## بسم الله الرحمن الرحيم Sudan University of Science and Technology College of Graduate Studies

Study on Productivity and Plant Preference by Sheep and Goats Grazing Natural Rangelands in El Domokeya area, North Kordofan, Sudan

دراسة إنتاجيه وتفضيل نباتات المراعى الطبيعية بواسطة الضأن والماعز في منطقة الدموكية، شمال كردفان، السودان

Thesis submitted for the fulfillment requirements of the degree of Doctor of Philosophy (PhD) in range Sciences

#### By

### **Mohammed Fatur Mohammed Fatur**

B.Sc. (Hon),

Kordofan University; 1995

M.Sc. University of Khartoum; 1999

Supervisor

Prof. Babo Fadlalla

Co. Supervisors

Dr. Abdelaziz Karamalla

Ustaz. Abdelrahman Alteib

September 2009

# بِسْمِ اللهِ الرَّحُمُنِ الرَّحِبْمِ مِ

سَبِّحِ ٱسُمَ رَبِّكَ ٱلْأَعْلَى ۞ ٱلَّذِى خَلَقَ فَسَوَّىٰ ۞ وَٱلَّذِى قَدَّنَ فَهَدَىٰ ۞ وَٱلَّذِى قَدَّرَ فَهَدَىٰ ۞ وَٱلَّذِى أَخُرَ جَ ٱلْمَرُعَىٰ ۞ فَجَعَلَهُ و غُثَآءً أَحُوَىٰ ۞ سَتُقُرِئُكَ فَلَا تَنسَىنَ ۞ إِلَّا مَا شَآءَ ٱللَّهُ إِنَّهُ و يَعْلَمُ ٱلْجَهُرَ وَمَا يَخُفَىٰ ۞ وَنُيَسِّرُكَ لِلْيُسُرَىٰ ۞ فَذَكِرُ إِن نَقَعَتِ ٱلذِّكُرَىٰ ۞ سَيَذَكَّرُ مَن يَخُشَىٰ ۞ وَيَتَجَنَّبُهَا ٱلْأَشُقَى ۞ ٱلَّذِى يَصُلَى ٱلنَّارَ ٱلْكُبُرَىٰ ۞

صدق الله العظيم

الأيات (1-12) سورة الأعلى

## **Table of Contents**

Title	Page
Dedication	I
Acknowledgment	II
List of tables	III
List of figures	VI
List of appendixes	VI
Abstract	VII
Abstract (Arabic)	XIII
Chapter One: Introduction	
1.1General	1
1.2 Problem statement	4
1.3 Justification	4
1.4 Objective of the study	5
1.4.1 Specific Objectives	5
Chapter Two: Literature Review	
2.1 Rangeland	6
2.2 Range Management	7
2.3 Interactions between range plants and range animals	7
2.4 Rangeland Plant Identification and Classification	8
2.5 Comparative nutritive value of grasses, forbs and shrubs	9
2.5.1 Grasses	9
2.5.2 Forbs	10
2.5.3 Shrubs	10
2.6 Herbaceous cover assessment	10
2.6.1 Biomass	10
2.6.2 Cover	11
2.6.3 Density	11
2.6.4 Frequency	12
2.6.5 Importance value (IV)	13
2.6.6 Carrying capacity	13
2.7 Nutritive Value of Forage	13
2.7.1 Sampling	13
2.7.2 Protein	14
2.7.3 Minerals and vitamins	15
2.7.4 Digestibility	15
2.8 Feeding behavior of animals	16
2.9 Voluntary Feed intake	18
2.9.1 Browsing	21

