

Dedication

To the soul of my father

To my mother

To my husband

To my sister and my brother

To my sister's daughters Matilda and Maram

To my supervisors

To my colleagues and friends

To all those

I dedicate this humble work

ACKNOWLEDGEMENT

At the end of my thesis I would like to thank all those people who made this thesis possible and an unforgettable experience for me.

First of all, I would like to express my deepest sense of Gratitude to my supervisor Prof. Dr. Babo Fadlalla Mohamed, who offered his continuous advice and encouragement throughout my thesis. I thank him for the systematic guidance and great effort he added to me in the scientific field. I would like to express my very sincere gratitude to Prof. Dr. Mekki Abdelateif Omer for the unfailing help he rendered during this work, and their valuable advice and encouragement.

I also wish to extend my thanks to the staff of El.Obeid Research Station represented in Mr. Mohamed Abuelgasim, Mr. Tarig Elteib, Mr. Abdelateif Sulaiman, Mr. Mohamed Sulaiman and Mr. Hassan Yassin to their assistance in field work. My great thanks to Miss. Safa Abdelraheem and Mr. Abdalla Fadl Elmoula, for their assistance in the laboratory analysis. Appreciation also goes to IFAD financed Western Sudan Resource Management Programme for their assistance represented in Mr. Abdelhameed Adam Hamid and to the Drought Impact Mitigation Project and Ministry of Agriculture represented in Eng. Mekki Abdalla and Eng. Eltoum Elhag. Thanks are also due Dr. Ahmed Eldoma, for assistance with the statistical analysis.

I acknowledge my gratitude to Prof. Dr. Mult Ewald Schnug at the Institute of Crop and Soil Science, Federal Research Centre for Cultivated Plants - Julius Kühn-Institut, in Braunschweig, Germany for the absolute support to make this thesis possible and for giving me the absolute access to the laboratory and I am also

thankful to Dr. Sylvia Kratz, Mr. Helmut Kammerer and Ms. Edda Oelker for laboratory assistance.

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ABSTRACT

This experiment was conducted at El Obeid Research Station Farm at Bannu area, Sheikan Locality, North Kordofan State, over the two seasons of 2009/10 and 2010/11. The area has a unimodal annual rainfall of 300-400 mm occurring during July-October. The main economic activities are crop and livestock production. Livestock are raised either under sedentary or migratory systems where natural grazing is practised. The dominant livestock species are sheep, cattle, goats and camels. A main determinant of livestock production is low forage production resulting from low soil moisture due to low total precipitation and also to poor water infiltration rate associated with the prevalent type of sandy clay soils locally known as “gardud”. The objective of this study was to investigate the effect of re-seeding and water harvesting on rangeland forage biomass production, plant botanical composition, plant density and vegetation cover percent, at two range sites reseeded and un-reseeded and at flowering and seed set stages of growth. Diet botanical composition, voluntary intake of dry matter by grazing sheep, digestibility, the nutritional value of rangeland and the effect of three water harvesting techniques namely contour ridges, runoff strips and flat (control); and two planting methods specifically reseeded and natural regeneration (un-reseeded) on forage biomass production, plant density and vegetation cover were all also investigated.

The loop method was used to determine botanical composition of the rangelands, forage biomass production was estimated by use of cut and weigh method, diet botanical composition was estimated using the bite-count technique, voluntary intake was assessed using a relationship between total fecal collection and dry matter digestibility; and digestibility was measured by using acid insoluble ash method. The nutritional value of rangeland was evaluated by determination of the chemical composition to assess pasture quality.

On average, the total plant density at the reseeded range was 307 plant/m² compared with the un-reseeded range where it was 224 plant/m². The vegetation cover at the flowering stage at the reseeded site was 74.8% compared with 43.0% in the un-reseeded site, while at the seed set stage it was 70.6% and 41.8% at the reseeded and un-reseeded sites respectively. Forage biomass productivity at flowering stage was 2.13 (t/ha) and 1.82 (t/ha) at reseeded and un-reseeded sites respectively compared with seed set stage of 1.89 (t/ha) at the reseeded range and 1.68 (t/ha) at the un-reseeded range. These differences were highly significant (P<0.001). The differences in biomass productivity between the two sites was probably due to the management system, where broadcasting of seeds of some species increased plant density and led to a reduction in bare soil percent and consequently increased biomass productivity.

