-	Trees
24	*Leptadenia pyrotechnica*	Marakh	0.57	-	-	-	Shrubs
25	*Acacia nilotica*	Sunt	9.30	-	-	-	Trees
26	*Ziziphous spina christi*	Sidr	0.47	-	-	-	Trees
27	*Anogeissus leiocarpus*	Sahab	0.57	-	-	-	Trees
28	*Capparis sepiara*	Mrdo	0.18	-	-	-	Trees
29	*Capparis deciduas*	Tundob	1.07	-	-	-	Trees
30	*Seddera spp*	Singed	1.37	-	-	-	Shrubs
31	*Bauhinia rufescens*	Kulkul	0.08	-	-	-	Trees
32	*Permina resinosa*	Saat	0.23	-	-	-	Trees
33	*Cucmis prophetarum*	Tutu	0.23	-	-	-	Forbs
34	*Maerua crassifolia*	Sarh	0.0	0.0	0.0	NCP	Trees
35	*Mollugo noduavlis*	S eamelagrab	0.0	1.58	0.0	NCP	Forbs
36	*Tribulus terresttris*	Derassa	0.0	0.17	0.0	NCP	Forbs
37	*Solanum incanum*	Gebien	0.0	0.29	0.0	NCP	Forbs
38	*Indigofera aspera*	Lesan tair	0.0	0.16	0.0	NCP	Forbs
39	*Farsetia longisiliqua*	Aboadefir	0.0	1.35	0.0	NCP	Forbs
40	*Cenchrus biflorus*	Haskaneet	0.0	0.43	0.0	NCP	Grass
41	*Unidentified*	-	0.0	0.13	0.0	NCP	Forbs
42	*Tephrosia spp*	Herasha	0.0	0.41	0.0	NCP	Forbs
43	*Aristida adscensionis*	Umhiraibu	0.0	0.14	0.0	NCP	Grass
Total			100	100			

*relative preference index (RPI) % = species in diet% ÷ species botanical composition%

PC** Plant classification, **PP** = Preferred Plant (RPI > 1.50), **DP** = Desirable Plant (RPI 0.70 to 1.49), **UP** = Undesirable Plant (RPI < 0.70), **NCP** = non consumed plant

The diets selected by camel grazing in northern site during 2013 are presented in Table (4.17). Again browse formed the largest part of the diet amounting to (74.37%), followed by forbs (16.62%) and then grasses (9.01%).

Trees that constituted the largest part of the diets of grazing camels were *Acacia mellifera* (22.64%), *Acacia nubica* (19.20%), *Acacia tortils* (16.89%) and *Boscia sengalensis* (7.99%). *Acacia nubica and Boscia senegalensis* are not usually considered of forage value for other domestic ruminants such as cattle, sheep and goats. However data obtained through the socioeconomic study support the finding that these two trees are among those selected by camels.

Two forbs were high in the diet of camels at northern site. These were*Justicia kotschyi* (12.69%) and *Tripogon minmus* (2.57%).*Justicia* also had a high RPI (1.76%) indicating that it is a preferred plant. On the other hand Tripogon, though present in the diet, yet it has a low RPI (0.45%) and as such classified as undesirable plant. The presence of grasses in the diets of camel's is low*Brachiria eruciformis* and *Eragrostis diplachnoides* were found in the diet of camels at 2.84% and 1.85% respectively but their RPI (0.42% and 0.16% respectively) are low and are considered undesirable plants. Since the range was grazed at the stage of seed set the low RPI of these plants are not surprising.Some plants appeared in the diet but were not detected in botanical composition such as *Cucmis prophetarum* (0.14% in diet*)* and *Cucumis sativus (*0.02% in diet) while other plants were common in the range forming a high percentage but were not selected by grazing camels. Examples of these plants include *Cyperus rotundus* (2.99%)*, Mollugo noduavlis* (2.80%) *and Urochloa trichopus* (2.52%).

Table 4.17 Botanical composition of the diets of camels grazing at seed set stage during 2013 in north site

No	Latin names	Vern names	Diet%	Species%	*RPI	**PC	Type
1	*Justicia kotschyi*	Nana	12.69	7.2	1.76	PP	Forbs
2	*Tephrosia uniflora*	Arcane	0.28	0.28	1.00	DP	Forbs
3	*Eragrostis diplachnoides*	Mohoya	1.85	11.60	0.16	UP	Grass
4	*Brachiria eruciformis*	Umdefertain	2.84	6.75	0.42	UP	Grass
5	*Echinocloa colona*	Defra	1.33	9.74	0.14	UP	Grass
6	*Schoenfeldia gracilis*	Danab elnaga	1.54	11.7	0.13	UP	Grass
7	*Cenchrus biflorus*	Haskaneet	0.21	3.00	0.07	UP	Grass
8	*Tripogon minmus*	Fart arnab	2.57	5.66	0.45	UP	Forbs
9	*Solanum incanum*	Gebien	0.04	1.28	0.03	UP	Forbs
10	*Tephrosia sp*	Herasha	0.05	1.21	0.04	UP	Forbs
11	*Corchorus olitorius*	Molukhia	0.10	2.57	0.04	UP	Forbs
12	*Tribulus terresttris*	Derassa	0.48	5.06	0.09	UP	Forbs
13	*Aristida spp*	Gaw	0.02	1.86	0.01	UP	Grass
14	*Ipomoea sinesisvar*	Hantoot	0.25	1.75	0.14	UP	Forbs
15	*Zornia diphylla*	Sheliniy	0.023	0.68	0.03	UP	Grass
16	*Dactyloctenium aegyptium*	Abuasabi	1.20	18.94	0.06	UP	Grass
17	*Cucumis sativus*	Ajour	0.02	-	-	-	Forbs
18	*Acacia tortils*	Seyal	16.89	-	-	-	Tree
19	*Balanites aegyptiaca*	Mukheit	7.99	-	-	-	Tree
20	*Abutilon pannosum*	Gargadan	0.53	-	-	-	Shrubs
21	*Acacia nubica*	Laoat	19.20	-	-	-	Tree
22	*Grewia tanex*	Gudeim	2.05	-	-	-	Tree
23	*Acacia mellifera*	Kitr	22.64	-	-	-	Tree
24	*Permina resinosa*	Saat	3.71	-	-	-	Tree
25	*Cucmis prophetarum*	Tutu	0.14	-	-	-	Forbs
26	*Commiphora Africana*	Gafal	0.46	-	-	-	Tree
27	*Balanites aegyptiaca*	Heglig	0.9	-	-	-	Tree
28	*Eragrostis tremula*	Bano	0.0	0.47	0.0	NCP	Grass
29	*Alycicarpus glumaceus*	Umsabiha	0.0	0.75	0.0	NCP	Forbs
30	*Mollugo noduavlis*	Seam elagrab	0.0	2.80	0.0	NCP	Forbs
31	*Cyperus rotundus*	Seida	0.0	2.99	0.0	NCP	Grass
32	*Aristida adscensionis*	Umhiraibu	0.0	0.72	0.0	NCP	Grass
33	*Urochloa trichopus*	Hochst	0.0	2.52	0.0	NCP	Grass
34	*Trianthema portulacastrum*	Tarba	0.0	0.29	0.0	NCP	Forbs
35	*Zalya pentandra*	Raba	0.0	0.15	0.0	NCP	Forbs
36	*Ziziphous spina Christi*	Sidr	0.0	-	-	NCP	Tree
37	*Cordial rothii*	Andrab	0.0	-	-	NCP	Tree
Total			100	100			

