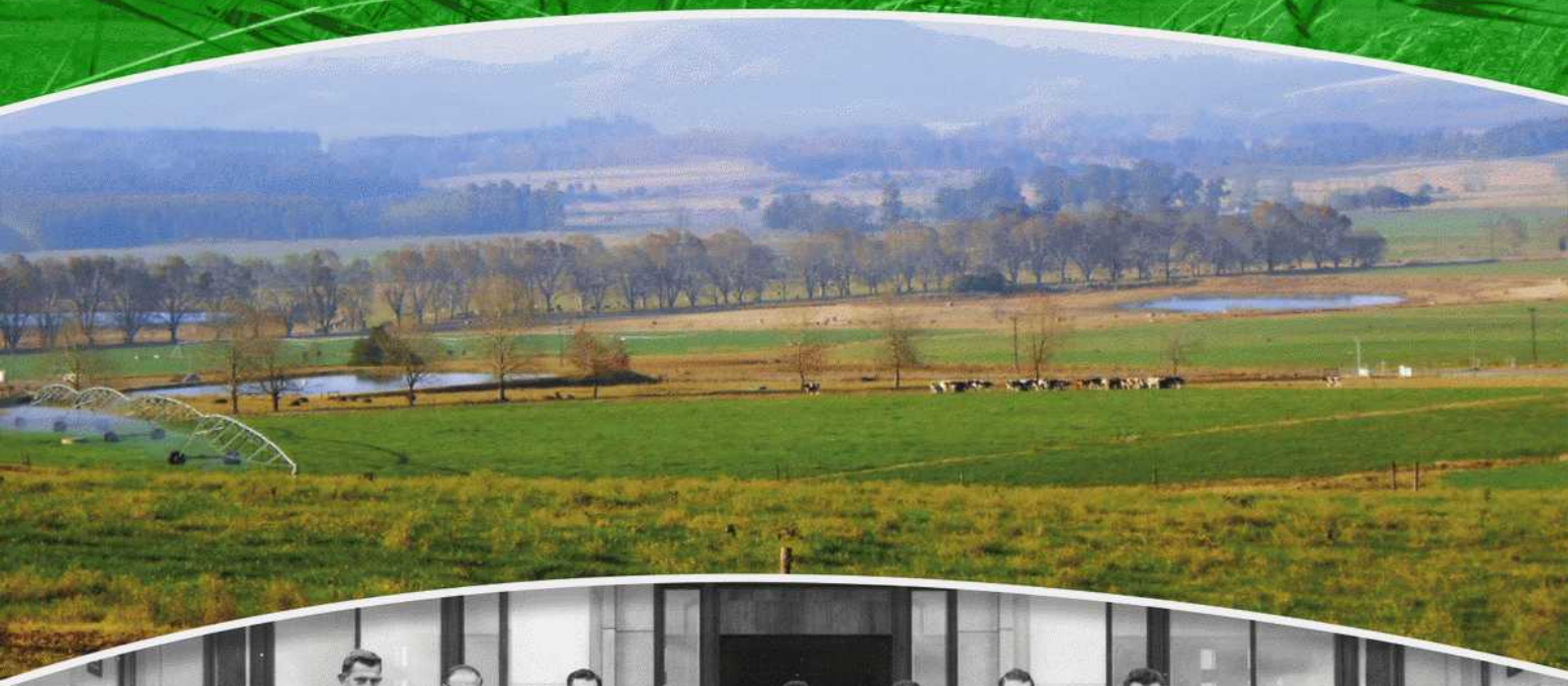
1966-2015

50th Annual Congress 2015



Celebrating 50 years of Advancing Rangeland Ecology and Pasture Management in Southern Africa

19 - 23 July | Royal Agricultural Showgrounds | Pietermaritzburg, KwaZulu-Natal

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Grassland Society of Southern Africa

50th Annual Congress
&
6th Research Skills Workshop

Celebrating fifty years of rangeland ecology and pasture management in Africa

Royal Agricultural Showgrounds
Pietermaritzburg

19 to 23 July 2015

The Grassland Society of Southern Africa

cordially invites you to our

50th Anniversary Gala Dinner

to be held at the
Royal Agricultural Show Grounds (Hall 8)
Pietermaritzburg

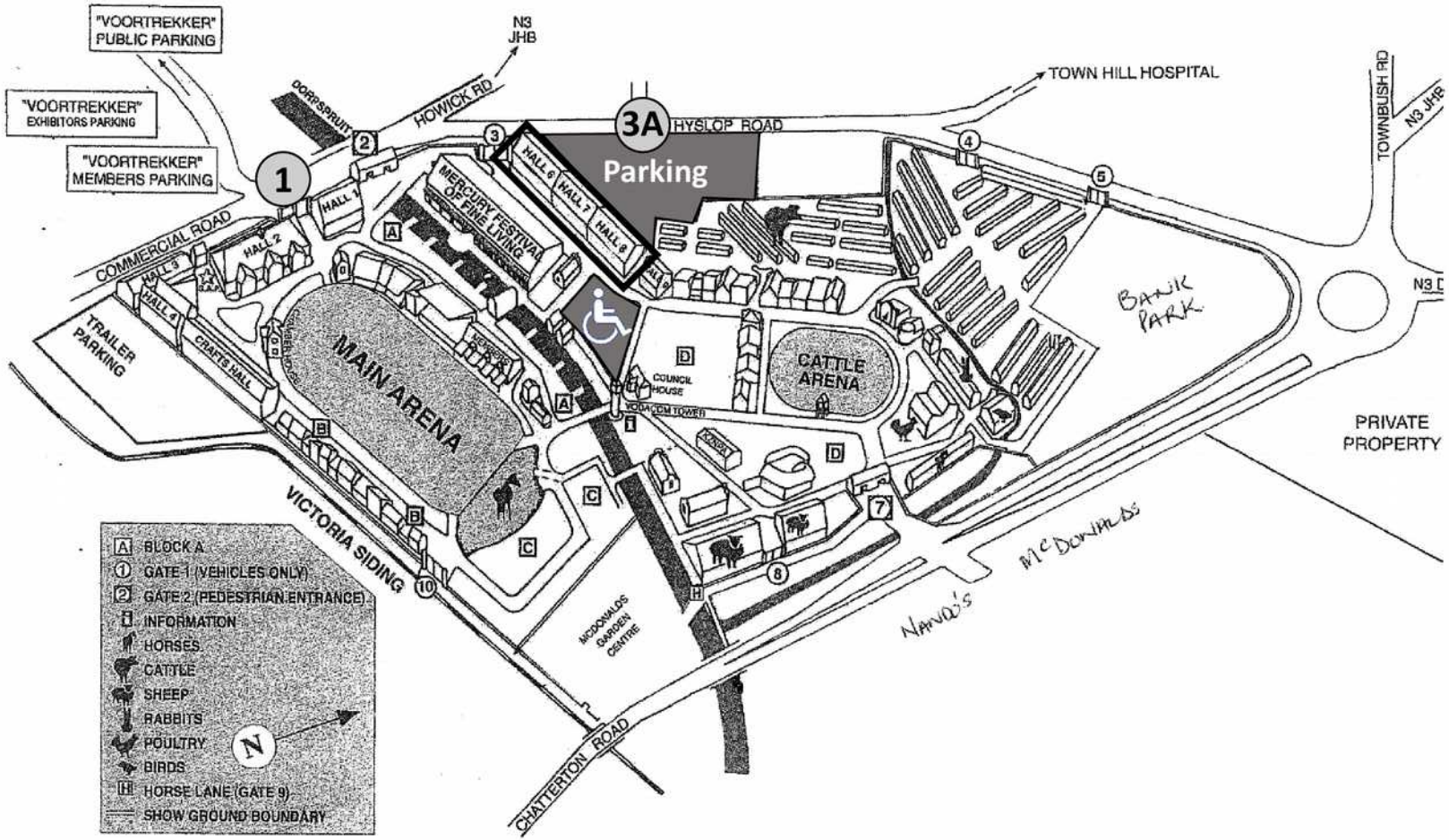
on the *23rd of July 2015*

at 18:30 for 19:00

Attire: Semi-formal

Please direct queries to Michelle Tedder on tedder@ukzn.ac.za

GSSA Congress 50 – Royal Show Grounds, Pietermaritzburg



General Parking behind Hall 6, 7 & 8 – Enter through gate 3A
Disabled Parking in front of Hall 8 – Enter through gate 1

Map of Royal Agricultural Showgrounds

Collect a bead

Meet promising young scientists as they present their plans for exciting new research at the Research Proposals Session. Collect a bead from each author and stand a chance to win a prize at the Gala Dinner on Thursday!

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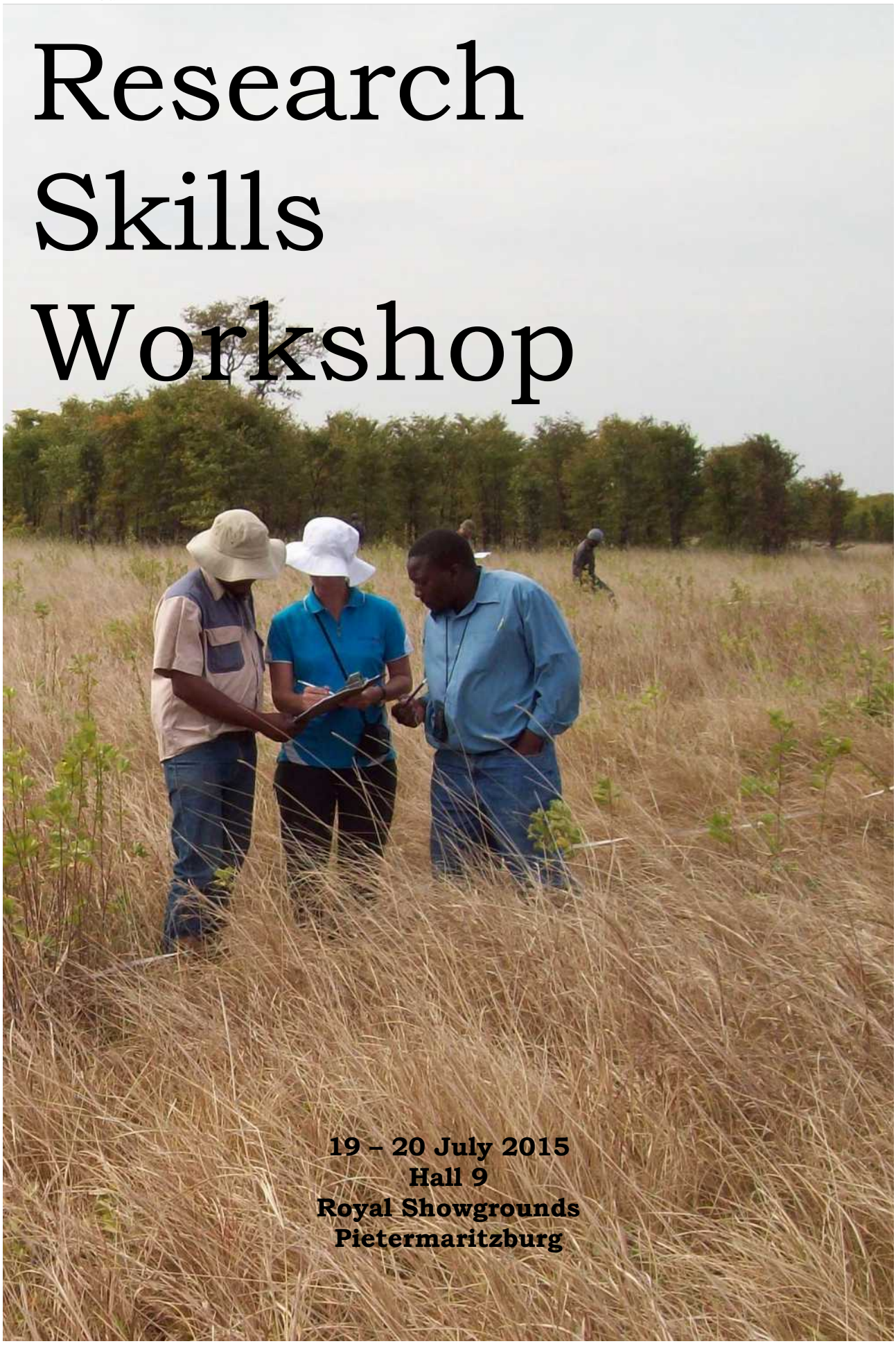
Research Skills Workshop



19 – 20 July 2015
Hall 9
Royal Showgrounds
Pietermaritzburg

Sunday 19 July 2015

Time	Description	Speaker	Page
12:00	***Registration opens (Hall 8)***		
13:00	***Lunch (Council House)***		
14:00	Welcome and Introduction	Justin C O du Toit	
14:05	The research question	Tim O'Connor	5
14:50	Throwing the bones, Paul the Octopus, trichotillomaniacal Swedes, and some other important statistical issues in grassland research	Craig Morris	5
15:45	***Tea***		
16:15	Supervisors vs. students needn't be Venus vs. Mars	Wayne Truter	6
16:45	Smartphones, tablets and Android apps for fieldwork	Clement Cupido	6
17:15	Question and answer session		

Monday 20 July 2015

Time	Description	Speaker	Page
09:00	Welcome and introduction		
09:10	Showing your working: What is good about science, and why it matters	David Spurrett	8
10:10	People, the environment, and community research	Terry Everson	8
10:40	Obtaining funding for research: applicant and funding body perspectives	Adrian Schrader	9
11:10	***Tea (Hall 8)***		
11:40	Managing photographs for optimum use	Clement Cupido	9
12:00	Useful tools for plant identification: Vouchers, on-line resources, field herbaria and digitisation	Christina Curry	10
12:30	The ethical and humane care of animals used for scientific purposes	Theresa Coetzer	11
13:00	***Lunch (Council House)***		
14:00	Chaos to order: Managing research data effectively	Justin du Toit	12
14:30	Presenting effectively with PowerPoint	Terry Olckers	12
15:00	Ten tips for designing the perfect poster	Adrian Schrader	13
15:30	***Tea (Hall 8)***		
16:00	Reviewing	Alan Short	13
16:30	Manuscript writing	Tony Palmer	14

Presentation Description and Speaker Profiles

The research question

Tim G O'Connor

South African Environmental Observation Network. Email: tim@saeon.ac.za

The research question is central to research, providing a point from which literature is reviewed and experiments are developed. This pivotal aspect of research is often not given the attention it deserves, and many research questions are later found to be essentially unanswerable, uninteresting to the scientific community, or even already answered in other research.