2.9.2 Grazing	22
2.9.2.1 Response of plant to grazing	23
2.9.2.1.1 Plant Defense Mechanisms	24
2.9.2.1.2 Plant Tolerance to Grazing	25
2.9.2.1.3 Competition among plants and selective grazing	26
2.10 Grazing systems and management	27
2.11 Movement of grazing animals	29
2.12 Palatability of Herbage and Animal Preference	29
2.12.1 Palatability of Herbage	30
2.12.2 Animal Preference	31
2.12.2.1 Plant preference classification	31
2.12.2.2 Preference index	32
2.13 Factors that Influence forage palatability	33
2.13.1 Animal factors	33
2.13.2 Plant factors	34
2.13.3 Environmental factors	34
2.14 Factors influencing relative preference	35
2.14.1 Palatability	35
2.14.2 Associated species	36
2.14.3 Climate and soil moisture	36
2.14.4 Kind of animal	36
2.15 Diet selection by small ruminants	37
2.16 Animal attributes that influence diet selection	38
2.16.1 Selecting species – sheep, goats, or cattle	38
2.16.1.1 Grazers	39
2.16.1.2 Browsers	39
2.16.1.3 Intermediate feeders	40
2.16.2 Multi-species grazing	41
2.16.3 Choosing a breed	41
2.16.4 Animal age	41
2.16.5 Body condition	42
2.16.6 Sex of animal	43
2.17 Botanical composition of the diet of grazing animals	43
2.17.1 Procedures used to evaluate the botanical composition of	43
the grazing animals' diet	
2.17.1.1 Direct observation of the animal	44
2.17.1.2 Utilization techniques	45
2.17.1.3 Stomach analysis	46
2.17.1.4 Fecal analysis	46
2.17.1.5 Fistula techniques	47
Chapter Three: Materials and Methods	
3.1 The study area	49
3.1.1General	49

3.1.2 Location of the study site	50
3.1.3 Climate	50
3.1.4 Vegetation	50
3.1.5 Population	51
3.2 Vegetation attributes measurements	52
3.2.1 Sampling design	52
3.2.2 Botanical composition of grassland	56
3.2.3 Biomass estimate	57
3.2.4 Density and frequency of range plants	59
3.2.5 Available browse of shrubs and density	61
3.2.5.1 Available browse of shrubs	61
3.2.5.2 Density of trees	61
3.2.6 Assessment of carrying capacity	62
3.3 Nutritional value of the range plants	62
3.3.1 Voluntary intake	62
3.3.1.1 Total fecal collection	62
3.3.1.2 <i>In vitro</i> digestibility	65
3.3.2 Determination pasture quality	67
3.3.3 Diet selection by the grazing animals	68
3.4 Investigation of the socio-economical aspects impacting on	70
range utilization use	
3.5 Data analysis	70
Chapter Four: Results and Discussions	
4.1 Vegetation attributes	71
4.1.1 Vegetation measurements	71
4.1.1.1 Plant composition and Relative composition %	71
4.1.1.2Vegetation cover, bare soil and litter%	74
4.1.1.3 Plant density/m2 and relative density%	75
4.1.1.4 Plant frequency and relative frequency%	75
4.1.1.5 Biomass Productivity (ton/hectare)	79
4.1.1.6 Carrying capacity	80
4.1.1.7 Dominant species on rangeland (Importance value IV)	82
4.1.1.8 Available browse of shrubs and density of trees on	83
protected and open rangeland	
4.1.2 Nutritional value of range	84
4.1.2.1 Chemical analysis of selected rangeland plants	84
4.1.2.2 Chemical analysis of the herbage biomass	86
4.1.2.3 In vitro digestibility and energy content of the rangeland	88
plants	
4.2 Animal attributes	89
4.2.1 Diet selection by the grazing animal (sheep & goats)	89
	89
4.2.1.1 Chemical composition of the diet selected by grazing	UJ

sheep and goats	
4.2.1.2 The botanical composition of the diets of grazing sheep	91
4.2.1.3 The botanical composition of diets of grazing goats	95
4.2.1.4 The voluntary intake of dry matter (DMI) by grazing	99
sheep and goats	
4.2.1.5 Distance walked (Km/day) by grazing sheep and goats	100
in the protected and open rangeland.	
4.2.1.6 In vitro digestibility and the energy density of the	102
grazing diets	404
4.2.1.7 Crude protein content of the diet selected and the intake	104
of crude by grazing sheep and goats	
4.3 Interaction between animals and plants	106
4.3.1 Rangeland as affected by animals use	106
4.3.1.1 Type of livestock	106
4.3.1.2 Duration of use	107
4.3.1.3 Diet selection	111
4.4.2 Range characteristics in relation to animal use pattern	113
4.5 Social-economic aspect of rangeland use	120
4.5.1 Personal characteristics	120
4.5.2 Pattern of rangeland use	123
4.5.3 Problem related to rangeland use	126
4.5.4 Indigenous Knowledge and herding practices	128
Chapter Five: Conclusions and Recommendations	
5.1 Conclusions	131
5.2 Recommendations	132
References	134