*relative preference index (RPI) % = species in diet% ÷ species botanical composition%

PC =Plant classification: **P** = Preferred Plant (RPI > 1.50), **DP** = Desirable Plant (RPI 0.70 to 1.49)

UP = Undesirable Plant (RPI < 0.70), **NCP** =non consumed plant

Results in Table (4.18) show the diet selected by camels grazing in the southern site during 2014.Grasses held the largest share of the diet selected (42.32%) followed by browse (31.51%) and then forbs (26.19%).

Grasses with highest presence in the diet were *Dactyloctenium aegyptium* (18.36%).*Cyperus rotundus* (9.2%), *Echinocloa colona* (6.61%) and *Eragrostis diplachnoides* (5.08%).Out of these grasses *Cyprus rotundus* had a RPI of 2.0 % and classified as preferred while *Dactyloctenium aegyptium* was classified as desirable having a RPI of 1.15% .The forbs most selected at the southern site were *Ipomoea sinesisvar* (15.08%) *and Justicia kotschyi* (3.37%).

These two forbs had a high RPI being 4.51% and 3.59% respectively both classified as preferred plants. On the other hand the trees found in large percentage in the composition of the diet of grazing camels were *Grewia tanex* (9.25%), *Boscia sengalensis* (6.1%), *Acacia tortils* (3.1%) *and Permina resinosa* (3.08%).Some plants appeared in the diet selected by camels even though they were not detected in botanical composition such as *Cucmis prophetarum (*1.3%) and *Panicum maximum (*0.52%).Also some plants formed a high percentage in the range as common plants but were not detected in the diets of grazing camels. These include *Trianthema portulacastrum* (3%)*, Fimbristyls dichotomo* (2.72%) *and Mollugo noduavlis* (2.09%).

Table 4.18 Botanical compositions of the diets of camels grazing at seed set stage during 2014 in southern site

No	Latin name	Vern name	diet%	Species %	*RPI	**PC	Type
1	*Ipomoea sinesisvar*	Hantoot	15.08	3.34	4.51	PP	Forbs
2	*Oxygonum atriplicifolium*	Umhamid	0.95	0.63	1.51	PP	Forbs
3	*Justicia kotschyi*	Nana	3.37	0.94	3.59	PP	Forbs
4	*Cyperus rotundus*	Seida	9.2	4.59	2.0	PP	Grass
5	*Commelina kotschyi*	Ibrrg elfaki	1.5	1.04	1.44	DP	Forbs
6	*Tripogon minmus*	Fartarnab	1.99	2.09	0.95	DP	Forbs
7	*Dactyloctenium aegyptium*	Abuasabi	18.36	16	1.15	DP	Grass
8	*Eragrostis diplachnoides*	Mohoya	5.08	5.0	1.02	DP	Grass
9	*Echinocloa colona*	Defra	6.61	9.0	0.73	DP	Grass
10	*Panicum maximum*	Tomam	0.52	0.00	0.0	-	Grass
11	*Alycicarpus yaginalis*	Umngigirh	0.69	5.42	0.13	UP	Forbs
12	*Zalya pentandra*	Rabaa	0.35	7.00	0.05	UP	Forbs
13	*Oxygonum atriplicifolium*	Umdefertain	0.21	1.04	0.20	UP	Grass
14	*Alycicarpus glumaceus*	Umsabiha	0.4	5.63	0.07	UP	Forbs

15	*Indigofera aspera*	Lesan tier	0.12	0.41	0.29	UP	Forbs
16	*Eragrostis tremula*	Banw	0.19	5.32	0.04	UP	Grass
17	*Aristida mutabilis*	Gaw	1.94	10.54	0.18	UP	Grass
18	*Portulaca oleracea*	Regla	0.03	1.57	0.02	UP	Forbs
19	*Tribulus terresttris*	Derassa	0.09	2.00	0.05	UP	Forbs
20	*Trigonella hamosa*	Umgreen	0.19	6.47	0.03	UP	Forbs
21	*Schoenfeldia gracilis*	Danabelnaga	0.21	0.94	0.22	UP	Grass
22	*Corchorus olitorius*	Molukhia	0.1	1.25	0.08	UP	Forbs
23	*Unidentified*	Zeraelbaoda	0.03	0.10	0.3	UP	Forbs
24	*Boscia sengalensis*	Mukheit	6.1	-	-	-	Tree
25	*Balanites aegyptiaca*	Sidr	0.12	-	-	-	Tree
26	*Permina resinosa*	Saat	3.08	-	-	-	Tree
27	*Acacia tortils*	Seyal	3.1	-	-	-	Tree
28	*Acacia mellifera*	Kiter	2.01	-	-	-	Tree
29	*Acacia nilotica*	Sunt	1.23	-	-	-	Tree
30	*Maerua sengalensis*	Serah	1.0	-	-	-	Shrubs
31	*Grewia tanex*	Gudeim	9.25	-	-	-	Tree
32	*Maerua crass folia*	Sarh	0.54	-	-	-	Tree
33	*Balanites aegyptiaca*	Heglig	1.37	-	-	-	Tree
34	*Bauhinia rufescens*	Kalkal	1.44	-	-	-	Tree
35	*Umdantfiet*	-	2.27	-	-	-	Tree
36	*Cucmis prophetarum*	Tutu	1.3	-	-	-	Forbs
37	*Indigofera spp*	Sharaya	0.0	0.10	-	NCP	Forbs
38	*Mollugo noduavlis*	Semelagrab	0.0	2.09	-	NCP	Forbs
39	*Trianthema portulacastrum*	Tarba	0.0	3.0	-	NCP	Forbs
40	*Fimbristyls dichotomo*	Umfesisiyat	0.0	2.72	-	NCP	Grass
41	*Parkin Sonia aculata*	Sesaban	0.0	0.21	-	NCP	Forbs
42	*Zornia glochidiata*	Sheliniy	0.0	0.31	-	NCP	Grass
43	*Solanum dubium*	Gebien	0.0	0.21	-	NCP	Forbs
44	*Polygala erioptera*	Merikh	0.0	0.53	-	NCP	Forbs
45	*Alliums cepa*	Basal	0.0	0.73	-	NCP	Forbs
46	*Amarannthus graecianis*	Tamalika	0.0	0.10	-	NCP	Forbs
47	*Tephrosia uniflora*	Argana	0.0	0.21	-	NCP	Forbs
48	*Cassia acutifolia*	Senamka	0.0	-	-	NCP	Shrubs
49	*Acacia Senegal*	Hashab	0.0	-	-	NCP	Tree
50	*Leptadenia pyrotechnica*	Marakh	0.0	-	-	NCP	Shrubs
51	*Capparis sepiara*	Mrdo	0.0	-	-	NCP	Tree
Total			100	100			