Prof **Tim O'Connor** is an Observation Science Specialist at SAEON. He was previously Professor and Head of the Department of Range and Forage Resources at the University of Natal, and is currently associated with Witwatersrand University. He has published extensively over the past three decades, mainly on plant community ecology and plant/fire/herbivore interactions.

Throwing the bones, Paul the Octopus, trichotillomaniacal Swedes, and some other important statistical issues in grassland research

Craig D Morris

Agricultural Research Council, Animal Production Insitute, South Africa. Email: Morris@ukzn.ac.za

This presentation discusses three issues in making statistical decisions in the murky light of uncertainty, and a fourth issue around statistical reliability:

- Comprehending variability: why we need statistics, sampling variability, and the central limit theorem.
- Sampling and experimentation to measure variability: proper- and pseudo-replication, and limits of inference.
- Comparing and evaluating variability: test statistics based on ratios of systematic to error variance, and
- How reliable are our statistical tests?, and Isn't it time to get rid of P-values?

Craig Morris is a grassland ecologist employed by the Agricultural Research Council, Animal Production Institute, based at the University of Kwazulu-Natal in Pietermaritzburg. His applied research and data analyses have spanned a range of scales from microbes to mountains, with some decent grasslands (and dark chocolate) in between. He has authored and co-authored numerous studies on grassland ecology and on the ways in which knowledge is disseminated among peers.

Supervisors vs students needn't be Venus vs Mars

Wayne Truter

University of Pretoria. Email: wayne.truter@up.ac.za

Mentorship of young researchers in both academic and research institutions is a vital role that senior staff are expected to fulfil, but choosing the best supervisor is not always simple. This presentation will cover some of the considerations when choosing a supervisor as well as the best practices from both the mentor and the mentee in making the relationship productive and peaceful for all parties involved.

Dr **Wayne Truter** is currently employed by the University of Pretoria as a senior lecturer and researcher in the Department of Plant Production and Soil Science. His field of specialization is planted pastures, forage crops and the application thereof in land reclamation. He currently manages various research projects for the Pasture Seed Industry, Water Research Commission as well as land reclamation projects for the Coal Mining Research Association of the Chamber of Mines. He also heads the Land Rehabilitation Services Unit at the Business Division of the University of Pretoria. He is responsible for the undergraduate teaching of Pasture Management to Veterinary and Agricultural students. He also presents undergraduate courses in Environmental Resource Assessment and Monitoring, Turfgrass Management, Scientific Writing and Presentation Skills. Postgraduate training is also one of his responsibilities, where he currently supervises 16 students, both MSc and PhD, in the fields of planted pastures, irrigation of pastures, land reclamation and rangeland management.

Smartphones, tablets and Android apps for fieldwork

Clement F Cupido

Agricultural Research Council. Email: ccupido@uwc.ac.za

Smartphones are becoming increasingly popular in modern society. It is predicted that by 2018 more than 50% of cellphone users will have smartphones. These devices can be personalised by downloading applications (apps), which are small software packages that is available for free or at a small cost. Apps essentially turn a smartphone into a multipurpose device which can be used to perform tasks that could be more than useful during fieldwork and in the office. The apps that will be discussed include GPS, mapping and tracking apps, field notebook, gradient calculators, random number generators, smart voice recorders, toolbox kits, field guides and more. In addition, the means to backup and email information collected using apps will also be discussed.

Clement Cupido is a rangeland ecologist for the Agricultural Research Council. He works primarily in the Succulent Karoo biome in the Namaqualand Uplands and has a keen interest in the ecosystem services herding has to offer. He is based at the University of the Western Cape's Biodiversity and Conservation Biology Department where he supervises and co-supervises several post grad students who are working within the arid zone along the west coast region. He has a keen interest in outdoor and studio photography.

Illustration 1: Briza

Showing your working: What is good about science, and why it matters

David Spurrett

University of KwaZulu-Natal, South Africa. Email: david.spurrett@gmail.com

Science isn't perfect, but it is valuable. Even though it can and does make mistakes, the ways it works and communicates have distinctive features that we need to understand in order to see why it is valuable, and what we need to do if we want to participate properly. In this talk I try to explain these features, by reference to the idea of 'showing your working'.

Professor **David Spurrett's** career at the University of KwaZulu-Natal includes service as Head of the School of Philosophy and Ethics, elected member of University Senate, elected member of University Council, representative on the Finance Committee of Council, and Programme Director for Cognitive Science.

People, the environment, and community research

Terry M Everson

University of KwaZulu-Natal, School of Life Sciences, South Africa, email: eversont@ukzn.ac.za

People are an integral component of almost all natural systems on earth, yet are often viewed as being 'unnatural'. Research in natural systems often ignores the human aspect; alternatively, the human component of a system is accommodated as a function and within the context of a particular society.

Dr **Terry Everson** is a senior lecturer at the University of KwaZulu-Natal, with which she has had a long involvement. She has been involved in community land rehabilitation projects in the Upper Thukela catchments for the past 12 years. In 2006 she won the research category of the Women in Water awards for her outstanding contribution in advancing the cause of women in Water, Sanitation and Forestry Sectors.

Obtaining funding for research: applicant and funding body perspectives

Adrian M Shrader

University of KwaZulu-Natal, South Africa. Email: Shrader@ukzn.ac.za

In today's economy, obtaining funds for research is challenging and highly competitive. This presentation will cover some do's and don'ts when it comes for applying for funds. Moreover, as Adrian in the Chairman of a committee that awards bursaries to students, he will provide the additional perspective of what funding agencies look for and expect.

Dr **Adrian Shrader** is a Senior Lecturer of Wildlife Conservation and Management at the University of KwaZulu-Natal (UKZN), Pietermaritzburg. His research focuses primarily on the behavioural ecology of large mammalian herbivores, their interactions with vegetation, and the factors governing their foraging, habitat use, and movements. Adrian has conducted research at the University of the Witwatersrand, University of Pretoria, Nelson Mandela Metropolitan University and UKZN. In addition to ecological research, Adrian has a particular interest in presenting complex scientific findings – be they in the written, poster, or oral forms – in a clear and understandable way. Finally, Adrian has been part of the Gay Langmuir Bursary for Wildlife Research committee at UKZN for the past eight years, and Chairman for the past four.

Managing photographs for optimum use

Clement F Cupido

Agricultural Research Council, Animal Production Institute, South Africa. Email: ccupido@uwc.ac.za

Photographs are normally saved in folders with one unique name or number. An image might contain a lot of information, eg. a picture of a cow grazing in the grassland biome. Adding tags (e.g. cow, grazing and grassland) to a picture makes it much easier to search images in your photo library. Tags, which are essentially keywords or phrases that make it easy to search for images within a certain category. Tips on renaming pictures in bulk and how to reduce image size for email purposes, websites, presentations and reports will also be shared.

Useful tools for plant identification: Vouchers, on-line resources, field herbaria and digitisation

Christina Curry

Bews Herbarium, University of Kwazulu-Natal, South Africa. Email: potgietercj@ukzn.ac.za

My presentation will touch on the following:

- Steps to follow to facilitate accurate plant identification;
- Why proper voucher specimens are important;
- Available electronic and on-line resources;
- How to construct a field herbarium, and why it is useful;
- The value of digitising plant collections, and how it can substitute for field herbaria;
- Important reasons why field botanists and grassland scientists, researchers and consultants need to contribute data and vouchers to recognised herbaria.

Christina Curry (nee Potgieter) has been the Senior Technician in the Bews Herbarium (UKZN, Pietermaritzburg campus) since 1999. During this time she submitted her PhD in Botany and graduated in 2010. She knows the value of proper herbarium vouchers and plant identification, but also understands the difficulty that students and field workers face with project deadlines, field seasons, and general lack of resources for plant identification. Apart from assisting students, researchers and field workers with preparing vouchers and accessing herbarium resources, she also has experience with vegetation assessment.

Christina has authored or co-authored nine research papers and four popular articles, and presented papers at national and international conferences. She has managed several specimen digitisation projects in the Bews herbarium, and regularly instructs interested groups and students on plant pressing and herbarium use. She serves as an NGO representative on the KZN SFRA-LAAC (the committee that comments on new timber permit applications) and has been an active committee member, Chair and Vice-chair of the KZN Inland branch of the Botanical Society of SA.

The ethical and humane care of animals used for scientific purposes

Theresa HT Coetzer

University of KwaZulu-Natal, South Africa. Email: coetzer@ukzn.ac.za

An introduction will be given about the ethical aspects (the way animals are treated) involved when domesticated animals and wildlife form part of a research project. Emphasis will be placed on the procedures to follow with regards to permission from the ethical committee to do research of any sort on such animals.

- Animal rights and animal welfare
- Moral Status of animals
- Animals in Agriculture
- Animal research and experimentation
- History of animal use
- Contributions to animal and human health
- The three Rs principle
- South African legislation and the South African National Standard 10386
- Alternatives to animal experimentation

Professor **Theresa Coetzer** established the Animal Research Ethics Committee (AREC) at the former University of Natal in the late 1990s and was Chair of AREC until recently. She is the co-author of the Chapter, Animal rights and animal welfare, in Ethics in Agriculture - an African Perspective (2005), A Van Niekerk (Ed) Springer Academic Press. She is a Biochemist and conducts research on proteolytic enzymes of African trypanosomes, (parasites carried by tsetse flies) which cause sleeping sickness in humans and nagana in cattle. A diagnostic test for nagana based on the proteolytic enzyme antigens was developed in her laboratory and is now being adapted as a lateral flow test for use in the field.

Chaos to order: Managing research data effectively

Justin C O du Toit

Department of Agriculture, Forestry and Fisheries, Grootfontein Agricultural Development Institute, South Africa, email: justindt@daff.gov.za

Experiment or monitoring data are often captured and stored in ways that reduce their potential, make them inaccessible, and allow them to be lost. Some simple principles and tools allow the information in even huge datasets to become easily available and pliable.

Justin du Toit is a Production Scientist at the Grootfontein Agricultural Development Institute. He has taught in the fields of agriculture and grassland science at the University of Fort Hare, the University of KwaZulu-Natal, and the Grootfontein Agricultural Development Institute. His current research interests are climate/grazing effects on vegetation change in the eastern Karoo, and how this affects production agriculture.

Presenting effectively with PowerPoint

Terry Olckers

University of KwaZulu-Natal, School of Life Sciences, South Africa, email: olckerst@ukzn.ac.za

Platform presentations are nowadays usually dependent on PowerPoint. Despite this technology, many presentations fail to effectively convey the statement the presenter is trying to make.

Dr **Terry Olckers** is a senior lecturer in Entomology at the University of KwaZulu-Natal. He acquired his PhD from Rhodes University before being employed by the Plant Protection Research Institute of the Agricultural Research Council. He has been affiliated with the Working for Water Programme in South Africa, Landcare Research in New Zealand, and the Federal University of Parana in Brazil. He has given presentations in many countries across the world, and has published over 35 scientific papers on biological control of alien invasive plants.

Ten tips for designing the perfect poster

Adrian M Shrader

University of KwaZulu-Natal, South Africa. Email: Shrader@ukzn.ac.za

Presenting posters at conferences is generally perceived to be second choice after giving a talk. However, if posters are put together well, you can get people to stop, look, and chat to you about your research. Moreover, these chats can last much longer, and thus you can gain more feedback, than if you were to give a talk. In this presentation, Adrian will provide 10 simple tips to improve you posters, and get people to spend more than 11 seconds looking at them.

Reviewing

Alan Short

Themeda Eco Consulting, Pretoria, South Africa. Email: alan@ThemedaEco.co.za

The anonymous peer-review system is central to scientific research. Carefully executed reviews can substantially improve the quality of a paper, and in turn the abilities of the author. The review process can also be frightening to inexperienced authors, and the comments of reviewers need to be taken in the correct light. Reviewers who are overly interested in structure rather than content can be of disservice to authors. At the same time, being invited to peer-review a paper for the first time can be daunting for a young scientist.

Alan is a rangeland ecologist with 14 years' experience in the fields of rangeland monitoring, land planning, resource assessment and livestock and biodiversity management in rangelands and landscapes transformed by agriculture. Alan serves as an Associate Editor on the African Journal of Range and Forage Science, the academic journal of the Grassland Society of Southern Africa.