The species that were established by reseeded practice namely *Blepharis linarifolia*, *Crotalaria spp.* and *Dactyloctenium aegyptium* formed 6.78%, 4.55% and 0.72% respectively in the botanical composition on rangeland. At the flowering stage acid insoluble ash digestibility was higher in the reseeded range (67.3%) than in the un-reseeded range (64.7%) and was also higher for the reseeded site (64.2%) compared with the un-reseeded site (59.9%) at seed set stage. These differences were highly significant (P<0.001).

At the flowering stage, dry matter intake in this study was 52.80 g/kg w^{0.75} and 40.99 g/kg w^{0.75} at the reseeded and un-reseeded range sites respectively. At the seed set stage, intake was 37.51g/kg w^{0.75} and 29.08 g/kg w^{0.75} at the reseeded and un-reseeded range sites respectively. Some plant species were classified as preferred species such as *Ipomoea blepharosepala*, *Crotalaria spp.*, *Indigofera spp.*, *Tephrosia spp.*, *Dactyloctenium aegyptium* and *Sesbania sesban* and others as undesirable species such as *Echinochloa*

colonum, *Acanthus spp.*, *Ipomoea sp.*, *Solanum dubium*, *Acacia nubica* and *Tribulus terrestris* because these plants lost their leaves at seed set stage. These results indicate that the more nutritious plants and plant parts might have already been selected and consumed by livestock leaving the ones with less nutritive value. There were highly significant differences between chemical analysis of the plants selected by sheep and of the herbage biomass in the crude protein and crude fiber content between the phenological stages of flowering and seed set in the reseeded site and also in the un-reseeded site.

Depending on the results, crude protein (CP), crude fiber (CF), enzyme soluble organic matter (ESOM), enzyme in-soluble organic matter (EIOM), water soluble carbohydrate (WSC), acid detergent fiber (ADF), acid detergent lignin (ADL), crude cellulose (CC), neutral detergent fiber (NDF) and hemi-cellulose (HC) were predicted by NIRS with good degrees of accuracy, thus, it was concluded that the accuracy of utility of NIRS to predict these parameters was acceptable. Therefore, NIRS application could be adopted to estimate above parameters because the laboratory methods take a lot of time.

Under runoff strips, contour ridges and flat plant densities were 291 plant/m², 262 plant/m² and 162 plant/m² at reseeded range. In the un-reseeded range site these were 236 plant/m², 223 plant/m² and 124 plant/m² respectively. Vegetation cover for the three water harvesting methods in the reseeded site were 86.9%, 85.9% and 38.9%. In the un-reseeded range site these were 76.8%, 80% and 26.1% respectively. Forage biomass production in the reseeded site was 3.65, 2.25 and 0.65 t/ha for the three treatments respectively. In the un-reseeded range site the values were 2.85, 1.75 and 0.55 t/ha respectively. These differences were highly significant (P<0.001).

The study gave strong evidence that marginal and fragile environments provide enough feed for livestock. The results provided very useful indicators for use in

designing range management practices, such as selecting species required for reseeding deteriorated range and in identifying key species that will form a base for range management. Livestock diets' botanical composition could be used as an indicator for range quality. The results were discussed in relation to effect of increasing soil moisture content and reseeding on improving forage biomass production and animal production and on livelihoods and mitigation of environmental degradation. It was concluded that water harvesting techniques and reseeding resulted in increased biomass production and plant cover from rangelands.

ملخص الأطروحة

أجريت هذه التجربة في مزرعة البحوث الزراعية في منطقة بنو، محلية شيكان، ولاية شمال كردفان، خلال المواسم 2009/10 و 2010/11. هذه المنطقة تستقبل سنوياً أمطاراً تتراوح بين 300-400 ملم تبدأ من يوليو وحتى أكتوبر. النشاط الإقتصادي الرئيسي في المنطقة هو الزراعة وتربية الحيوانات. تربي الحيوانات تحت النظام شبه المستقر أو الترحالي في المرعي الطبيعي. أغلبية أنواع الحيوانات التي تربي هي الضأن والبقر والماعز والإبل. المحدد الرئيسي للإنتاج

الحيواني هو تدني إنتاجية العلف الناتجة من تدني رطوبة التربة وذلك نتيجة لقلّة كمية الأمطار السنويةً وضعف معدل التسريب هذا مع وجود نوع من التربة الرملية الطينية ويطلق عليها محلياً "القرود".