RPI = relative preference index (RPI) % = species in diet% ÷ species botanical composition%

PC =Plant classification: **PP** = Preferred Plant (RPI > 1.50), **DP** = Desirable Plant (RPI 0.70 to 1.49)

UP = Undesirable Plant (RPI < 0.70), **NCP** = non consumed plant

Results pertaining to the diets selected by camels grazing in the northern site during 2014are presented in Table (4.19).Browse by far dominated the diet selected amounting to 98.44% of the diet, while grasses and forbs were only 0.74% and 0.82% respectively.

Among trees, *Acacia mellifera* showed the highest percent in the diet *(*43.59%) followed by *Permina resinosa* (14.35%), *Acacia nubica* (12.9%) and *Acacia tortils* (10.46%).as regards forbs *Justicia kotschyi*was the most selected though the level was only (0.37%). Grasses most selected were *Aristida mutabilis* (0.33%) and *Eragrostis diplachnoides* (0.22%). Again some plants in abundance in the range but were not selected by grazing camels such as *Tribulus terresttris* (11%).*Eragrostis tremula* (4.27%), *Aristida adscensionis* (4.17%) *and Mollugo noduavlis* (4.05%).

Table 4.19Botanical composition of the diets of camel grazing at seed set stage during 2014 in northern site

No	Latin name	Vern name	Diet%	Species %	*RPI	**PC	Type
1	*Echinocloa colonum*	Defra	0.05	2.08	0.02	Up	Grass
2	*Eragrostis diplachnoides*	Mohoya	0.22	10	0.02	Up	Grass
3	*Dactyloctenium aegyptium*	Abuasabi	0.02	10	0.002	Up	Grass
4	*Brachiria eruciformis*	Umdefertain	0.1	8.64	0.01	Up	Grass
5	*Aristida mutabilis*	Gaw	0.33	5.00	0.07	Up	Grass
6	*Tripogon minmus*	Fartarnab	0.07	13.47	0.005	Up	Forbs
7	*Justica kotschyi*	Nana	0.37	2.08	0.18	Up	Forbs
8	*Schoenfeldia gracilis*	Danabelnaga	0.02	11.06	0.002	Up	Grass
9	*Boscia sengalensis*	Mukheit	3.37	-	-	-	Tree
10	*Permina resinosa*	Saat	14.35	-	-	-	Tree
11	*Acacia tortils*	Seyal	10.46	-	-	-	Tree
12	*Acacia mellifera*	Kiter	43.59	-	-	-	Tree
13	*Maerua sengalensis*	Serah	0.07	-	-	-	Shrubs
14	*Grewia tanex*	Gudeim	5.97	-	-	-	Tree
15	*Acacia nubica*	Laoat	12.9	-	-	-	Tree
16	*Commiphora Africana*	Gafal	0.56	-	-	-	Tree
17	*Umdantfiet*	-	4.1	-	-	-	Tree
18	*Capparis sepiara*	Mardo	2.55	-	-	-	Tree
19	*Adansonia digtata*	Tebaldi	0.52	-	-	-	Tree
20	*Cucmis prophetarum*	Tutu	0.38	-	-	-	Forbs
21	Unidentified	Zeraelbaoda	0.0	0.11	-	NCP	Forbs
22	*Alycicarpus yaginalis*	Umngigirh	0.0	0.11	-	NCP	Forbs
23	*Trianthema portulacastrum*	Tarba	0.0	1.00	-	NCP	Forbs
24	*Zalya pentandra*	Rabaa	0.0	0.33	-	NCP	Forbs
25	*Zornia glochidiata*	Sheliniy	0.0	1.64	-	NCP	Grass
26	*Aristida adscensionis*	Umhiraibu	0.0	4.17	-	NCP	Grass
27	*Euphoebia aegyptiaca*	Umlibaina	0.0	0.55	-	NCP	Forbs
28	*Trianthema portulacastrum*	Tarba hamra	0.0	1.97	-	NCP	Forbs
29	*Cenchrus biflorus*	Haskaneet	0.0	1.08	-	NCP	Grass
30	*Indigofera aspera*	Lesan tair	0.0	0.11	-	NCP	Forbs
31	*Tribulus terresttris*	Derassa	0.0	11	-	NCP	Forbs

32	*Mollugo noduavlis*	Semelagrab	0.0	4.05	-	NCP	Forbs
33	*Oxygonum atriplicifolium*	Umhamid	0.0	0.43	-	NCP	Forbs
34	*Ipomoea vagans*	Han toot	0.0	1.42	-	NCP	Forbs
35	*Corchorus olitorius*	Molukhia	0.0	3.00	-	NCP	Forbs
36	*Cyperus rotundus*	Seida	0.0	0.55	-	NCP	Grass
37	*Trigonella hamosa*	Umgreen	0.0	0.76	-	NCP	Forbs
38	*Eragrostis tremula*	Banw	0.0	4.27	-	NCP	Grass
39	*Alycicarpus glumaceus*	Umsabiha	0.0	0.55	-	NCP	Forbs
40	*Solanum dubium*	Gebien	0.0	1.21	-	NCP	Forbs
41	*Cucumis sativus*	Ajour	0.0	0.11	-	NCP	Forbs
42	*Vigna sun hum*	Tagtaga	0.0	0.22	-	NCP	Forbs
43	*Polygala erioptera*	Merikh	0.0	0.22	-	NCP	Forbs
44	*Cassia acutifolia*	Senamka	0.0	0.11	-	NCP	Forbs
45	*Commiphora Africana*	Gafal	-	-	-	NCP	Tree
Total			100	100			

RPI= relative preference index (RPI) % = species in diet% ÷ species botanical composition%

PC= Plant classification:

PP = Preferred Plant (RPI > 1.50), **DP** = Desirable Plant (RPI 0.70 to 1.49), **UP** = Undesirable Plant (RPI < 0.70), **NCP** = non consumed plant

Herbaceous and browse ratio:

Plant types most selected by grazing camels at the two range sites during seasons 2013and 2014 were 62.87% browse, 22.42% forbs and 14.72% grasses.However according to observer of camel the total bites per hour were(133 and 114) bite and per five second (11 and 10) bites respectively in southern and northern range sites in season 2013. But in season 2014the number of bite per hour were (93 and 147) bite and per five second (8 and 12) bite respectively at the southern to northern range sites. The tree parts most selected by grazing camels were twigs, leaves, pods, fruits and flowers.