Manuscript writing

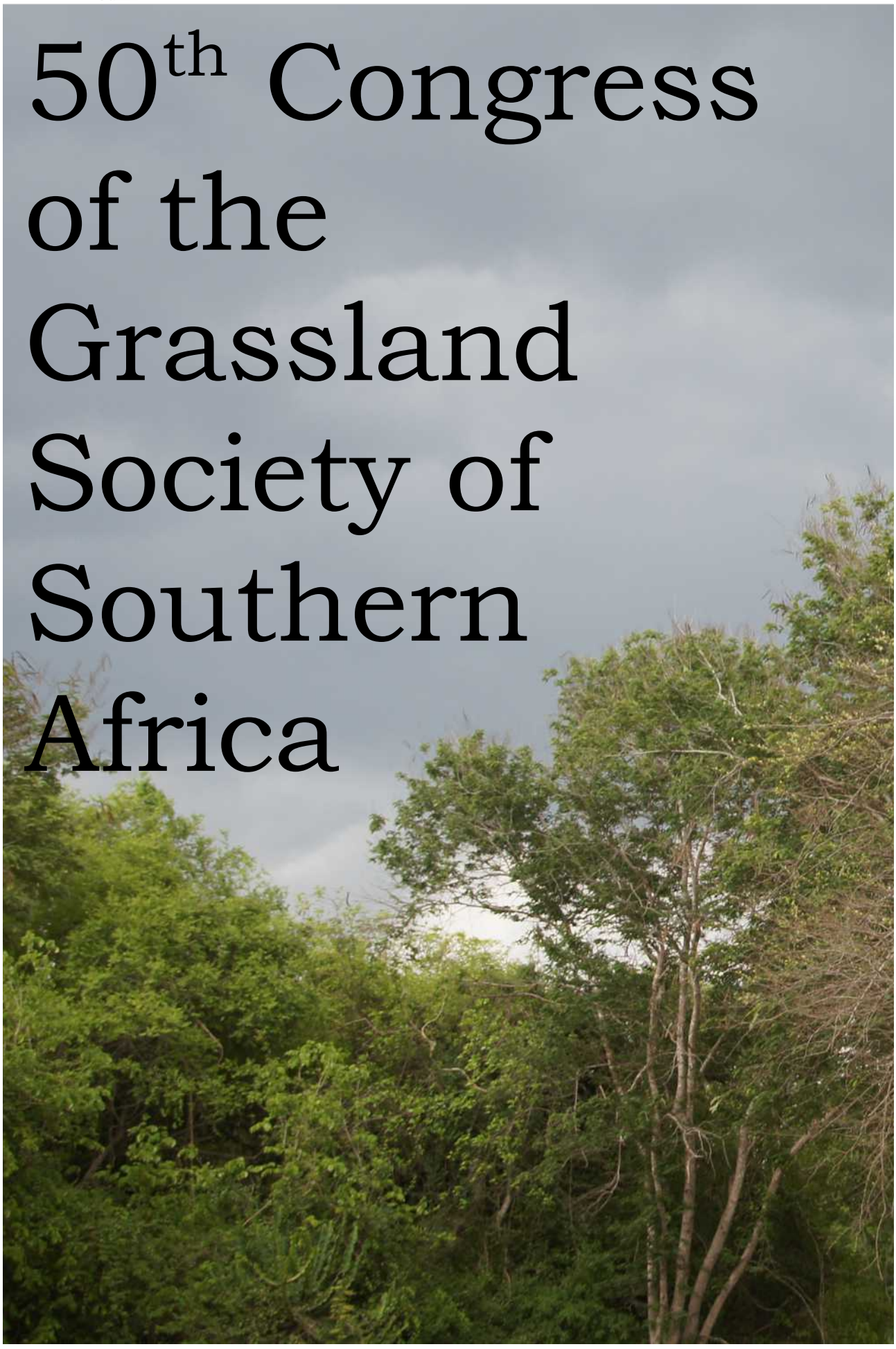
Tony (A) R Palmer

Agricultural Research Council – Animal Production Institute, South Africa, email: palmert@arc.agric.za

Peer-reviewed articles ('papers') are the accepted means of recording and communicating ideas and findings in science. However, the process of scientific writing, especially for beginner scientists, is an arduous one, and scathing reviews of submissions often permanently discourage promising students.

Dr **Tony Palmer** leads a research group in the ARC-Animal Production Institute that focuses on using earth observation to assess landscape water use. He has developed landscape analysis techniques which detect changes in natural rangeland (field survey, remote sensing, forage production modelling) and has defined new perspectives on rangeland condition assessment (e.g. using high resolution infra-red imagery). He was awarded a C1 rating by the National Research Foundation (NRF) for his research on the use of MODIS products to measure landscape scale plant water use and net primary production.

50th Congress of the Grassland Society of Southern Africa



Congress programme summary

Time	Final programme events			Venue
Monday 20 July 2015				
18:00	Meet and greet and introductory talks			Hall 6
Tuesday 21 July 2015				
09:00	Plenary (Kevin Kirkman)			Hall 6
10:30	***Tea***			
11:00	Session 1: Veld productivity and quality (Igshaan Samuels)	Hall 6	Session 4: Communal range I (Brigid Letty)	Hall 7
13:00	***Lunch***			
14:00	Session 2: Vegetation change (Tony Palmer)	Hall 6	Session 5: Communal range II (Susi Vetter)	Hall 7
16:00	***Tea***			
16:30	Session 3: Research proposal posters	Hall 8	Session 6: communal range posters	Hall 8
17:00	***Annual General Meeting***			
19:00	***Dinner***			***Hall 8***
Wednesday 22 July 2015				
09:00	Plenary (Ian Rushworth)			Hall 6
09:50	Session 7: Bush encroachment I (Ntuthuko Mkhize)	Hall 6	Session 9: Wildlife (Beanélri Janecke)	Hall 7
10:30	***Tea (hall 8)***			
10:50			***Tea (hall 8)***	
11:00	Session 8: Bush encroachment II (Julius Tjelele)	Hall 6		
11:20			Session 10: General poster viewing	Hall 8
12:00	***Tours***			
18:00	***GSSA History***			***Hall 8***
18:30	***Journal Special Issue launch***			***Hall 8***
19:00	***Dinner***			***Hall 8***
Thursday 23 July 2015				
09:00	Plenary (Michelle Tedder)			Hall 6
10:00	***Tea***			***Hall 8***
10:30	Session 11: HRM Special Session I (Ian Little)	Hall 6	Session 15: Pasture posters viewing	Hall 8
11:00			Session 16: Pastures I (Derryn Harris)	Hall 7
13:00	Lunch			
14:00	Session 12: HRM Special Session II (Ian Little)	Hall 6	Session 17: Pastures II Sigrun Ammann	Hall 7

Time	Final programme events			Venue
15:00	Session 13: WWF workshop I (Augustine Morkel)	Hall 6		
16:00			***Tea***	
16:30	Session 14: WWF workshop I I (Augustine Morkel)	Hall 6	Session 18: Pastures III (Erika van Zyl)	Hall 7

Congress organising committee

Chairperson	Kevin Kirkman
Secretary	Michelle Tedder
Scientific committee chairperson	Peter Scogings
Additional Members	Michelle Keith
	Sindiso Chamane
	Erika van Zyl
	Ian Rushworth
	Cobus Botha
	Janet Taylor
	Stuart Demmer

Grassland Society of Southern Africa: 2014/15 Council

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Additional Member (Assistant Publications Editor)	Keletso Mopipi
Additional Member (Assistant Publications Officer)	James Puttick
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Chairperson of Trust	Rina Grant
Chairperson of Professional Affairs Committee	Leslie Brown
Chairperson of Congress organising committee	Kevin Kirkman

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Awards

Platform adjudication guidelines

Each year the Society awards a medal and certificate for the **Best Presentation** and for the **Best Presentation by a Young Scientist**. Congress delegates are asked to help in this process by judging the platform presentations. The primary objective of these awards is to encourage and promote the standard of presentation of papers at the Congress. Platform presentations are expected to last for no more than 15 minutes and the audience and presenter are then provided with a five minute question and answer period. **The Norman Rethman Planted Pastures Award** will be judged by an appointed panel of adjudicators.

To qualify for the Best Presentation by a Young Scientist award, the presenter should meet one of the following criteria:

- be under the age of 35 at the start of the Congress, or
- have given seven or less presentations at prestigious scientific meetings, or
- have done seven or less years of work in the respective discipline associated with their presentation.

NB: Any person wishing to be considered for the Best Presentation by a Young Scientist award should enter their name with the Congress administrator before the start of the Congress

Session chairs should preferably appoint the adjudicators for the presentations in their session several hours before the session begins. Each platform presentation should be adjudicated by as many judges as possible, but session chairs should appoint **at least four judges per presentation**. Completed adjudication sheets should be collected by the session chair following the session and handed to the Congress administrator for data entry purposes.

Adjudicators give a value (1-10) to each of four questions. Considerable guidance is provided here to try to reduce variation. Additionally, judges are asked to indicate whether the subject of the presentation lies within their own interests. These values should provide some interesting patterns that will help us to be fairer in following years. Space is given for general comments about the presentation and these may be used in the case of a tie occurring but also to provide general feedback to the presenters. An example of an adjudication sheet follows on the next page.

Poster Adjudication Guidelines

An award is also given to the **Best Poster** on display during the Congress. Congress delegates are asked to assist in judging this award according to certain criteria which are given on the adjudication sheet. Posters will be accompanied by a three minute oral presentation which should summarise the important points presented on the poster. Two minutes are allocated to a brief question and answer session. **The Best Research Proposal Poster** will be judged by an appointed panel of adjudicators.

Session chairs must appoint the adjudicators for the presentations in their session several hours before the session begins. Each poster should be judged both BEFORE the oral presentation begins, i.e. before the session starts, and during the oral presentation. Each poster presentation should be adjudicated by as many judges as possible, but session chairs should appoint **at least four judges per presentation**. Completed adjudication sheets should be collected by the session chair following the session and handed to the Congress administrator for data entry purposes.

Essentially a poster should convey its primary message concisely, preferably within a three minute reading time. Adjudicators give a value (1-10) to each of four questions relating to the physical poster and to one question relating to the oral presentation. Considerable guidance is provided here to try to reduce variation. Additionally, judges are asked to indicate whether the subject of the presentation lies within their own interests. These values should provide some interesting patterns that will help us to be fairer in following years. Space is given for general comments about the presentation and these may be used in the case of a tie occurring but also to provide general feedback to the presenters. An example of a poster adjudication sheet follows after the platform adjudication sheet.

NB: Please note that adjudication results are sent to presenters following the end of the Congress – so positive and constructive comments are encouraged!

GSSA Annual Congress platform presentation score sheet

Session Name:		
Presentation Title:		
Presenter Name:		
One	**The speaker's interaction with the audience was (CIRCLE YOUR SCORE):**	
A	Worse than I'd expect at this congress (no eye contact, stood with back to audience, did not speak audibly, etc)	1 2
B	Slightly below average – the speaker was not too bad, but needs to work on presentation skills.	3 4
C	Normal – I'd expect most presentations to be of this quality	5 6
D	Slightly above average – not a perfect presentation, but enjoyable	7 8
E	Better than I'd expect at this congress (the speaker had a very good rapport with the audience)	9 10
Two	**The quality of the visual aids was (CIRCLE YOUR SCORE):**	
A	Worse than I'd expect (too little/much information, too many/few, writing too small, pictures/graphs unclear, etc.)	1 2
B	Slightly below average – visual aids were not bad, but could use some work.	3 4
C	Normal – visual aids were understandable and supportive, and what I'd expect.	5 6
D	Slightly above average – visual aids on average were as I'd expect, but some of them stood out nicely	7 8
E	Better than I'd expect (the visual aids supported the presentation but did not distract the viewer, were exciting, gave me ideas on how I should structure visual aids in future)	9 10
Three	**The supporting evidence (data, case studies, reviews, etc.) was (CIRCLE YOUR SCORE):**	
A	Worse than I'd expect (too few data to draw conclusions, inappropriate analysis of data, omission of other important studies, poorly explained, over-complicated)	1 2
B	Slightly below average – the evidence generally held together, but there were some problems	3 4
C	Normal – the conclusions were supported by evidence and I understood what was going on	5 6
D	Slightly above average - similar to most presentations, but some of the information was particularly valuable	7 8
E	Better than I'd expect (complex ideas presented clearly, appropriate and interesting graphs, thorough reviews of other studies, clear link between data, theory and conclusions)	9 10
Four	**The overall value to the congress of this presentation was (CIRCLE YOUR SCORE):**	
A	Low (the talk did not contribute significantly to the session; perhaps should have been presented as a poster)	1 2
B	Slightly below average – valuable, but perhaps not to this audience, or the quality was a bit below average	3 4
C	Normal (this is the type of presentation I'd expect at this congress)	5 6
D	Slightly above average – similar to most other presentations, but more presentations should emulate this one	7 8
E	High (this contributed more than most other presentations)	9 10
Five	**The subject of this presentation is (TICK ONE):**	
A	Relatively foreign to me – many of the issues that are being discussed fall outside my experience and interests	
B	Relatively familiar to me – while I do not consider myself an expert in this field, I have an interest in the subject	
C	My area of direct interest – I am highly familiar with the subject, and I have direct experience in this field	
GENERAL COMMENTS RELATING TO THIS PLATFORM PRESENTATION:		

GSSA Annual Congress poster presentation score sheet

Session Name:		
Poster Title:		
Presenter Name:		
One	**The length and detail of the poster were (TICK ONE):**	
A	Too brief and lacking in detail	
B	Just right – I could read and understand it in 3 minutes or less	
C	Too busy, took too long to read and understand	
Two	**Poster presentation, i.e. colours, font size, use of graphs and pictures, etc. was (CIRCLE YOUR SCORE):**	
A	Terrible – this poster gave me a headache, and I could not work out what was going on	1 2
B	Below average – I could see what was going on, but some editing would really have improved things	3 4
C	Average – most of the posters at this congress have this quality presentation	5 6
D	Above average – fonts, colours, and pictures are well presented, and allow rapid appraisal and understanding	7 8
E	Spectacular - this should be used as an example of how to do a poster	9 10
Three	**The scientific content of the poster (CIRCLE YOUR SCORE):**	
A	Zero – the scientific content of this poster is totally unconvincing. Most information is wrong	1 2
B	Below average –too little information, faulty reasoning, statistics and/or results are flawed	3 4
C	Average – the information in this poster is what I would expect from this congress	5 6
D	Above average – the information here is interesting, exciting, and made me think	7 8
E	Fantastic – very interesting, publishable results	9 10
Four	**The overall value to the congress of this POSTER was (CIRCLE YOUR SCORE):**	
A	Non-existent (no relevance to this type of congress)	1 2
B	Low (the poster did not contribute significantly to the session)	3 4
C	Acceptable (this is the type of poster I was expecting to see)	5 6
D	High (this contributed more than most other posters)	7 8
E	Exceptional (this was a highlight of the session, and one of the top contributions to the congress; this poster presenter should be encouraged to present platform presentations around this topic in the future)	9 10
Five	**The subject of this poster is (TICK ONE):**	
A	Relatively foreign to me – many of the issues that are being discussed fall outside my experience and interests	
B	Relatively familiar to me – while I do not consider myself an expert in this field, I have an interest in the subject	
C	My area of direct interest – I am highly familiar with the subject, and I have direct experience in this field	
GENERAL COMMENTS RELATING TO THIS POSTER PRESENTATION:		

The Peter Edwards Award

Farming is a backbone of African economies and sound land-use is a backbone of conservation of natural resources. The **Peter Edwards Award** award is made each year to a land-user in the area of the annual Congress in recognition of the sound application and practice of the principles of range and forage science and conservation.