الهدف من هذه الدراسة هو معرفة أثر إعادة الإستزراع وحصاد المياه علي إنتاجية المراعي الطبيعية والتركيب النوعي للنباتات وكثافة النباتات ونسبة الغطاء النباتي، في مرعي مستزرع وآخر طبيعي في فترتي الإزهار وتكوين البذور. تم قياس التركيب النوعي لوجبة الضأن، وكمية المادة الجافة المأكولة ارادياً ومعامل الهضم والتركيب الكيميائي لنباتات للمراعي الطبيعية. كما تهدف الدراسة الى ومعرفة تأثير ثلاث تقنيات حصاد مياه وهي التروس الكنتورية وشرائط الجريان السطحي والشاهد؛ وطريقتين للإستزراع هما إعادة الإستزراع والتجديد الطبيعي (لا استزراع) علي إنتاجية المرعي، وكثافة النباتات والتغطية النباتية.

استخدمت طريقة اللوب لقياس التركيب النوعي للمراعي الطبيعية كما تم تقدير إنتاجية المراعي بطريقة القطع والوزن وتقدير التركيب النوعي لوجبة الضأن عن طريق حساب القضامات و تقدير كمية الغذاء المأكول طوعاً عن طريق العلاقة بين كمية الروث المستخرج ومعامل هضم المادة الجافة الذي قيس باستخدام طريقة الرماد الذي لا يذوب في الحمض قدرت القيمة الغذائية للمراعي الطبيعية بتحديد التركيب الكيميائي لقياس جودة المرعي.

أشارت النتائج إلى أن مجموع كثافة النباتات في المرعي المستزرع، في المتوسط، كانت 307 نبات/م² مقارنة ب 224 نبات/م² بالمرعي الطبيعي. كما كانت نسبة الغطاء النباتي في فترة الإزهار في المرعي المستزرع 74.8% مقارنة مع 43.0% في المرعي الطبيعي، بينما في فترة تكوين البذور كانت 70.6% و 41.8% في المرعي المستزرع والطبيعي على التوالي. كانت إنتاجية المرعي في فترة الإزهار 2.13 (طن/هكتار) و 1.82 (طن/هكتار) في المرعي المستزرع والطبيعي على التوالي مقارنة بفترة تكوين البذور حيث بلغت 1.89 (طن/هكتار) في المرعي المستزرع و 1.68 (طن/هكتار) في المرعي الطبيعي. هذه الفروقات معنوية عالية (

($P < 0.001$). قد تكون الفروقات في إنتاجية المراعى بين الموقعين ناتجة عن الفرق في نظام الإدارة، حيث تؤدي إعادة إستزراع بعض النباتات لزيادة الكثافة وإنخفاض في نسبة الأرض المعراة وبالتالي زيادة إنتاجية المراعى.

وتمثل النباتات التي تم تأسيسها عن طريق إعادة الإستزراع وهي (بغيل) *Blepharis* و *linarifolia*، و(طقطاقة) *Crotalaria spp.*، و(ابو أصابع) *Dactyloctenium aegyptium* تمثل 6.78%، 4.55% و 0.72% علي التوالي في التركيب النوعي للنباتات في المرعى. في فترة الإزهار نجد أن معامل هضم المادة الجافة بطريقة الرماد الذي لا يذوب في الحمض كانت أعلى في المرعى المستزرع (67.3%) مقارنة بالمرعى الطبيعي (64.7%)، وايضاً نجدها أعلى في المرعى المستزرع (64.2%) مقارنة بالمرعى الطبيعي (59.9%) في فترة تكوين البذور. هذه الفروقات كانت معنوية.