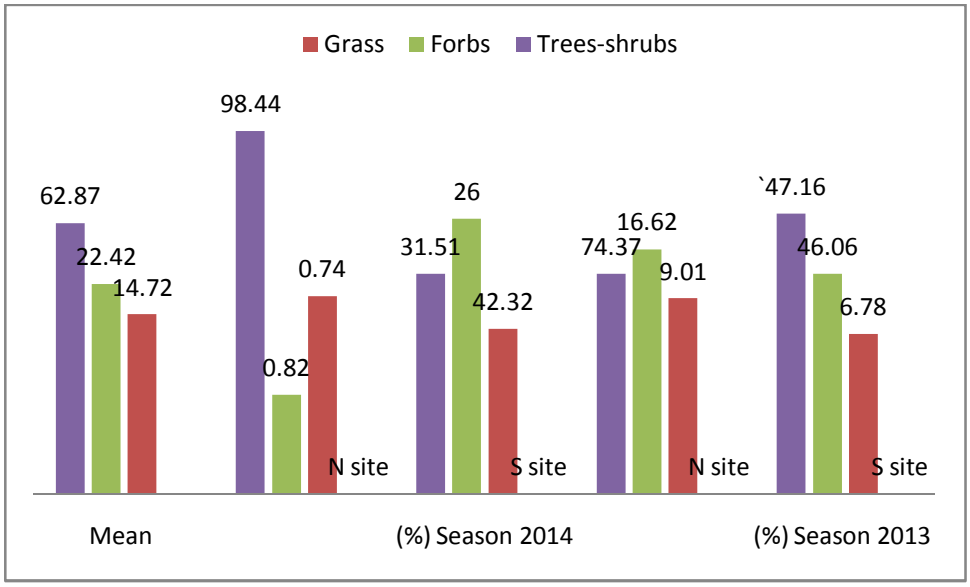


Figure.4. Percent browse and herbaceous plants in diet selected by camels during two seasons 2013 and 2014.

4.4 Socio-economic aspects of rangeland use

4.4.1 Personal characteristics

All herder respondents in this study were malesbecause the management of camels needed protection and care and roaming to far places, so it is a task assumed by male members of household.

Table (4.20) shows the age groups of livestock raisers. Most herders were in the age range of 21-40 (46%) and 41-60 (40%) years. Differences in age groups involved in camel rearing are highly significant (P<0.000). The results indicatethat camel rearing absorbs the most active individuals in the community since it is a tedious job. So men less than or more than 60 years of age are rarely associated with camel rearing.

Table 4.20 Distribution of respondents according to age groups

Age groups	Number	Percent
Less than 20	5	10
21– 40	23	46
41 – 60	20	40
More than 60	2	4

Total	50	100
DF	---	2.3
Sig	---	***

***Significant at 0.000 level

The education level of the livestock raisers is presented in table (4.21).There were highly significant different (P<0.000) in education level. About 60% of respondents had education at the Khalwa and primary school level. Some 30% of the respondents had intermediate and secondary school education. Only 4% of the respondents had university education and 6% were illiterate. Awareness level is an important factor in relation to extension activities required to promote technologies that can contribute to improving the livelihoods of camel producers.

Table 4.21: Distribution of respondents according to education level

Education level	**Number**	**Percent**
Illiterate	3	6
Khalwa	17	34
Primary	13	26
Intermediate	7	14
Secondary	8	16
University	2	4
Total	50	100
DF	---	3
Sig	---	***

***Significant at 0.000 level

Table (4.22) shows that main source of income of livestock raisers. There were highly significant differences (P<0.001) among respondents with respect to source of income. The main source of income was grazing (84%). Agriculture came second at (14%) and trade third at 2%.

Table 4.22: Distribution of respondents according to main source of income

Main source of income	Number	Percent
Grazing	42	84
Agriculture	7	14
Trade	1	2
Government service	0	0
Total	50	100
DF	---	1
Sig	---	***

***Significant at 0.001 level

4.4.2. Pattern utilization of pasture

Table (4.23) shows the distribution of respondents according to livestock production system. Most respondents were transhumants and nomads (46% and 46%respectively). The nomadic system is the most prevalent pattern in most rangeland areas of Darfur region.

Table 4.23: Distribution of respondents according to livestock production system

Production system	Number	Percent
Sedentary	4	8
Transhumant's	23	46
Nomads	23	46
Total	50	100
DF	-	1
Sig	-	***

***Significant at 0.001 level.

The duration of using rangeland in north Darfur state is provided in Table (4.24). There were highly significant difference (P<0. 002) in the duration of using rangeland by the livestock raisers. Most respondents (84%) reported that they use the land for a limited period. Only 18% use the land all year round.

Table 4.24: Duration of using rangeland

Duration of using rangeland	Number	Percent
Throughout the year	9	18
limited period	41	82
Total	50	100
Df	-	0.8
Sig	-	***

***Significant at 0.001 level.

The reasons for using rangeland for limited period are shown in Table (4.25). The vast majority (61%) of respondents reported that availability of forage is the major determinant that limits the period of their use of the land. Absence of pests and diseases were quoted by 27% of respondents as a reason limiting stay in a specific area and forage quality was indicated by 12%.The differences were highly significant ($p<0.000$) .

Table 4.25: Reasonsforusing rangeland for a limited period

The reason of using rangeland	Number	Percent
Abundance of forage	25	61
Quality of forage	5	12
Absence of diseases/pests	11	27
Total	41	100
Df	-	0.5
Sig	-	***

***significant at 0.001 level.

When asked whether they prefer grazing around the villages or grazing far from the villages all respondents (100%) reported that grazing far from the villages is better than grazing around the villages.