Objective: The aim of the award is to recognise top farmers in different areas of southern Africa, and thereby encourage the wise use of natural resources.

Criteria: Potential recipients are identified by the Congress Organising Committee each year. The recipients are short-listed and farms or land-units visited by an adjudication panel comprising members of the Organising Committee and local advisory personnel. The recipient need not be a member of the GSSA but should be encouraged to join. Considerations when identifying potential candidates might include the following:

- The recipient should be utilising veld (range and/or pasture for domestic livestock production and/or game farming.
- Farming practices should include, as far as possible, sound cultural and management practices which are recommended to ensure the optimum economic utilisation, conservation and reclamation of natural resources.
- Contribution to his/her community by way of participation and leadership in, for example, study groups, soil conservation committees, conservancies or organised agriculture.
- Where a group is identified to receive the award, for example, a study group, soil conservation committee, conservancy, tribal authority or a community making use of communal land, the leader in such a group would receive the award on behalf of such a group.

Grassland Society of Southern Africa Prestige Award

This award is made to the scientist whose work has made a significant impact on range and forage science and/or practice.

Objective: The primary aim of this award is to encourage the scientific advancement of the discipline of range and forage science in Africa. It is aimed at all research fields that have an influence on the development of science, and applies to research work that breaks new ground in the discipline.

Criteria:

- This award should only recognise outstanding contributions to the science of the discipline.
- The research programme or the interpretation should be innovative.
- The results and, in particular, the interpretation which is applied to them should have a substantial impact on the discipline.
- Signed nominations must be submitted in writing together with a motivation to the Honorary Secretary (as per Constitution).
- Decisions regarding this award are made by secret ballot/unanimous vote at a Council meeting.
- It is not mandatory for this award to be made at each Congress.

Grassland Society of Southern Africa Meritorious Award

This award is made to a member of the GSSA in recognition of exceptional service to the Society.

Objective: The primary aim of this award is to encourage active and meaningful participation in the running of the GSSA. It is not made in recognition of research but rather for contributions to the development of the Society.

Criteria:

- The recipient must have contributed significantly to the development of the Society over extended period of time.
- The GSSA must have benefited from such contribution in some manner, (i.e. an inactive Council member serving on the Council for more than five years does not qualify).
- Signed nominations must be submitted in writing together with a motivation to the Honorary Secretary (as per Constitution).
- Decisions regarding this award are made by secret ballot at a Council meeting and require a two thirds majority.
- It is not mandatory for this award to be made at each Congress.

Young Grassland Scientist Award

Objective: This award is made to encourage new researchers in the discipline.

Criteria:

- The award is available only to members of the Society who have been involved in scientific research in the discipline for less than five years by 31 January of the year in which the Congress is held.
- The award is made to an individual only once.
- The award should be made on the all-round performance of new scientists. Factors which should be taken into consideration include the quality of the research and its presentation (in the form of both Congress presentations as well as publications), as well as the potential impact the research has on the discipline of range and forage science.
- At least one peer-reviewed scientific publication and one formal conference presentation (no posters, and not necessarily at the GSSA Congress) must be made by every nominee. The amount of supervision associated with such presentations of research must be taken into account.
- Signed nominations must be submitted in writing together with a motivation to the Honorary Secretary (as per Constitution).
- Decisions regarding this award are made by secret ballot at a Council meeting.
- It is not mandatory for this award to be made at each Congress, and the award may be made to more than one person in any particular year.

Grassland Society of Southern Africa Honorary Membership

This award is made to a person whom the Society wishes to honour by reason of meritorious services rendered for the realisation of the objects of the Society or by reason of his/her eminence in science.

Best Paper Published in the African Journal of Range and Forage Science

This award is made to the author/s of the best paper published in the African Journal of Range and Forage Science in the preceding year.

- The award will be made annually at each Congress.
- The paper should be innovative and make a significant contribution to Grassland Science.
- The paper should preferably be central to the discipline although this is not a prerequisite provided it makes a significant contribution to Grassland Science.
- The scientific procedures used in the paper must be of a high standard, given the constraints of the study in question. In this regard, potential winning papers must be "passed" by the editorial committee (to eliminate the necessity of extensive review by the adjudication committee).
- Within these broad guidelines, the adjudicators are given reasonably wide leeway to choose, in their opinion, the "best scientific paper".

The Faux Pas Award

"Every village has its own idiot . . .
Every circus has its own clown . . .
But this trophy is dedicated
to our very own star . . ."

Johannes Evert Kappeyne van de Coppello was the first recipient of this coveted award at the 30th Annual Congress held in Kroonstad in January 1995. Each year, Congress delegates have kept their eyes and their ears open to find the most deserving Village Idiot amongst the group and so far it has always found a home to keep it safe and in prominent view for the year.

So make a note of all the hilarious moments, the embarrassing moments, the "oops" moments, and cast your vote for the winner of the Faux Pas award of the 50th Annual Congress of the Grassland Society of Southern Africa. Nominations should be received by Thursday 23rd July at 3pm. Hand them in at the registration desk.

Congress 50 scientific programme

Monday 20 July 2015

Time	Title	Presenter	
18:00	Meet and Greet and welcome	Kevin Kirkman	
18:10	The role of scientific societies	Scott Collins	34
18:30	Presidential address	Tony Palmer	

Tuesday 21 July 2015 (A)

Time	Title	Name	Page
	Plenary		
09:00	Opening Address	Albert Modi	
09:15	Trends in grassland science: does the past predict the future?	Scott Collins	35
09:45	What are we doing to our climate? And what is the climate likely to do to us in South Africa?	Roland Schulze	36
10:30	***Tea***		
	Session 1: Veld productivity and quality		
11:00	Progress made on using earth-observation-based estimation of grass nutrients and biomass as indicators of rangeland (forage) quality and quantity in the savanna environments	Abel Ramoelo	37
11:20	Herbaceous plant species richness: How does it relate to grazing veld condition?	Petros Ngwenya	38
11:40	Effects of tannins on body weight, faecal nitrogen and nutritionally related blood metabolites of free-ranging goats in African savannas	Ntuthuko Mkhize	39
12:00	Influence of tannin-rich Acacia karroo on blood profile of indigenous Pedi goats	David Brown	40
12:20	Effects of post burn re-growth and protein supplements on foraging behaviour and diet selection of goats	Michael Mokwala	42
12:40	Long term effect of fire season on photosynthetically active radiation, leaf area index, biomass production and soil chemical properties in the Döhne Sourveld of Eastern Cape, South Africa	Zama Ndovela	43
13:00	***Lunch***		
	Session 2: Vegetation change		
14:00	Systematic land-cover change in KwaZulu-Natal, South Africa	Debbie Jewitt	44
14:20	Using Acacia tortilis demography to predict vegetation shift in the gravel plains of Sharjah, United Arab Emirates	Lisa Hebbelmann	46
14:40	The effects of gut passage and dung fertilization on seedling establishment of Dichrostachys cinerea and Acacia nilotica	Julius Tjelele	47
15:00	Regular fire maintains stable grasslands in the KwaZulu-Natal Drakensberg: Evidence from a long-term burning trial	Colin S Everson	48
15:20	Fire in the Nama-Karoo – a shift from dwarf-shrubland to sparse grassland	Justin du Toit	49
15:40	The effects of fire on species and growth form diversity in Namaqualand Granite Renosterveld	Megan Simons	49
16:00	***Tea***		

Time	Title	Name	Page
16:30	***Session 3: Research proposal posters***		
	Communal rangelands		
	Assessing the quality of available forage, and its effects on livestock productivity in the semi-arid communal rangelands in South Africa	Sharna Sparks	50
	Assessing the concept: Livestock water productivity in the rehabilitation and management of rangelands after the clearing of invasive alien plants	Bukho Gusha	51
	Unpacking the role of urban-rural linkages associated with livestock production on livelihoods, rangeland management and water supply in the rural areas of the Eastern Cape	Andiswa Finca	52
	Investigating intergenerational dynamics and agrarian institutions in South Africa's semi-arid rangeland commons	Melvin Swarts	53
	Medicinal uses of cactus pear by livestock farmers in Makhuduthamaga local municipality in the Limpopo province	Dimakatso Phaahla	54
	The effect of fire history on root carbohydrate concentrations of encroaching Terminalia sericea at the Waterberg Plateau Park, central Namibia	Siphiwe P Lutibezi	54
	General		
	The effect of environmental factors and rangeland condition on Seriphium plumosum L. invasion susceptibility	Gilbert Pule	55
	Improving soil surface conditions by using brush-packing to facilitate germination establishment on overgrazed rangelands	Reletile T Modungwa	56
	Ecosystems, carbon and nitrogen responses to bush encroachment in the semi-arid areas of the Eastern Cape	Tanki Thubela	57
	The effect of fire and grazing on soil microbial and plant diversity in fynbos and renosterveld vegetation types in Nieuwoudtville	Lyle M Lucas	58
	How does burning, mowing and high-intensity grazing affect tuft and seedling dynamics of key species in the tall dry grassveld in KwaZulu-Natal, South Africa?	Stephanie M Lyle	59
	Pastures		
	Effects of cultivar selection, planting date and cutting frequency on dry matter yield of Raphanus sativus, in the North West Province, South Africa	Matsobane A Ngoasheng	60
	Assessing the potential of tagasaste for forage improvement in Eastern Cape Thornveld	Craig Trethewey	61
	Legumes from the Northern Cape Province of South Africa and their potential use as forage crops	Francuois Muller	62
	The reinforcement of aged Digitaria eriantha cultivations	Yvette Brits	63
	Nutritional impact of supplementing tree lucerne (Chamaecytisus palmensis) on dry season productivity of growing goats	Ntuwiseni E Mmbi	64
	Introduction of tree lucerne (Chamaecytisus palmensis) on an existing Eragrostis curvula pasture stand.	M Norman Magoro	65
	Seasonal effects on pasture establishment of three grass-legume seed mixtures used for coal mine rehabilitation	Nico J le Roux	66
17:00	***Annual General Meeting***		***33***
19:00	***Dinner***		

Tuesday 21 July 2015 (B)

Time	Title	Presenter	Page
	Session 4: Communal range I		
11:00	The impact of green innovations on sustainable livestock systems in communal rangelands	Terry Everson	67
11:20	Assessing livestock farmers' understanding and adaptations to climate change in arid regions of South Africa	Khululiwe Ntombela	68
11:40	Evaluating holistic management in Hwange Communal Lands, Zimbabwe: An actor-oriented livelihoods approach, incorporating everyday politics and resistance	Tapiwa Chatikobo	69
12:00	Promoting the use home-mixed supplements as alternatives to commercial supplements in smallholder beef production systems of the sub-humid region of Zimbabwe	Irenie Chakoma	70
12:20	The potential of replacing conventional dairy supplements with forage legume-based diets in Zimbabwe's smallholder dairy sector	Lovemore Gwiriri	71
12:40	Improving market participation and competitiveness of communal area beef farmers in Zimbabwe's Mashonaland East Province through better feeding and value chain initiatives.	Godfrey Manyawu	72
13:00	***Lunch***		
	Session 5: Communal range II		
14:00	Forage seed production and trade as a pathway out of poverty in the smallholder sector: Lessons from the Zimbabwe Crop Livestock Integration for Food Security (ZimCLIFS) Project	Irenie Chakoma	74
14:20	Rehabilitation of degraded grassland systems through reseeding improved forage legumes using ecologically-sound techniques for enhancing productivity	Elly Sabiiti	75
14:40	Voluntary intake and palatability indices of Pedi goats fed different levels of Acacia karroo leaf meal by the cafeteria method	David Brown	76
15:00	Apparent digestibility, microbial protein supply and nutrient supply kinetics of selected forage legumes in goats	Simbarashe Katsande	77
15:20	The effect of herbage conditioning and natural aeration methods on rate of moisture loss and crude protein content of Lablab purpureus herbage during hay-making	Godfrey Manyawu	78
15:40	Fine-scale modelling and mapping of soil functional characteristics and vegetation across landscapes: A case study from communal lands of Bushbuckridge	Wayne Twine	78
16:00	***Tea***		
16:30	**Session 6: Communal range poster viewing**		
	Early growth performance of dolichos (Lablab purpureus) fodder banks for communal dairy cattle in the Eastern Cape Province	Hennie J van Rooyen	79
	Early growth performance of spineless cactus pear (Opuntia spp.) fodder banks for communal dairy cattle in the Limpopo Province	Flip Breytenbach	80
	Do nutrients alleviate the negative effect of defoliation on decreaser and increaser grasses?	Craig D Morris	81
	Practical implications of introducing a rotational rest-based grazing system into a communal area near Matatiele, Eastern Cape	Brigid Letty	82