في فترة الإزهار، بلغ وزن المادة الجافة المأكولة في هذه الدراسة 52.80 جرام/كيلوجرام وزن أبيض أي و 40.99 جرام/كيلوجرام وزن أبيض في المرعى المستزرع والطبيعي علي التوالي. في فترة تكوين البذور كانت الكمية المأكولة من المادة الجافة 37.51 جرام /كيلوجرام وزن أبيض و 29.08 جرام /كيلوجرام وزن أبيض في المرعى المستزرع والطبيعي علي التوالي. بعض الأنواع النباتية صنفت كنباتات مفضلة مثل: حنتوت وطقطاقة وشرايا وفريشة وابو اصابع وسوريب والبعض الآخر صنفت كنباتات غير مرغوبة مثل: دفرة وتمر الفار وتبر وجبين ولعوت وضريسة وذلك بسبب أن هذه الانواع مفضلة بحكم نوعها كما ان بعض النباتات لم تفضل لأنها فقدت أوراقها في فترة تكوين البذور. هذه النتائج تعطي مؤشرات تفضيل للأنواع المختلفة من النباتات الرعوية والأجزاء التي أختيرت وأستهلكت بواسطة الحيوانات. كذلك وجدت فروقات معنوية بين التحليل الكيميائي للنباتات التي أختيرت بواسطة الضأن وعلف المرعى في البروتين الخام ومحتوي الألياف الخام وبين فترتي الإزهار وتكوين البذور في المرعى المستزرع والطبيعي. بناءً علي النتائج المتحصل عليها بطرق التحليل التقليدية وطريقة معامل انعكاس جوار الأشعة تحت الحمراء لكلٍ من المادة العضوية الذائبة في العصارة الهضمية)

(ESOM) والمادة العضوية التي لا تذوب في العصارة الهضمية (EIOM) والكربوهيدرات التي تذوب في الماء (WSC) والألياف التي تذوب في منظم حمضي (ADF) واللجنين الذي يذوب في منظم حمضي (ADL) والسيليلوز الخام (CC) والألياف التي تذوب في منظم محايد (NDF) والهيميسليلوز فقد وجد أن الطريقتين تعطيان نتائج بدرجة من الدقة متقاربة. وعليه فإن استخدام طريقة معامل انعكاس جوار الأشعة تحت الحمراء يمكن قبولها لقياس هذه المكونات الكيميائية وبالتالي يمكن تفضيل هذه الطريقة وذلك لأن الطرق التقليدية تستهلك الكثير من الوقت والجهد.

كانت كثافة النباتات تحت شرائط الجريان السطحي، والتروس الكنتورية والشاهد 291 نبات/م²، و 262 نبات/م² و 162 نبات/م² في المرعي المستزرع على التوالي. بينما في المرعي الطبيعي مثلت 236 نبات/م²، 223 نبات/م² و 124 نبات/م² علي التوالي. بلغت نسبة التغطية النباتية الناتجة عن لطرق حصاد المياه المختلفة في الموقع المستزرع 86.9%، 85.9% و 38.9% بينما كانت في المرعي الطبيعي 76.8%، 80% و 26.1% علي التوالي. كما كانت إنتاجية المراعي في المرعي المستزرع في التروس الكنتورية وشرائط الجريان السطحي والشاهد 3.65 طن/هكتار، 2.25 طن/هكتار و 0.65 طن/هكتار علي التوالي. أما في المرعي الطبيعي فقد كانت 2.85 طن/هكتار، 1.75 طن/هكتار و 0.55 طن/هكتار علي التوالي. هذه الفروقات عالية المعنوية (P<0.001).

أعطت الدراسة حقائق قوية وذلك في البيئات الهشة والهامشية التي تقدم غذاء مقدراً للثروة الحيوانية. هذه النتائج ذات فائدة قصوي في تصميم تطبيقات إدارة المراعي، كإختيار الأنواع النباتية المطلوبة لإعادة تأهيل المراعي ومعرفة النباتات المفتاحية والتي تكون الأساس لإدارة المراعي. مؤشرات التفضيل تمكن من إختيار أنواعالنباتات لاستخدامها في عمليات الاستزراع عند العمل في إعادة تأهيل المراعي. نوقشت هذه النتائج على ضوء علاقة تأثير زيادة رطوبة التربة على إنتاجية العلف من المراعي الطبيعية وعلي تحسين البيئات المتدهورة. خلصت الدراسة إلي أن تقنيات حصاد المياه وإعادة الإستزراع نتجت عنها زيادة في إنتاجية

المرعي وفي التغطية النباتية وانها بالتالي تساعد في زيادة واستقرار الانتاج الحيواني في المناطق قليلة الامطار ذات التربة القردودية.