All respondents (100%) reported that range in the past was better than now and the main reason was quality of plant species (42%), abundance of plant species (34%). Reasons for better pasture in the past are presented in Table (4.26). All respondents reported that range quality and quantity was better in the past than at present. The reasons cited were mainly related to quality (42%), abundance (34%), limited cultivated area (12%), small number of animals (8%) and little or no tree felling (4%).

Table 4.26: Reasons why range was better in the past

Reason for better pasture	Number	Percent
Quality of plant species	21	42
Abundance of plant species	17	34
Limited cultivated area	6	12
Small number of animals	4	8
Little or no tree felling	2	4
Total	50	100
DF	-	2
Sig	-	***

***Significant at 0.001 level.

4.4.3 Preference of plants as assessedby camel herders

Table (4.27) shows the range plants preferred by camels according to respondents. The plants preferred most were *Acacia mellifera* (7.62%), *Acacia senegal* (6.39%), *Blepharislinarifolia* (4.91%), *Acacia nubica* (4.18%), *Acacia tortilis* (3.93%), *Ipomoea sinensis* (3.93%), and *Boscia sengalensis* (3.93%).

Table 4.27: Preferred plant species as reported by herders

Latin name	**Vern name**	**Type**	**Respondents**	**%**
Acacia mellifera	Kitir	Tree	31	7.62
Acacia Senegal	Hashab	Tree	26	6.39
Blepharis linearifolia	beg hail	Forbs	20	4.91
Acacia nubica	Laoat	Tree	17	4.18
Ipomoea sinensis	Han toot	Forbs	16	3.93
Acacia tortilis	Seyal	Tree	16	3.93
Boscia sengalensis	Mukheit	Tree	16	3.93
Balanites aegyptiaca	Higleag	Tree	15	3.69
Zalya pentandra	Raba	Forbs	15	3.69
Sesamum alatum	Kargina	Forbs	15	3.69
Acacia seyal	Talh	Tree	12	2.95
Bocrhavia vertiollata	Shalob	Forbs	12	2.95
Grewia tenax	Gudeim	Tree	11	2.70
Leptadenia pyrotechnica	Marakh	Shrubs	11	2.70
Cenchrus biflorus	Haskaneet	Grass	11	2.70
Sclerocarya birrea	Humied	Tree	10	2.46
Commiphora africana	Gaful	Tree	10	2.46
Acacia nilotica	Sunt	Tree	9	2.21
Echinochloa colona	Difra	Grass	9	2.21
Indigofera spp	Sharaya	Forbs	9	2.21
Combretum capituliflorum	Shohat	Tree	9	2.21
Dactyloctenium aegyptium	Omasabie	Grass	7	1.72
Permian resinosa	Seat	Tree	6	1.47
Trichilia emetica	Mahagir	Tree	6	1.47
Guiera sengalensis	Ghibaish	Tree	5	1.23

Alysicarpus yaginalis	Abu negagera	Forbs	5	1.23
Ziziphus spina Christi	Sidr	Tree	5	1.23
Anogeissus leiocarpus	Sahab	Tree	5	1.23
Momordica balsmina	Ayer	Forbs	5	1.23
Tribulus terrestris	Derassa	Forbs	4	0.98
Aristida abscensionis	Gaw	Grass	3	0.74
Adonsonia digitata	Tebaldi	Tree	3	0.74
Bauhinia rufescens	Kulkul	Tree	3	0.74
Capparis decidua	Tundob	Tree	3	0.74
Chrozophora sengalensis	Arksy	forbs	3	0.74
Farsetia longisclizua	Dahaian	forbs	3	0.74
Justicia kotschyi	Nana	Forbs	3	0.74
Pappaphorum spp	Um malih	Grass	3	0.74
Anticharis linrearis	Nadiana	Forbs	2	0.49
Justicia schimperi	Um dridemat	Forbs	2	0.49
Combretum cordofanum	Habeel	Tree	2	0.49
Fagonia cretica	Um showka	Forbs	2	0.49
Neurada procum bens	Sadaan	Shrub	2	0.49
Cordia rothii	Andrab	Tree	2	0.49
Corchorus olitorius	Molukhia	Forbs	2	0.49
Ephaltus alata	Remta	Forbs	2	0.49
Parkinsonia aculata	Sesaban	Forbs	2	0.49
Tripogon minmus	Fart elarnab	Forbs	2	0.49
Aristida paposa	Bayad	Grass	2	0.49
Polygala eriotera	Marikh	Forbs	1	0.25
Oxygonum atriplicifolium	Um hamit	Forbs	1	0.25
Capparis sepiaria	Mardo	Tree	1	0.25
Amaranthus graecianis	Tamalika	Forbs	1	0.25
Indigofera spinosa	Singid	Shrubs	1	0.25
Salvador a persica	Arak	Tree	1	0.25
Arenaria spp	Khoshin	Forbs	1	0.25
Aristida paposa	Nossay	Grass	1	0.25
Cadaba rotundifolia	Karmat	Shrubs	1	0.25
Lannea humilis	Leon	Tree	1	0.25
Terminalia laxiflora	Daroat	Tree	1	0.25
Citrullus colocynthis	Hanzal	Forbs	1	0.25
Aneilema lanceolatum	Bweid	Forbs	1	0.25
Total			407	100

The bulk of the diet selected consisted of browse species (56.3%) followed by forbs (30.49%) and grasses (8.85%). The trend is similar to that obtained when the bite count method was adopted where browse was the most selected by camels followed by forbs and grasses.

The range plants reported by respondents as not preferred by camels are indicated in Table (4.28). Plants ranking highest were *Cassia senna*

(14.91%),*Eragrostis tremula* (14.04%)*, Guiera sengalensis* (11.40%)and *Calotropis procera* (10.53%).According to diet selection by camel many plants in this table are not preferred, but the preference of Boscia *senegalensis*by camels was not expected as this plant is widely thought of as an increaser (FAO, 2003).

Table 4.28: Undesirable plant species as reported by herders

Latin name	Vern name	Type	Respondents	%
Cassia Senna	Senamka	Shrubs	17	14.91
Eragrostis tremula	Bano	Grass	16	14.04
Guiera senegalensis	Ghibaish	Tree	13	11.40
Calotropis procera	Oshar	Tree	12	10.53
Cassia tora	Kawal	Forbs	11	9.65
Aristida mutabilis	Gaw	Grass	10	8.77
Boscia sengalensis	Mukheit	Tree	6.0	5.26
Cassia mimosodes	Sekeran	Forbs	5.0	4.39
Abutilon pannosnm	um dfartain	Grass	5.0	4.39
Combretum cordofanum	Habeel	Tree	5.0	4.39
lannea humilis	Leon	Tree	3.0	2.63
albizzia amara	Arad	Tree	3.0	2.63
Aristida abscensionis	um hiraibu	Grass	3.0	2.63
Ficus spp	Jemez	Tree	2.0	1.75
Sorghum aethiopicum	Adar	Forbs	2.0	1.75
Gergeria alata	Gdgad	Forbs	1.0	0.88
Total			114	100

Table (4.29) shows the plants species that no longer exist despite their presence in the past as reported by herders in the study area. Those are most threatened.According to pastoralists the endangered plants were *Blepharis linarifolia* (30.26%), *monosnia sengalensis* (15.79%) and *Tephrosia spp* (11.84%).