Time	Title	Presenter	Page
	The herbaceous yield and soil nutrient content contribution of various leguminous pastures planted in two communal areas of the Eastern Cape Province	Unathi Gulwa	83
	Community leadership enhances rural development	Nobuntu P Mapeyi	84
	Veld condition assessment of the grazing areas used by emerging farmers in the Gauteng province, South Africa	Lucas Letsoalo	85

Wednesday 22 July 2015 (A)

Time	Title	Presenter	Page
	Plenary		
09:00	SAEON Cathedral Peak global change monitoring platform: Update on activities	Sue J. van Rensburg	86
09:20	International Livestock Research Institute (ILRI) in Southern Africa	Sikhalazo Dube	87
09:40	IPBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services	Luthando Dziba	88
	Session 7: Bush encroachment I		
09:50	Effects and use of multiple ignitions for controlling encroaching shrub species in north-eastern KwaZulu Natal	Winston Trollope	90
10:10	Local vs. landscape effects of bush encroachment on abiotic conditions and herbaceous composition and productivity	Susi Vetter	91
10:30	Is there an ecological and cost-effective answer to controlling bush encroachment?	Ross Goode	92
10:50	***Tea***		
	Session 8: Bush encroachment II		
11:20	Does it pay to reduce Acacia karroo? A cost-benefit standoff.	Neels de Ridder	93
11:40	Nutrient supplementation enhances shrub use by free-ranging goats: Implications for bush control in semi-arid savannas	Ntuthuko Mkhize	94
12:00	***Tours***		
18:00	***GSSA history***		
18:30	***Journal special issue launch***		
19:00	***Dinner***		

Wednesday 22 July 2015 (B)

Time	Title	Presenter	Page
	Session 9: Wildlife		
09:50	Tree trends in protected areas adjacent to the Kruger National Park	Mike J S Peel	96
10:10	The diet and ecology of introduced giraffe in Subtropical Thicket vegetation within the Little Karoo region of South Africa	Jamie Paulse	97
10:30	Variation between seasons and height strata in availability of browse to browsing game species	Beanélri Janecke	98
10:50	***Tea***		
11:20	**Session 10: General poster viewing**		
	The effect of high density livestock grazing on a mesic grassland in South Africa	Sindiso C Chamane	99
	Vegetation cover is critical for faunal diversity in moist highland grasslands	Ian Litte	100
	Degraded communal rangelands compromised by alien infestation: Is restoration possible?	Lumko Mboyi	101
	Big trees and elephant in protected areas adjacent to the Kruger National Park	Mike J S Peel	102
	Economic analysis of chemical bush control in Miombo woodlands	Mthunzi Mndela	102
	Fire history and frost in an arid savanna woodland: Understanding its impacts on vegetation structure and diversity at the Waterberg Plateau Park, Central Namibia	Vistorina Amputu	103
	Comparison of herbaceous plant species composition, diversity and rangeland condition between camps utilised by large and small stock at Neudamm Farm, central Namibia	Vistorina Amputu	104
	Influence of Acacia mearnsii (black wattle) on rangeland production in semi-arid South African grasslands: implications for rangeland rehabilitation	Onalenna Gwate	105
	Vegetation composition of Opuntia humifusa invaded cattle and sheep grazing areas of western South Africa	Lukas Chipfupa	106
	Morphology of the encroacher shrub Seriphium plumosum in Bankenveld grassland	Sellina E Nkosi	107
	Variation in grass morphological traits and their relation to fire in KwaZulu-Natal	Naledi Z Zama	107
	The effect of fire histories on soil nutrients, soil carbon and soil respiration on the Waterberg Plateau Park, central Namibia	Elise N Nghalipo	108
	Large-scale foraging behaviour of free-ranging goats: influence of herd size, season and landscape quality	Manqhai Kraai	109
	Seasonal regulation of condensed tannin consumption by intermediate feeders in a semi-arid savanna	Ntuthuko R Mkhize	110
	Condensed tannins increase the amount of time animals spend grazing	Ntuthuko R Mkhize	111
	Insect predation on Dichrostachys cinerea (Sickle bush) in Limpopo Thornveld	Phathu Khadiamovha	112
	The effects of associated pod quality on seed recovery and germination of Dichrostachys cinerea and Acacia tortilis fed ruminants	Piet K Monegi	113

	Impacts of high density of small farm dams on evapotranspiration and catchment water balance	Sukhmani K Mantel	114
	Reciprocal transplanting demonstrates local adaptation in Acacia karroo populations from Zululand, South Africa	Zivanai Tsvuura	115
	Ordination of plant communities in the Nooitgedacht section of Loskop Dam Nature Reserve	Sellina E Nkosi	115
	Impacts of fire on resource utilization of grazers and browsers in the Waterberg Plateau Park, central Namibia	Nekulilo Uunona	116
	The movements of Cape Buffalo (Syncerus caffer) in a confined park, Waterberg Plateau Park, in relation to fire history	Jill Heaton	117
	Fate of rhino survivors in South Africa: A critical evaluation of the current literature on the conservation of the South African rhinoceros	Jedidah A Jacob	117

Thursday 23 July 2015 (A)

Time	Title	Presenter	Page
	Plenary		
09:00	Reflections on land use in KwaZulu-Natal	Kelson Camp	118
09:20	Carbon cycling in dryland grasslands of the future: biotic and abiotic impact on litter decomposition	Heather L Throop	119
09:40	A conceptual basis for rangeland management	Richard Fynn	120
10:00	***Tea***		
	Session 11: HRM Special Session I		
10:15	A farmer's perspective	Robert Rawlins	122
10:35	Conserving Afromontane grasslands through fire and grazing in remnant ecological networks in a timber production mosaic	Lize J. van der Merwe	123
10:55	Response of vegetation, soil, animals and water cycle to different management regimes: Victoria Falls area, Zimbabwe	Mike J S Peel	124
11:15	(In)compatibility of scientific and holistic resource management	K P Kirkman	124
11:35	Grass, animals and people: A global dilemma	Peter Ardington	125
11:55	Managing the ecological role of fire in mesic grasslands	Dr Richard Lechmere-Oertel	125
12:15	Holistic management	Wayne Knight	126
12:35	Savory or Unsavory: The Application of Holistic Resource Management in Mesic Grasslands of KwaZulu-Natal	Cobus (J) O Botha	127
12:55	A meta-analysis: Does short duration grazing work in the grasslands?	Heidi-Jayne Hawkins	128
13:00	***Lunch***		
	Session 12: HRM Special Session II		
14:00	Panel discussion		
	Session 13: WWF workshop I		
15:00	Conservation Fundraising Workshop	Augustine Morkel	130
16:00	***Tea***		
	Session 14: WWF workshop II		
16:30	Panel Discussion		
18:30	***Gala Dinner***		

Thursday 23 July 2015 (B)

Time	Title	Presenter	Page
10:30	Session 15: Pasture posters viewing		131
	Evaluation of tillage effects on soil quality of kikuyu-ryegrass pastures	Pieter Swanepoel	131
	The monthly growth rate and total dry matter production of annual ryegrass cultivars in the southern Cape of South Africa	Lethu Zulu	132
	Germination and seedling establishment of indigenous legumes seeded on degraded mine soils	Zanele Ndhlazi	133
	Evaluation of four cultivated pasture species in different agro-ecological zones of Mpumalanga province	Thabile J Mokgakane	134
	Calibration of a disc pasture meter to estimate the differences in standing forage biomass in an oat (Avena sativa) trial in the Roggeveld region with three fertilization treatments: Preliminary results	Christiaan J Harmse	135
	The production of different lucerne cultivars in the Fish River Valley of the Eastern Cape, South Africa	Gideon Jordaan	136
	Quantitative characterization and fodder value of structural polysaccharides in maturing hybrid maize	Florence V Nherera-Chokuda	137
	Growth characteristics and fodder production potential of Sorghum bicolor	Eric C Timpong-Jones	138
	Relating canopy cover to water use of kikuyu pasture over-sown with temperate grasses or legume	Malissa Murphy	138
	Water use of mixed grass (kikuyu, ryegrass, cocksfoot and tall fescue species) and legume (clover and lucerne) pastures	Omphile Sehoole	139
	The water use efficiency of irrigated SA Standard and Super Cuf lucerne varieties, in relation to dry matter yield and leaf to stem ratio.	Alice Gwelo	140
	Water use and bioenergy potential of subtropical Poaceae species as second generation field crops	Heinrich Cloete	141
	Germination response of coated Digitaria eriantha seed in soils/substrates with different pH and salinity levels	P Juan Pretorius	142
	Session 16: Pastures I		
11:00	Pasture plant breeding in South Africa: lessons from the past and future needs	Sigrun Ammann	143
11:20	Could 'mosaic' irrigation and strategic feeding be a better economic option than broad-scale pasture or infrastructure development for livestock production in semi-arid environments? A case study from northern Australia	Neil MacLeod	145
11:40	The seasonal and annual dry matter production of Festulolium hybrids compared to Festuca spp. and Lolium spp. in the southern Cape	Janke van der Colf	146
12:00	Methane yield from pregnant heifers grazing natural veld and forage sorghum as measured with a Laser Methane Detector	Marsia Grobler	148
12:20	Direct anthelmintic effects of feeding Lespedeza cuneata hay (leaf material) on gastrointestinal parasites in sheep: In vivo studies	Erika van Zyl	148
12:40	Impact of fertilisation on the chemical quality of cultivated pasture soil	Pieter Swanepoel	149
13:00	Lunch		

Time	Title	Presenter	Page
14:00	**Session 17: Pastures II**		
14:00	Effects of nitrogen fertilization and cutting interval on biomass yield and quality of banagrass (Hybrid Pennisetum) and guinea grass (Panicum maximum) grown as biomass crops	Sabelo Ndlazi	150
14:20	The effect of bio-digester slurry on the mineral and chemical composition of napier fodder at different growth stages	Joseph Baloyi	152
14:40	Optical chlorophyll methods as tools for rapid and accurate nutritional assessment of pasture herbage: A review	Martin Hughes	152
15:00	Yield, nutritional value and condensed tannin level changes in Lespedeza cuneata under different defoliation frequencies and intensities	Erika van Zyl	153
15:20	Effect of types of legume intercrop on the mineral content of native Panicum maximum (Green Panic)	Olusola Aderinola	153
15:40	Evaluation of grazing Jersey and Angus/Jersey nurse cows in a multiple suckling calf rearing system	Josef van Wyngaard	154
16:00	***Tea***		
	Session 18: Pastures III		
16:30	Salinity effects on germination potential of selected pasture grass species used for mine rehabilitation	Mziwanda Mangwane	155
16:50	The value of coated Rhodes grass seed in rehabilitation	Leana Nel	156
17:10	Inter- and intra-species competition as influenced by variable seeding rates and nurse crop association	Dirk Coetzee	157

Agenda: Annual General Meeting

Grassland Society of Southern Africa

21 July 2015, 15:00 – 17:00

Royal Show Grounds, Pietermaritzburg

No	Agenda Item	Responsible
1.	Welcome	TP
2.	Present and apologies	TP
3.	Additions to and acceptance of the agenda	TP
4.	Approval of the minutes for 22 July 2014	TP
5.	Matters arising	
5.1.	Congress 51 (2016)	PS
5.2.	IGC/IRC bids	FdT, TP
5.3.	IRC 2016 Congress	TP
5.4.	Conservation award	JdT
5.5.	Global Rangelands website update	
6.	Scientific Editor's report	JB
7.	Publication Editor's report: Grassroots	PS
8.	Website Editor's report	PG
9.	Public Relations Officer's report	MS
10.	Professional Affairs Committee report	LB
11.	Trust report	RG
11.1.	Proposed amendments to the GSSA Trust relating to the new legal requirements for the change of Trustees	TP
12.	Honorary Treasurer's report	JdT
13.	Election of new Office Bearers	
13.1.	Vice President	
13.2.	Additional Member (Assistant Publications editor)	
13.3.	Additional Member (Assistant Publications editor)	
13.4.	Additional Member (Assistant website editor)	
13.5.	Additional Member (Assistant public relations officer)	
14.	General	
14.1.	Call for formal bid for Congress 52 (2017)	
15.	Date of next meeting	
16.	Closure	

Meet and Greet

The changing and uncertain role of scientific societies

Scott L Collins

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The Royal Society of was founded in 1660 as a mechanism to promote communication and exchange knowledge among scientists. Since that time thousands of scientific societies have formed, all of which have the same fundamental goal, to promote communication and share knowledge, primarily by hosting scientific meetings and publishing journals. Over time, larger scientific societies have become an end unto themselves by developing headquarters in national capitals, like Washington DC, with the goal of communicating science to a broader audience of educators, decision-makers and the public. Such infrastructure requires financial resources. In the past, the main sources of income for societies have been membership dues, journal subscriptions, particularly library subscriptions, and profits from annual meetings. At first many societies profited by self-publishing their journals, but now commercial publishers are gobbling up each other and they dominate the scientific publishing market. The change from print to online only publishing can lead to a decline in the "branding" of articles and society journals. Declining revenues from individual memberships and subscriptions hurt the bottom line, but the biggest pressures on scientific societies comes from the Open Access movement. Open Access (OA) benefits authors and readers by making products of scientific research freely available to anyone. But OA shifts the cost burden and economic model from institutional subscribers to authors, and threatens the viability of commercial publishers and the revenues these publishers pay to scientific societies. Despite numerous economic challenges scientific societies continue to serve the same essential goals that led to the establishment of the Royal Society 350 years ago, sharing and communicating knowledge.