Table 4.29: plants that were present in the past but no longer exist

Latin name	Vern name	Type	Respondents	%
Blepharis linarifolia	beg hail	Forbs	46	30.26
Monsonia sengalensis	Garin	Forbs	24	15.79
Tephrosia spp	Herasha	Forbs	18	11.84
Maerua grassifolia	Sarh	Tree	11	7.24
Arenaria spp	Khoshin	Forbs	9	5.92
Ipomoea cordiosepla	Hantoot	Forbs	8	5.26
Polygala erioptera	Marikh	Forbs	6	3.95
Tamarindus indica	Aradaib	Tree	6	3.95
Faidherbia albida	Haraz	Tree	5	3.29
Cucumis sativus	Ajour	Forbs	5	3.29
Aneilema lanceolatum	Bowed	Forbs	5	3.29

Convolvulus deserti	Karate	Forbs	3	1.97
Combretum colonum	Um toglgol	Forbs	2	1.32
Ziziphus spina christi	Sidr	Tree	2	1.32
Neurada procumbens	Sadaan	Forbs	2	1.32
Total			152	100

The effect of loss some plants on camel performance is shown in Table (4.30). According to those surveyed the effect of disappearance of some plants from the range oncamels was manifested in deterioration inhealth of the animals (38%), reduced production (20%) and decreased milk yield (14%).

Table 4.30: The effect of disappearance of plants on camels' performance

Effect	**Number**	**%**
Deterioration in health of animal	19	38
Decrease in production of animal	10	20
Decrease in milk yield	7	14
No effect	14	28
Total	50	100
Df	-	1
Sig	-	***

***Significant at 0.000 level

Table (4.31) shows the plant species that recently invaded the area as stated by herders. Plants that ranked high recently include *Eragrostis tremula* (41.66%), *Leptadenia pyrotechnica* (25%), *Schoenfeldia gracilis* (22.92%) and *Calotropis procera* (10.42%).

Table 4.31: plants species that have increased recently

Latin name	**Vern name**	**Type**	**respondents**	**%**
Eragrostis tremula	Bano	Grass	20	41.66
Leptadenia pyrotechnica	Marakh	Tree	12	25.00
Schoenfeldia gracilis	Danab elnaga	Grass	11	22.92
Calotropis procera	Oshar	Tree	5	10.42
Total			48	100

About 88% of the respondents said there are poisonous plants in the pasture. Table (4.32) shows that, the plants most cited by respondents as poisonous were *Tephrosia spp* (55.22%) and *Cuscuta hyaline* (16.42%).

Table 4.32: poisonous plants in study area

Latin name	Vern name	Type	Respondents	%
Tephrosia spp	Herasha	Forbs	37	55.22
Cuscuta hyaline	Hamool	Forbs	11	16.42
Unidentified	Umbrijango	Forbs	10	14.93
Farsetia longisiliqua	Umadafir	Forbs	6	8.96
Unidentified	Golem	Tree	3	4.48
Total			67	100

Tephrosia spp. and *Farsetia longisiliqua* appeared in plant measurement sbut did not appearin the diet selected by camel because camels avoid grazing poisonous plants. (Maxwell, 1938) reported that although grazing camels feed on a large number of types of plants, but quickly adapt on new pastures that are not used previously, often returning to the place where they grazed before.Camels have high ability to choose their diet so as to avoid grazing exotic weeds and toxic plants (leitz, 1929).Camels recognise poisonous plants growing in the area and will not eat them. However, if the camel is moved to a new area where different poisonous plants are found then it may eat those plants.

4.4.4. Kind of animals raised by pastoralists

Although most pastoralists raised sheep and goats beside camels, yet camels and sheep are kept by a larger number of pastoralists when compared with goats and cattle, Figure5 showed that andThe animal species most sold was sheep.

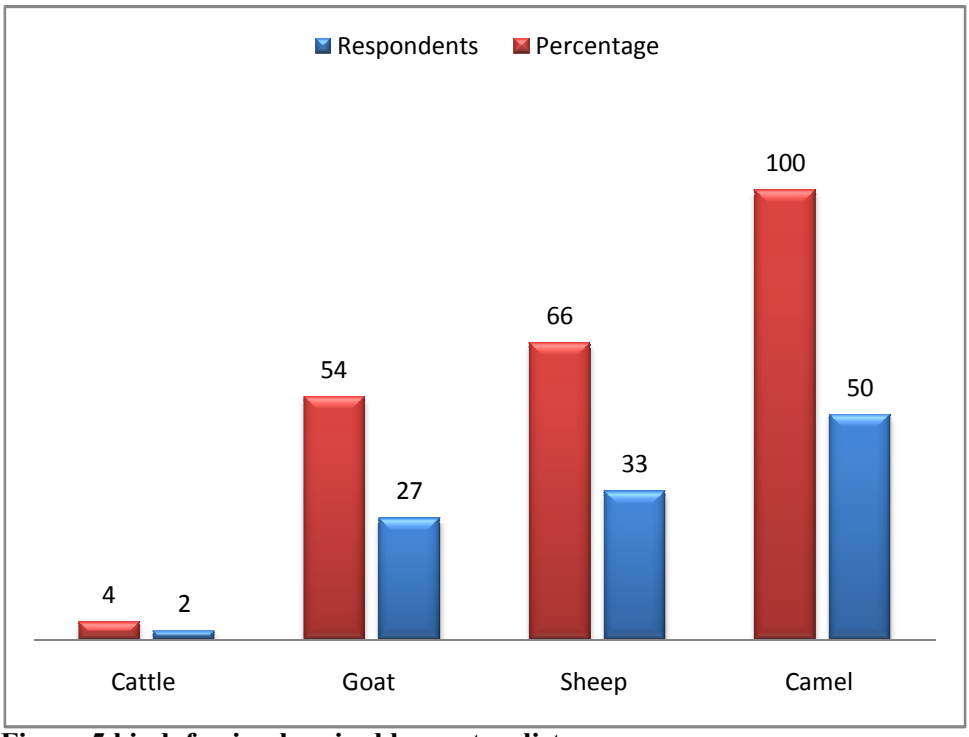


Figure.5.kindof animals raised by pastoralists

According to respondents almost all people sell some of their animals in order to get money. Animals sold were mostly males in the age of1-2 years as reported by 54% of respondents (Tables4.33 and 4.34). Moreover only 12% of respondents stated that, they sell animals before they are one year old. This is an area for extension to convince pastoralists to sell animals at an earlier age as this reduces pressure on the range and avails markets with meat that is tenderer.