Plenary

Chair: Kevin Kirkman

Trends in grassland science: does the past predict the future?

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Grass-dominated ecosystems cover between 25 and 40% of terrestrial environments globally, with natural grasslands occupying large areas in Eurasia, Africa, South America, North America, and Australia. The strong regional correlation between environmental variables and grass-dominated ecosystems suggests that the general emergence and maintenance of grassland ecosystems is controlled by a common set of large-scale drivers, including climate variability, fire, and grazing animals, all of which are increasingly controlled directly or indirectly by human activities. Most of the world's natural grasslands formed during the late Miocene, a time when atmospheric CO_2 levels decreased and modern climatic patterns, particularly increasing seasonality of rainfall, were established. Currently we are witnessing a global reversal during which shrub or bush encroachment is occurring in many grasslands globally. Given the importance of grasslands for conservation of biodiversity, food and fiber, and carbon sequestration, this global scale reversal of patterns formed during the Miocene requires an internationally collaborated effort to develop coordinated, distributed measurements and experiments to determine how global environmental change will affect the structure and function of the world's native grassland ecosystems.

Keywords: DroughtNet, Nutrient Network, shrub encroachment, synthesis

What are we doing to our climate? And what is the climate likely to do to us in South Africa?

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Vast emissions of greenhouse gases into the atmosphere in the past few decades have resulted in an enhanced greenhouse effect and ever-increasing temperatures, with 2014 having been globally the hottest year on record. Consequences of global warming are wide-ranging, with both gradual "pushes" into new climates and "pulses" of extreme events projected to occur. Using climate scenarios appropriately downscaled to account for local topographic conditions in South Africa, examples are shown of possible effects of climate change on temperatures, rainfall variability, climate zones, human and animal discomfort, chill units, food security, the wine industry, the timber industry as well as on grassland yields and fodder banking. Looking into the future, the presentation concludes with the need to find a sustainable balance between our natural capital and development and assesses the degree to which humanity is still operating in a "safe space".

Session 1: Veld productivity and quality

Chair: Igshaan Samuels

Progress made on using earth-observation-based estimation of grass nutrients and biomass as indicators of rangeland (forage) quality and quantity in the savanna environments

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Traditional means of assessing leaf nutrients and biomass as indicator of grass or rangeland quality and quantity for wider area is stymied by expensive labour costs and tedious methods. Leaf nutrients such as leaf nitrogen (N) and biomass varies over variety of scales. Estimation of these variables for larger areas can only be achieved using earth observation, such as remote sensing sensors to provide synoptic views of the landscape. Spatially-explicit information on grass quality and quantity is crucial to inform decision making for planning and management of savanna ecosystems. These variables are critical for spatial zoning of grazing camps, deriving carrying capacity of herbivores and disease contact risk models. Leaf N and biomass play a crucial role in understanding the distribution, densities and feeding patterns of both wild herbivores and livestock. Leaf N is one of the major nutrient requirements for herbivores, and known to positively correlate with protein, while biomass is a measure of available grazing resource for animals. Leaf N estimation has been foiled by the paucity of satellite-based sensors that sample reflected electromagnetic energy in the red-edge region sensitive to foliar chlorophyll and N. Medium resolution satellites such as Landsat, SPOT and MODIS are also generally not suitable to discriminate grass and tree signals in heterogeneous and patchy savannas. The emergence of high-resolution multispectral sensors with red-edge information such as RapidEye, SumbandilaSat, and Sentinel-2 (to be launched 2015) provides new opportunities for rangeland quality assessment at regional level. Biomass estimation accuracy using remote sensing has been challenged by the signal saturation problem; this is rather minimized with the use of the red-edge band. The objective of the study is to review the studies focusing on the earth-observation-based estimation of leaf N and biomass as indicators of rangeland quality and quantity at various scales. The case study for this review covers studies undertaken around the Kruger National Park (KNP), Sabi Sands and Bushbuckridge communal rangelands for the past 5 to 10 years. The studies that assessed the utility of the red-edge band from the new generation of remote sensing data were prioritized. Most of the studies concurred with the fact that the use of red-edge band improves estimation of leaf N and biomass as compared to conventional remote sensing sensors. The first regional map for leaf N was generated with the use of the commercial satellite sensor such as RapidEye, and then the World View-2. The launch of Sentinel-2 with the red-edge band will thus provide opportunities to accurately map leaf N and biomass with freely available data. The study demonstrates the progress in estimating leaf N and biomass from local to regional scale to inform the decision makers (farmers, resource and park managers as well as policy makers) for effective planning and management of the savanna ecosystems.

Keywords: leaf nitrogen, biomass, remote sensing, estimation, mapping, earth observation, rangeland, livestock,wildlife, savanna

Herbaceous plant species richness: How does it relate to grazing veld condition?

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A vegetation study was conducted in twelve plots within the Moist Midlands Mistbelt grassland in KwaZulu-Natal, with the aim of investigating whether a relationship existed between the grazing veld condition and herbaceous plant species richness. The objectives included determining veld condition for the twelve respective plots using the benchmark method, determining the herbaceous plant species richness using the Jackknife Estimate of Species Richness and ultimately conducting a correlation analysis between veld condition scores and species richness. The results revealed that there was no relationship between grazing veld condition and species richness ($r = -0.2723$, $P = 0.392$, $df = 10$, $n = 12$). Veld condition scores ranged from 2.43 – 120.65% whereas species richness ranged from 46 – 107 (observed) and 60 – 136 (estimated) species per plot. There was a positive curvilinear relationship between observed grass and forb species richness ($r = 0.5478$, $P = 0.0652$, $df = 10$, $n = 12$). It seemed that sites which were found to be in poor condition from a grazing perspective could still be valuable for biodiversity conservation by virtue of their high species richness. Caution should be exercised to avoid treating weedy annual species as equal to the robust perennial species when using species richness as an indicator of biodiversity value. This means that veld condition scores cannot be used as indicators of species diversity and vice versa. This finding has implications for decision-making processes pertaining to land-use development applications which are evaluated by nature conservation authorities as it indicates that grazing veld condition score is not sufficient to conclude whether or not a particular site is of low or high biodiversity value. Therefore, the assessment of veld condition for biodiversity purposes still requires different approaches to those used for grazing veld condition and these could include diversity indices and others.

Keywords: grazing, plant-herbivore interactions, rangeland condition, veld assessment

Effects of tannins on body weight, faecal nitrogen and nutritionally related blood metabolites of free-ranging goats in African savannas

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Current understanding of the effects of condensed tannins (CTs) on large herbivore productivity is largely based on results from simple lab and feeding experiments with captive animals. There is, therefore, an urgent need for field experiments that capture the complex behavioural and physiological responses of herbivores to plant secondary chemistry to better understand how individual differences and environmental conditions influence growth and productivity of large herbivores. In a field experiment, we tested whether CTs reduce body weight of goats by reducing nutrient absorption and increasing faecal nitrogen excretion. Forty-five female goats were divided into three groups and orally dosed each day with either CTs, polyethylene glycol 6000 (PEG, a polymer that neutralizes dietary tannins), or water. We measured average daily body gain, body weight, faecal nitrogen and four blood metabolites from all goats in the dry and wet seasons. The average daily body gain for animals dosed with PEG was higher than that of CT and control goats. Repeated measures of body weights were not influenced by the treatment but significantly increased over time within seasons. CT dosed goats excreted the highest faecal nitrogen and had the lowest blood protein concentrations, while the opposite was true for PEG goats in both seasons. Other blood metabolites indicated a negative influence of CT on energy and protein metabolism. Despite the observed potential to reduce nutrient absorption and increase nitrogen excretion, CTs did not affect growth performance. However, PEG's ability to increase the average daily body gain, reduce nitrogen excretion and increase circulatory nutrients indicates that diet composition of free ranging goats can have large influences on goat productivity.

Keywords: productivity, growth rate, performance, nutrient, absorption, goat production, ruminant nutrition

Influence of tannin-rich *Acacia karroo* on blood profile of indigenous Pedi goats

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Acacia karroo is a promising fodder for goats during the critical dry season in communal rangelands. The only limitation to the use of this browse legume is the presence of condensed tannins. A study was conducted to investigate the effects of tanninferous *Acacia karroo* (A) on blood profiles of indigenous Pedi goats fed *Setaria verticillata* (S) hay as a basal diet. Twenty apparently healthy indigenous Pedi goats weighing 18±2 kg were randomly divided into five groups of four animals per group. Each group was assigned in a completely randomized design to the five treatments which include $S_{80}A_{20}$, $S_{75}A_{25}$, $S_{70}A_{30}$, $S_{60}A_{40}$ and $S_{50}A_{50}$ and fed for 22 days. 10 ml of blood samples were collected from the jugular vein on the last day for haematological and serum biochemical assays. White blood cell, red blood cell, haemoglobin, haematocrit, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration were not influenced ($p>.05$) by the dietary treatment. Serum biochemical parameters were also similar ($p>.05$) among the treatments except for total protein (TP). Goats on diets $S_{60}A_{40}$ and $S_{50}A_{50}$ had significantly reduced serum TP (64 and 58 $g.l^{-1}$ respectively). The reduced serum TP can be associated with the presence of anti-nutritional factor, that is, tannin present in *Acacia karroo.* Most of the haematological and biochemical values obtained were within the normal range for healthy goats. Inclusion of *Acacia karroo* in the goat's diets up to 30% had no deleterious effect on the blood profile indices. Haematological tests might be helpful in understanding the health and immune status of indigenous Pedi goats supplemented with tannin-rich *Acacia karroo.*

Keywords: blood profile, tannin, goats, total protein

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Illustration 2: Van Schaik

Effects of post burn re-growth and protein supplements on foraging behaviour and diet selection of goats

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Encroaching woody plant species negatively affect rangeland productivity by reducing carrying capacity for livestock. The increase and the redistribution of woody plant species remains a challenge to farmers interested in grass production for their livestock. The objectives of this study were to determine the effects of strategic supplementation using post-burn regrowth and protein licks to increase the intake of chemically defended *Acacia karroo* trees by goats. Goats were subjected to the following treatments: control (no post-burn regrowth and no protein licks), post-burn regrowth (i.e. using fire), protein licks, and post-burn regrowth + protein licks. The interaction of post-burn regrowth, protein licks and season ($p<.034$) as well as fire and season ($p<.033$) had a significant effect on bite rate during grazing (of grasses) by goats. However, there were no significant effects of fire (post-burn regrowth), protein licks, season and their interaction on bite rate by goats during browsing of *A. karroo* trees. Goats are opportunistic feeders and have the ability to select plants that are most nutritious. The significant effect of post-burn regrowth, protein licks and season support strategic use of protein supplementation to increase the use of herbage, which may be advantageous in managing the encroachment of woody plant species.

Keywords: woody plant encroachment, herbaceous layer, post-burn forage, prescribed burning, plant secondary metabolites, bush encroachment

Long term effect of fire season on photosynthetically active radiation, leaf area index, biomass production and soil chemical properties in the Döhne Sourveld of Eastern Cape, South Africa

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A study was conducted on the long-term burning trial in the Döhne Sourveld to investigate the effects of seasons of burning on species composition, fraction of photosynthetically active radiation (fPAR), leaf area index (LAI), biomass production and soil chemistry. The trial was established in 1988 at the Döhne Agricultural Development Institute and treatments comprised of July, August, September, October and November burns applied between 15 July and 15 November. Each treatment was replicated three times in a randomised block design. Botanical composition of herbaceous species was determined using the nearest plant method. Species diversity was determined using the Shannon-Wiener Index. fPAR was measured using an AccuPAR LP-80 ceptometer, and the corresponding LAI values computed. A disc pasture meter was used to determine above ground biomass. Biomass below the disk was harvested, dried and weighed. The effects of season of burning on species abundance were tested using two-way ANOVA, while treatment effects on light interception, biomass production and soil chemical properties were tested using one-way ANOVA. Soil samples were collected and analysed for C, N, P, K, Mg, pH, Zn, Mn and Fe contents. The grass species comprised three Decreaser species, four Increaser I and fourteen Increaser II. Increaser I were the most abundant (52%), while Decreaser species were the least abundant (16%). *Tristachya leucothrix* was the most abundant species across all thetreatments. Burning treatments resulted in no significant effect on species diversity ($p>.05$). In June 2012, burning treatments yielded no significant effect on fPAR ($p>.1$), but in January 2013, the fPAR was significantly affected by burning treatments ($p<.1$). In winter survey, LAI in winter survey was significantly affected by the season of burn ($p<.1$) with the November burn being significantly lower than the September burn. Burning treatments had no significant effect on biomass production both in winter and summer surveys. Pairwise comparisons showed that the August burn had the highest mean biomass production than all other treatments ($kg.ha^{-1}$), while the September burn resulted in the lowest ($p>.1$). Regression results showed a positive correlation between the biomass production and settling height of the disc pasture meter. Burning treatments had no significant effect on N, P, K, Mg, C, pH, Zn, Mn and Fe contents ($p>.1$) for both the winter and summer surveys. The Zn content was significantly the lowest in September and November fire treatment ($p<.1$) during summer survey. The August and November burning treatments had significantly higher Mn quantities than all other burns ($p<.1$) in winter survey. The Mn content was significantly high in August and November burning treatments. It is recommended that the Döhne Sourveld should be best burnt in October and November because the decreaser species *T. triandra* had highest relative abundance during this period.

Keywords: fire, grassland, photosynthetically active radiation, leaf area index, biomass production, season, veld condition

Session 2: Vegetation change

Chair: Tony Palmer

Systematic land-cover change in KwaZulu-Natal, South Africa

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Habitat loss is recognised as one of the major drivers of biodiversity loss in the world. KwaZulu-Natal (KZN) contains high levels of biodiversity but is experiencing a rapid loss of natural habitat. The patterns, processes and rates of land-cover change in the province were investigated in order to effectively plan for biodiversity conservation. The Intensity Analysis Framework was used to investigate the systematic land-cover changes occurring in the province using three land-cover maps (2005, 2008 and 2011) developed by Ezemvelo KZN Wildlife. Using the national 1994 and 2000 land-cover maps, the rates of habitat loss between 1994 and 2011 were determined. Between 2005 and 2011, 7.6% of the natural habitat of the province was converted to anthropogenic land-uses. Habitat loss was driven by agriculture, timber plantations, the built environment, dams and mines. The swapping of anthropogenic categories back to secondary vegetation was tracked. The rate of habitat loss since 1994 was 1.2% per annum. The biodiversity conservation implications of these landscape changes are discussed and recommendations for fulfilling legislative requirements, such as fulfilling criteria B (rate of loss of natural habitat) of the national list of threatened ecosystems in need of protection, are made. The loss of natural habitat in KZN is significant, posing challenges for biodiversity conservation. Bolder thinking on the part of conservation professionals is required if this biodiversity is to be safeguarded for future generations to enjoy and benefit from.

Keywords: biodiversity, conservation, habitat loss, Intensity Analysis Framework, legislation

Illustration 3: EKZNW

Using *Acacia tortilis* demography to predict vegetation shift in the gravel plains of Sharjah, United Arab Emirates

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Elebredi protected area presently conserves a small area of the last remaining *Acacia tortilis* woodland in the Emirate of Sharjah, UAE. Protection for the last three years has provided a platform to examine *A. tortilis* recruitment, seedling, and small tree survivability through harsh summers in the absence of heavy browsing pressure and harvesting in surrounding areas. Inland gravel plains characterized by tall *A. tortilis* trees are experiencing a vegetation shift from *A. tortilis* tree-dominated vegetation to a shrub-dominated state. With this change there is a decrease in plant biomass causing rain water infiltration to decrease. This results in a higher water runoff and subsequent loss of fertile topsoil to erosion by wind, leading ultimately to decreased perennial plant diversity. An analysis of aerial imagery has revealed that between 2005 and 2015 a 15% decrease in *A. tortilis* trees in some areas. Recruitment is low, when present, with seed germinability reduced by high bruchid beetle infestations (70±16%). Since heavy grazing by camels has been described as the greatest threat to biodiversity in the UAE, this study aimed to examine whether an *A. tortilis* population would be able to successfully recruit in the absence of these large herbivores. The inland region of the UAE received a comparably high rainfall during the 2014 rainy season (approximately 80 mm) and extremely low rainfall in the 2015 rainfall season (10 mm). The high 2014 rainfall resulted in high *A. tortilis* germination rates both in and outside of the Elebredi Protected Area where up to 4±2.7 seedlings/m^2 were measured within the protected area and 1.4±1.6 seedlings/m^2 outside the protected area. This provided an opportunity to examine seedling and small tree survival over the harsh summer months in the absence and presence of herbivores. Mortality of seedlings was 69.8% within the protected area and 100% outside the protected area resulting in a significantly lower seedling density of 1.6±2.9 seedlings/m^2 (t_9=2.2, p<.001) in the protected area. In the protected area seedlings that were able to survive the harsh summer months grew 1.9 ±6.9 cm in height with an average increase in the number of branches or stems from 1.2±0.6 in 2014 to 1.9±1 in 2015. A simple model using a 10-year rainfall cycle estimation for the Emirate of Sharjah predicts that although seedling survival in the protected area is extremely low, current recruitment success over time should result in an increase in seedling and small tree densities over the next 20 years, providing seed germination can occur during years with high rainfall. This would agree with similar studies where tree biomass production increased when camels were excluded from rangeland areas. Unfortunately it appears that the complete absence of recruitment outside the protected area will result in a vegetation shift from *A. tortilis* dominated gravel plains to shrub dominated gravel plains affecting the biodiversity, carrying capacity and the provision of ecosystem services.

Keywords: *Acacia tortilis*, recruitment, seedling survival, vegetation shift, herbivory

The effects of gut passage and dung fertilization on seedling establishment of *Dichrostachys cinerea* and *Acacia nilotica*

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Dichrostachys cinerea and *Acacia* species pods have higher nutritive value than grasses and other browse plants during the dry season and form an important part of the diet of livestock. Ingested seeds of these species pass through the digestive tract of livestock and usually remain viable even after mechanical (chewing) and chemical (digestive) scarification. We studied seedling emergence, seedling establishment and recruitment of *D. cinerea* and *A. nilotica* seeds dispersed by cattle and goats under natural conditions. Significantly more *A. nilotica* and *D. cinerea* seeds were retrieved from cattle (40.0±3.6% and 25.7±3.9%, respectively), than goats (11.7±3.1% and 13.2±3.8%, respectively). However, there was a significant interaction between animal species (goats, cattle) and other factors such as seed recovery day, seed germination treatment (seeds placed on top of the soil with no dung, seeds buried 2 cm under the soil with no dung, seeds buried 2 cm under the soil with dung) and season (dry, wet) on percentage seedling recruitment. Most importantly, seeds retrieved from goats (11.96±0.06%) recruited significantly better than seeds retrieved from cattle (7.62% ± 0.05) and control seeds (i.e. no passage through the gut) (4.12±0.02%). More seeds can potentially germinate and recruit following seed ingestion by goats than cattle and untreated seeds. Goats may facilitate woody plant encroachment by enhancing seedling emergence.

Keywords: dung nutrients, recruitment, scarification, seedling emergence, woody plant encroachment

Regular fire maintains stable grasslands in the KwaZulu-Natal Drakensberg: Evidence from a long-term burning trial

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Extensive component and long-term research in southern Africa has been devoted to understanding the effects and potential role of fire on mesic grasslands. The replicated (n = 3) Brotherton burning experiment in the important catchments of the KwaZulu-Natal Drakensberg is particularly valuable because 11 different combinations of different frequencies and seasons of burn have been applied since 1982. Botanical composition has been consistently sampled by the same team (C & T Everson) every second year during the first 10 years of the trial, and in 2004 and 2015. Some treatments were terminated in 2000, but seven have been maintained. Distance-based multivariate control charts indicated that annual or biennial burning, irrespective of dormant season (autumn, winter, spring) and intensity, maintained temporal fluctuations in grassland composition with the bounds of expected random deviations from the original composition. In contrast, a summer burn rapidly and markedly depleted grasses and overall cover, and increased herbaceous forbs. Fire protected plots and, to a lesser extent those burned every 5 years, moved steadily and predictably away from their initial state. The key changes induced by eliminating regular fire was an initial shift from dominance by the pyrophilous grass, *Themeda triandra* to a greater abundance of fire-sensitive species such as *Tristachya leoucothrix* and *Stiburus alopecuroides*. This was followed by an increase in *Harpochloa falx* and a proliferation of herbaceous forbs as well as native and exotic shrubs. It is concluded that regular controlled burning during the dormant season is required to maintain the composition of mesic grassland in a stable state, and that untimely burning and fire suppression constitutes an important undesirable disturbance to the stability and structure of the montane grassland ecosystem.

Keywords: burning, fire frequency, long-term trial, season, species composition

Fire in the Nama-Karoo – a shift from dwarf-shrubland to sparse grassland

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The Nama-Karoo biome in South Africa is dominated by dwarf shrubs with grasses, shrubs, geophytes and herbs at varying levels of abundance. The position of the Nama-Karoo/grassland boundary is determined in part by rainfall amount, and in recent years there has been an increase in grassiness, correlated with good rains. This has allowed wildfires, an unusual occurrence, to burn at several sites in the central and eastern regions of the biome. The general effect of fire has been to convert dwarf shrublands to grassland with the extirpation of several nonsprouter species. It is anticipated that these non-sprouters will recolonise by seed over time, but could be eliminated if fire frequency is high enough to eliminate their seedbank. It is predicted that if grassy conditions persist in the Nama-Karoo, then fire will be an important factor that shapes the Nama-Karoo rassland boundary.

Keywords: biome shift, non-sprouter, resprouter

The effects of fire on species and growth form diversity in Namaqualand Granite Renosterveld

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Renosterveld is one of the richest vegetation types in terms of plant diversity in South Africa. However, this vegetation type is severely fragmented and transformed. Presently, less than 9% of the original extent of Renosterveld remains in South Africa, of which less than 2% is formally conserved. Namaqualand Granite Renosterveld is a near-endemic and highly threatened vegetation type in Namaqualand and has been severely transformed by cropping and grazing. In addition, renosterveld is under threat from frequent unplanned fires. Over the last 15 years, more than 20 fire incidences have occurred in the Kamiesberg Uplands where renosterveld is present. The aim of this study is to assess the post-fire plant recovery mechanisms adopted by plants and the effects fires have on the plant diversity of renosterveld over time. This study was conducted in the Leliefontein communal area in Namaqualand. Historical data from NASA fire archive http://rapidfire.sci.gsfc.nasa.gov/ was used to study the occurrences of fires and determine the fire regime for the Kamiesberg Uplands. Vegetation sampling commenced from April to September 2014. Ten burned and 10 adjacent unburned sites were selected for the study. The effects of fire on plant diversity and post-fire vegetation recovery were assessed using 10 x 10 m quadrats in each site. The Shannon-Weiner diversity index was used to determine alpha diversity at each site and within each growth form. Preliminary results show that there was no statistically significant difference ($p>0.05$) in alpha diversity of the burned and its adjacent unburned site. Growth forms responded differently to fire, being that their diversity did not change significantly ($p>.05$). However, herbs and succulents showed a significant decrease ($p<.05$) in alpha diversity in the burned areas. Over time the species and growth form diversities did not change, except for non-succulent shrubs that showed a significant positive increase over time ($p<.05$), as fire presumably promoted their growth. In general, the data point to the fact that plant diversity is not solely affected by fire alone but possibly by livestock grazing and biophysical factors as well.

Keywords: fire, diversity, Namaqualand Granite Renosterveld, semi-arid rangeland, Kamiesberg Uplands

Session 3: Research proposal posters

Communal rangelands

Assessing the quality of available forage, and its effects on livestock productivity in the semi-arid communal rangelands in South Africa

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The livestock farming industry of southern Africa is divided into two broad categories, commercial and communal farming. In the Northern Cape Province, particularly within the Steinkopf communal area, livestock farming is characterised overall by low productivity. Within these extensive farming systems, the nutritive value, digestibility and feed intake are among the most important factors, which determine livestock performance. The required concentrations of these mineral nutrients in specific individuals are vital as concentrations below or above the threshold may lead to various deficiencies such as infertility, stillbirths, retarded growth rates and high death rates in young lambs. The aim of the project is to determine the causes for the overall low productivity within the Steinkopf communal area. The objectives are to:

1. study the diet preference of the livestock;
2. identify the essential nutrients in preferred fodder species;
3. test for sufficient quantities of particular essential elements present within livestock by analysing blood plasma; and
4. correlate the quality of diet with livestock performance indicators.

To achieve these objectives, this study will evaluate the soil and plant content as well as livestock interactions with the plant material. Furthermore, this study intends to analyse soil and plant samples to conduct nutrient analysis. In addition, blood plasma will be analysed for trace element analysis. This study is relevant as it helps farmers to understand the quality of available forages and may assist farmers in managing their livestock productivity more efficiently. Consequently, improved productivity of farms in Steinkopf contributes to farmers generating a better income.

Keywords: communal farms, drought, livestock, disease, fodder, blood plasma

Assessing the concept: Livestock water productivity in the rehabilitation and management of rangelands after the clearing of invasive alien plants

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Livestock ranching is a significant livelihood strategy for communal farmers in Africa. In land under communal tenure and traditional ownership, livestock's contribution to livelihoods is mainly through providing different products and services, however their productivities are generally low. Livestock outputs in these traditional economies include many different products such as meat, hides and skin, milk, draught power, manure and transport, as well as services such as risk spreading, socio-cultural roles and nutrient cycling. Livestock and water interactions are crucial challenges as livestock production generally utilizes large quantities of water for feed production and is responsible for environmental degradation due to overgrazing. Assessing livestock water productivity for specific products still needs to be undertaken for communal areas. Therefore, this study will assist in improving the understanding and knowledge of communal people on how to produce more outputs from their livestock while using minimal water. Using livestock water productivity model, the study will provide an overview of primary factors of livestock water productivity at local scale and quantify livestock water use and productivity.

Keywords: livestock water productivity, livestock water productivity model, livelihood, water interactions.