Table 4.33: Reasons for sale of animals by pastoralists

Reasons of sale	Respondents	Percentage
To get money	47	94
Changing animals breeds	2	4
Reduce the number of animals	1	2
Total	50	100
Df	-	1
Sig	-	***

***Significant at 0.000 level

Table 4.34: Age for sale of animals according to respondents

Sale age of animals	Respondents	Percentage
Less than 6 months	1	2
6 months –year	6	12
1-2 years	27	54
2-3 years	10	20

Above 3 years	6	12
Total	50	100
Df	-	3
Sig	-	***

***Significant at 0.000 level

4.4.5. Problems related to the use of pasture

4.4.5.1. Rangeland deterioration in study area according to respondents

According to most respondents there was deterioration in the pasture (92%), and the main reasons for the deterioration were decrease in rainfall (44%) and overgrazing (34%) (Table4.35).

Table 4.35: Cause of deterioration of pasture in study area

Cause of deterioration	Respondents	Percentage
Decreased rainfall	22	44
Overgrazing	17	34
Desert creeping and soil erosion	7	14
No deterioration	4	8
Total	50	100
Df	-	2
Sig	-	***

***Significant at 0.000 level

4.4.5.2. Damage caused by nomads in pasture

Most respondents claim that, there is damage caused by nomads to the pasture (90%) while (10%) reported that, nomads caused no damage. The main causes for damage were seasonal fires (32%), lack of fodder (30%) and lack of water (18%), Table (4.36).

Table 4.36: Main problems faced by nomads

Causes' of damage	Respondents	Percentage
Seasonal fires	16	32
Lack of fodder	15	30
Lack of water	9	18
Early grazing	5	10
No damage	5	10
Total	50	100
Df	-	2
Sig	-	***

Camels are fed salt at all times during the year but in the dry season pastoralists are inclined to feed Sodiumbicarbonate only .Table 4.37shows that camels needa large amount of salt followed bycattle, sheep and then goats. Salt is very important for camels. They need salt more frequently than do cattle or sheep. Camels consume 1 kg of salt a week and it is advisable to leave salt with camels every week.

Table 4.37. Feedingcamelswith salt, quantity andnumber of times

Animal species	**Sodiumchloride/Lb.**	**Sodium bicarbonate/Lb.**	**number of times Sodiumchloridefed / week**	**number of times Sodium bicarbonate fed / week**
Camels	1	0.5	3	1
Sheep	0.25	0.25	2	1
Cattle	0.5	0.5	3	1
Goat	0.25	–	Daily	–

Chapter Five

Conclusion and Recommendations

5.1 Conclusions

Based on the results obtained it can be concluded that, the rangeland was dominated more by grasses than forbs. The vegetation cover, density, frequency, dry matter production, and carrying capacity wee better in the southern range site but the available browse was low. Also, the carrying capacity was different form one season to the other. This has prompted the herders to adopt a nomadic system in search of water and good grazing lands. The trees and shrubs were the main source of feed and constituted the highest percentage in the diet of camels followed by forbs and grasses were least. The plants that constituted the highest percentage in diet selected by camels were: *Tephrosia uniflora, Ipomoea sinesisvar, Corchorusolitorius*, *Oxygonumatriplicifolium, Justicia kotschyi, Tripogon minmus*, *Echinocloa colona*, *Acacia tortilis*, *Boscia senegalensis*, *Acacia mellifera*, *and Perminaresinosa*, *Acacianubica*, *Grewiatanex, and Dactyloctenium aegyptium*. These plants were also reported by camel herders as preferred plants suggesting that herder's perceptions on plant quality should be taken into consideration when assessing diet preference by camels as this saves time as well as human and financial resources. Camels herders keep more sheep than goats and cattle .The main threats to camel nomads are decline in rainfall, overgrazing, desert creeping, soil erosion and, more recently, insecurity.

5.2 Recommendations

The following recommendations are proposed:

1. The range should be properly managed to avoid overgrazing, early grazing should be avoided.

2. There is need for more research on plant/animal interaction and on the nutritive value of plants found to be preferred this will contribute to better understanding of the grazing process.

3. Improving natural rangeland by reseeding of plants preferred by camels to increase the productivity of herds from meat and milk.

4. The laws that protect natural rangelands and forests must be activated to reduce unauthorized cutting of trees and seasonal fires that harm the natural range.

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Appendixes

Appendix (1)

بسم الله الرحمن الرحيم

جامعة السودان للعلوم والتكنولوجيا

كلية الدراسات العليا

كلية علوم الغابات والمراعي

قسم علوم المراعي

استبيان

نباتات المراعى المفضلة للأبل فى المناطق شبة الصحراوية

المعلومات ادناه لأغرض البحث فقط

1- <u>المعلومات العامة</u>

1/ القرية\فريق..... 2/ المحلية.....3/ القبيلة..... 4/رقم الاستبيان..(.....)

3/ الجنس ذكر ( ) أنثى ( )

4/ العمر: 1- أقل من 20 . 2- من 20-40 . 3- من 40-60 . 4- أكثر من 60 سنة

5/ مستوى التعليم : 1- أمي 2- خلوة 3- ابتدائي 4- متوسط 5- ثانوي 6- جامعي

6/ المصدر الرئيسي للدخل : 1- رعى حيوان 2- زراعة 3- تجارة 4- مرتب 5- أخري

2- <u>نمط الاستخدام</u>

1/ هل أنت : 1- مستقر 2- شبة مستقر 3- مترحل

2/ طرق استخدام المرعي :

1- استخدام طول العام 2- استخدام لفترة محددة (حدد الفترة)..... 3/ إذا كانت الإجابة باستخدام المرعي لفترة محددة لماذا هذه الفترة؟

.....

4/ هل تترحلون بالحيوانات إلى مناطق أخري؟ 1- نعم ( ) 2- لا ( )

5/ إذا كانت الإجابة بنعم هل سبب الترحال؟ 1- قلة الماء 2- قلة المرعى 3- تفادى الأمراض 4- أخري

6/ هل للمرأة دور في إدارة الحيوان والعملية الإنتاجية : 1- نعم ( ) 2- لا ( )

7/ إذا كانت الإجابة بنعم ما هو الدور؟.....

8/ من وجهة نظرك ايهما أفضل من ناحية الصحة والإنتاج :

1- الحيوانات التي ترعى حول القرية 2- الحيوانات التي ترعى لمسافات بعيدة من القرية

9/ هل يحدث تذبذب موسمي في إنتاج اللبن ؟ 1- نعم ( ) 2- لا ( )

10/ إذا كانت الإجابة بنعم هل ذلك بسبب ؟

1- قلة النباتات الرعوية 2- عدم جودة النباتات الرعوية 3- أخرى .....

11/ هل توجد نباتات (مخلفات محاصيل ، مراعي طبيعية ، محاصيل زراعية) تحفظ في الصيف كعلف للحيوانات ؟
1- نعم ( ) 2- لا ( )

12/ إذا كانت الإجابة بنعم ما هي تلك النباتات؟

.....

3- <u>استخدام المرعي</u>

1/ ما هي النباتات الجيدة والأكثر استساغة للابل؟

....
.....
..... 2/ ما هي النباتات الغير جيدة وغير مستساغة للا بل؟

.....

3/ ما هي النباتات الموجودة سابقا وغير موجودة حاليا؟

....
.....

4/هل أثرت أختفاءها على تغذية الابل ؟ 1/ نعم( ) 2/ لا ( )

5/اذاكان الاجابة بنعم فى ماذا يتمثل التأثير؟.....

6/ماهى انواع النباتات التى ظهرت مؤخراً فى المرعى ؟.....

7/ هل توجد نباتات سامة بالمرعى؟ 1- نعم ( ) 2- لا ( )

8/ إذا كانت الإجابة بنعم ماهى ؟.....

9/ايهما أفضل : 1- المرعي سابقا 2- المرعي الحالي

10/ ولماذا.....

11/ هل الرعي في المرعي الطبيعي كافي لتغذية الحيوانات؟ 1- نعم ( ) 2- لا ( )

12/ إذا كانت الإجابة بلا هل السبب:

1- قلة المرعي 2- كثرة الحيوانات 3- الزراعة 4- أخري.....

13/ هل تعطى الحيوانات التي ترعى على المرعى الطبيعي غذاء اضافى ؟ 1- نعم ( ) 2- لا ( )

14/ إذا كانت الإجابة بنعم ماذا تضيف وما هي الكمية.....

.....

15/ هل تعطى الحيوانات ؟ 1- ملح 2- عطرون 3- الاثنين معا

16/ ما هي الكمية من الملح أو العطرون التي تضاف وكم مرة تضاف؟

	الأبقار	الضأن	الابل	الماعز
الكمية من الملح				
الكمية من العطرون				
عدد المرات للملح				
عدد المرات للعطرون				

4- <u>الحيوان</u>

1/ ما هي أنواع الحيوانات التي تقوم بتربيتها وعددها؟

	الأبقار	الضأن	الماعز	الجمال	أخري
النوع					
العدد					

2/ هل تبيع جزء من الحيوانات : 1- نعم ( ) 2- لا ( )

3/ إذا كانت الإجابة بنعم لماذا ؟

1- للحصول علي العائد المالي 2- حتى لا يزيد عددها فيؤثر ذلك على المراعي الطبيعية

3- أخري(حدد).....

4/ هل تبيع ؟ 1- الذكور 2- الإناث 3- الاثنين معا

5/ ما هو نوع الحيوان المباع ؟ 1- الأبقار 2- الضأن 3- الماعز 4- أخري (حدد).....

6/ هل تبيع في سن؟ 1- (حتى 6 شهور) 2- (6 إلى سنة) 3- (1-2سنة) 4-(2-3سنة) 5- أكثر من (3سنة)

7/ من يقوم برعي القطيع: 1- أحد أفراد العائلة 2- مستأجر 3- أخري

8/ إذا كانت الإجابة بمستأجر هل المقابل؟ 1- نقود (حدد)..... 2- حيوانات(حدد) ..... 3- أخري

9/ هل مالكي الحيوانات يستأجرون راعي واحد؟ 1- نعم ( ) 2- لا ( )

10/ ما هي مصادر المياه للحيوانات؟ 1- الحفائر 2- الدونكى الحكومي 3- الدونكي الخاص 4- بئر 5- أخري.....
ز

11/ هل هناك رسوم تدفع عند شرب الحيوانات؟ 1- نعم ( ) 2- لا ( )

12/ إذا كانت الإجابة بنعم ما هو سعر الرأس للشرب؟

	الأبقار	الضأن	الماعز	الجمال	أخري
سعر الرأس					

13/ كم من الأيام تسقي الحيوانات في الصيف؟ الأبقار الضأن الماعز الجمال

14/ كم من الأيام تسقي الحيوانات في الشتاء؟ الأبقار الضأن الماعز الجمال

5- <u>المشاكل المرتبطة باستخدام المرعي</u>

1/هل هنالك تدهور في المرعي؟ 1- نعم ( ) 2- لا ( )

2/ إذا كانت الإجابة بنعم ما نوع التدهور؟ 1- زحف صحراوي وتعرية تربة 2- رعى جائر 3/قلة الامطار3/هل هنالك أضرار تسببها الرحل للسكان المحليين فى أرض المرعى ؟ 1/ نعم( ) 2/ لا ( )

4/أذاكان الاجابة بنعم مانوع الضرر؟ 1/حرائق موسمية 2/نقص المياه 3/الرعى المبكر 4/نقص فى العلف.5/ أخرى.

Appendix (2)

<u>Form: Bite count technique</u>

Date…….. Site……

Observer……. Kind of Animal……

NO. Of minutes	Animal**1**	Animal **2**	Animal **3**	Animal **4**	Animal **5**	Remarks
5						
5						
5						
5						
5						
5						

Appendix (3)

<u>Loop method recording sheet</u>

Date …… site …… sample plot ……..

Observer ……. Soils …… Transect number ……...

No	1	2	3	4	5	6	7	8	9	10	Remarks
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

Summary of symbols

Rocks (R).

Litter (L).

Bare soil (B.s).

Plant species (P.s).

Appendix (4)

<u>Data sheet frequency and density of plant</u>

Date …………. Site …………. Sample plot ………………

Soil ………….. Observer ………… Transects number ………..

Quadrat number	Plant species	Density	Cover %	Remarks

Appendix (5)

Data sheet for available browse

Date …… site ……. Sample plot ……..

Soil …… Observer …….. Transect number ……..

Quadrat number	Tree/shrubs name	Available twig number	Weight of twig

Appendix (6)

Pictures of Camels grazing and watered in study area