Unpacking the role of urban-rural linkages associated with livestock production on livelihoods, rangeland management and water supply in the rural areas of the Eastern Cape

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Livestock production plays an important but complex role economically, socially and environmentally. It contributes significantly to rural livelihoods and has cultural and spiritual attachments to most people. These continue even when people leave their rural homes to seek employment in urban areas. Purchasing livestock is one of the ways these urban migrants might maintain strong linkages with their rural homes. However livestock production also puts pressure on the ecosystem and natural resource such as land, air, biodiversity and water. This is more prevalent in villages where the grazing land is open access; and livestock owners do not need to account for how they manage the rangeland which often leads to rangeland degradation. Rangeland degradation adversely affects water quality and quantity as they result in high storm flows and rapid erosion, silting the dams and rivers; reducing their capacity and the water quality. This denotes that a solution depends on an understanding of the strong links between the different components in livestock keeping; that is livelihoods derived from livestock, cultural and spiritual significance and the impact on the ecosystem (vegetation cover changes and water supply) is required. Using a transdisciplinary approach, the present study will attempt to unpack how urban-rural linkages on livestock production impact rural livelihoods, rangeland management and water quality and quantity. To establish an understanding of how people perceive the current condition of their rangeland and water resource, a combination of focus groups, structured interviews and participatory GIS (PGIS), is used. While collection of the scientific evidence of the actual condition makes use of Remote Sensing, GIS, hydrological methods and ground measurements of biomass cover from the rangelands of the study sites.

Keywords: urban-rural linkages, livestock, rangelands, livelihoods

Investigating intergenerational dynamics and agrarian institutions in South Africa's semi-arid rangeland commons

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In rural development literature, agriculture is considered as the best vehicle to reduce rural poverty. Across the African continent aging of the farming population is causing concern as many young people are reportedly choosing not to pursue livelihoods in the agriculture sector, especially as farmers. Various commentators regard an aging farming population as a wake-up call for policy makers, in that inaction can lead to increasing food insecurity, rural poverty, increasing urban slums and economic decline. An aging farming population is also argued to be a sign of a lost opportunity to bring young people into the sector and benefit from their energy and greater openness to innovation. The claims that the youth are not interested in agriculture, and even the evidence on which these claims are based, needs thorough investigation. More recent studies revealed that rather than a lack of interest, the problem is with agrarian institutions and dynamics, e.g. around land, or older community members in rural areas discouraging bright, educated and ambitious young people to participate in agricultural activities. The tension between the desires of the older generation to retain control of resources and the desire of young people to receive their share of these resources, to form their own independent farms and households, and attain the status of economic and social adulthood is a common feature of many agrarian societies, but surprisingly neglected in research. The challenges of overcrowding and overgrazing that takes place in most semi-arid rangeland commons highlights that there is already competition over grazing resources and this is mainly as a result of lack of land that was caused by colonialism and Apartheid. In these semi-arid areas farmers also have limited options to diversify and this also leaves little opportunity for youth to start farming and accumulate livestock. Moreover, the land reform process so far has failed to create conditions in which the youth could participate and engage meaningfully. Thus, despite the fact that halve of the demand for land in SA are from those age 18-35, the youth play little or no role in land reform projects. This research will therefore first explore the participation or non-participation of rural youth in farming in 4 former Coloured reserves in the Northern Cape. It will further investigate the agrarian institutions and dynamics that might inhibit youth from participating in agriculture. Semi structured questionnaires and Q methodology (Q) will be conducted with 100 interviewees in total, which includes both youth and the current farmers. Semi-structured interviews will be preceded by observations, informal and unstructured interviewing in order to develop relevant and meaningful semi structured questions. Q Methodology provides a well-established means of systematically exploring and analysing different perspectives on a question or issue. Q is an appropriate methodology with which to explore questions about personal experience and matters of taste, values and beliefs and combines both qualitative and quantitative analysis.

Keywords: youth, agriculture, rangelands commons, unemployment, land reform

Medicinal uses of cactus pear by livestock farmers in Makhuduthamaga local municipality in the Limpopo province

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For decades, cacti have been exploited for their medicinal value all over the world. While most of the health benefits from cactus pear are based on studies that used humans and rats as models, very little is known about medicinal uses of cactus for livestock production. The aim of this study is to document farmers' knowledge on the utilisation of cactus species as medicine in livestock production at Makhuduthamaga area. Secondly, this study seeks to compare bioactivity among cactus species found in the wild with the cultivated cactus species. The study will be conducted at Makhuduthamaga municipality, in Limpopo Province. Focused individual interviews and focus group discussions will be used to investigate the knowledge of ethnoveterinary medicine in the area. Laboratory investigation will be done for validation purpose, chemical compositions will be determined using the Thin Layer Chromatography (TLC) and biological properties will be determined using the microplate method for Minimum Inhibitory Concentration.

Keywords: ethnoveterinary medicine, ailments, bioactive compounds, medicinal plants, cactus

The effect of fire history on root carbohydrate concentrations of encroaching *Terminalia sericea* at the Waterberg Plateau Park, central Namibia

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Fire is considered as an ecological disturbance that may kill or top-kill woody plants and may in turn maintain the co-existence of trees and grasses in savanna ecosystems. Fire may also be used as a preventative measure to combat encroachment of woody plants. The ability of encroaching woody plants to resprout after top kill by fire is due to the already established and functioning carbohydrate reserves stored in the roots. It might be possible to reduce the regrowth of woody encroaching species through the more frequent use of fire, if it is known how fast the root carbohydrate concentrations of encroaching resprouts return to pre-fire concentrations. The objectives of the present study are to determine and compare how different fire histories in the savanna woodland of the Waterberg Plateau Park affect the concentration of root carbohydrate reserves of encroaching *Terminalia sericea*. The Waterberg Plateau is divided into different blocks of different fire histories. The present study intends to address the following questions, "How does the concentration of root carbohydrate reserves of *Terminalia sericea* differ among blocks of different fire histories?" and "how rapidly do the root carbohydrate concentrations of *Terminalia sericea* return to pre-fire concentrations?". A total of 12 resprouts of *Terminalia sericea* will be collected from four treatment blocks, block 2a, 1a, 2b and 1b which were last burnt 1, 2, 15 and 25 years ago, respectively. Above ground and below ground biomass of the resprouts will be measured. The BECVOL method will be used to measure above ground biomass. The roots will be excavated and three discs will be sawn from the top 50cm of the main root which will be removed for carbohydrate analysis. Material used for Total Non-structural Carbohydrate (TNC) analysis will be oven dried, milled and sieved. For TNC analysis, polysaccharides, oligosaccharides and starch will be extracted. A two-way ANOVA will be used to compare normally distributed data to test for significant differences in root carbohydrate concentrations in blocks of different fire histories (time since last burn and average fire return interval). Post-hoc comparisons will be performed. Where log transformations do not satisfy ANOVA requirements, non-parametric tests and multiple post hoc comparisons by mean rank test will be used. From the preliminary data of above ground measurements, the mean tree height for blocks burnt 1, 2, 15 and 25 years ago are 0.74 m, 1.20 m, 2.22 m and 2.52 m respectively. The mean stem diameter for the same fire blocks are 1.24 cm, 1.81 cm, 4.90 cm and 5.02 cm.

Keywords: root carbohydrates, resprouts, *Terminalia sericea*, bush encroachment, fire, Waterberg Plateau Park

General

The effect of environmental factors and rangeland condition on *Seriphium plumosum* L. invasion susceptibility

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A complex interaction of factors has been proposed to cause woody plant encroachment and/or invasion. This suggests that development of any effective control method requires in-depth understanding of the ecology of encroaching and invasive species. One of the invasive species with little understood ecology is *Seriphium plumosum* L. This is an unpalatable fynbos shrub that is indigenous to South Africa. It is currently invading over half of the country's grassland biome and none of the proposed control methods has proven successful yet. The aims of this study are to; 1) understand the biotic and abiotic factors of rangelands invaded by *S. plumosum* in South African semi-arid grassland and, 2) predict its invasion susceptibility in un-invaded areas. The experiment will consist of a randomized block design, with 36 farms as blocks and 72 (36 encroached and 36 non-encroached) sites as treatments. The sites will be analysed for variance among environmental factors, with 95% level of confidence. Multivariate predictor of *S. plumosum* invasion will be analysed using regression trees and multiple regressions. The study will provide an insight on the factors determining the success of *S. plumosum* invasion of semi-arid grassland communities.

Keywords: grassland, shrub invasion

Improving soil surface conditions by using brush-packing to facilitate germination establishment on overgrazed rangelands

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Ecosystem changes indicated by degradation are mostly caused by livestock overgrazing, drought, woodcutting and veld fires. These ecosystem changes include decreased cover of vegetation. Overgrazing which is the repeated utilisation of grass plants until all reserved nutrients for regrowth are depleted, is characterized by the loss of biodiversity, reduction of species richness, loss of native topsoil and increase in surface runoff. The National Land Cover has indicated that 80% of South African land is used for agriculture and only about 11% has arable potential, the remaining 69% is used for grazing. It is therefore imperative to ensure proper land use is maintained in order to avoid possible land degradation. It is generally assumed that exclosures lead to better conditions of overgrazed lands; however the assumption is not well supported by studies. The major concern with exclosures is that, it is not always practical to remove all animals from the site and this method needs to allow natural plant succession which takes a long period. Because this passive restoration intervention cannot always work, a number of active restoration techniques can be used as alternatives such as brushpacking. Brushpacking is the use of tree branches as above ground obstruction to let seedlings establish without the threat of herbivores. Studies however do not report on microclimate conditions which are affected when brushpacking is used. This will mainly be a principle study looking at how brushpacking improves soil surface conditions to facilitate germination in overgrazed degraded lands. To test whether brushpacking improves the soil surface properties, soil moisture content, light interception, and soil surface temperature will be measured weekly after planting. Thereafter survival rates of the seedlings will be measured in order to evaluate which grass species will grow or mature under brushpack conditions. The aim is to scientifically classify and quantify a brushpack by packing different densities as treatments. Six tufted grass species will be tested on three treatments and replicated three times over two seasons; this will give a total of fifty-four plots per season in the study. The study will look at two study areas; firstly field experiments where a split-plot trial will be used, and secondly glasshouse experiments where a fully randomised pot-trial will be used. It is expected that the brushpack will provide favourable microclimate conditions to allow germination establishment of grass species in overgrazed rangelands. Furthermore when the brushpack improves soil surface conditions it will have a direct effect on the survival rates of the seedlings over time. Overgrazing is a major contributor to soil erosion. The research seeks to mitigate the impact of overgrazing before it leads to excessive and irreversible soil erosion by using cost effective and natural materials.

Keywords: land degradation, overgrazing, restoration, brushpacking

Ecosystems, carbon and nitrogen responses to bush encroachment in the semi-arid areas of the Eastern Cape

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Bush encroachment and its effects is still a debate among researchers; however there is evidence that poor land management and increased atmospheric carbon dioxide are considered to be the main drivers facilitating the spread of encroacher species. In semi-arid rangelands, bush encroachment leads to dense thicket bushes which negatively affect the carrying capacity and ultimately the economic value of rangelands. On the other hand trees assist in carbon sequestration and ultimately reduce global warming. When woody plant abundance increases in grasslands and savannas, there is significant uncertainty as to whether grass biomass productivity, change in soil properties, ecosystem carbon (C) and nitrogen (N) pools increase, decrease, or remain the same. Therefore, further investigation of the responses of ecosystems, carbon and nitrogen to bush encroachment are required. To understand the impacts of trees on these attributes, the following questions will be examined using different levels of indigenous bush density in the semi-arid region of the Eastern Cape as the case study: (1) Do trees increase or decrease grass species composition, quality and biomass, organic carbon and soil nitrogen content? (2) Which level of tree density has a stronger effect on grass and soil properties? Five plots of different simulated bush densities (12%, 25%, 50%, 75% and 100%) will be used to measure parameters. The study will be carried on four different seasons of the year to measure variations. Carbon and nitrogen will be examined on the leaves of the trees, grass component, and soil. Physical properties of soil such as compaction, texture, aggregate stability and moisture will be measured. Data will be analysed using general linear model (GLM) procedure of the SAS 1999 and results will be compared from different treatments and seasons to identify any significance related to hypothesis of the study.

Keywords: biomass, soil nitrogen, organic carbon, bush encroachment, overgrazing, soil moisture, semi-arid savanna

The effect of fire and grazing on soil microbial and plant diversity in fynbos and renosterveld vegetation types in Nieuwoudtville

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Fire has been used successfully to promote the growth of palatable fodder species for livestock, however little is known of the impact of this practise on soil communities. Soil is a dominant factor in determining the productivity and distribution of plant communities and thus we need to understand how fire affects soil biological processes, nutrient cycling and soil fertility. However, we also need to consider the additional effects of livestock grazing and trampling on soil characteristics. The aim of this study is to assess the impact of fire and grazing on soil and plant communities, by exploring the soil microbial community and botanical diversity of extensive rangelands. This aim will be addressed through the following objectives: (1) determining the impact of fire and grazing on soil microbial communities; (2) determining the impact of fire and grazing on plant diversity and composition. This study will be conducted in the Hantam-Tanqua Roggeveld situated in the Northern Cape, South Africa and forms part of one of two globally recognised arid biodiversity hotspots. The microbial community composition will be assessed using the phospholipid fatty acid (PLFA) analysis, a rapid and inexpensive way of assaying the biomass and composition of microbial communities in soils. Fatty acids will be extracted from whole soil samples and prepared for gas chromatography after being separated into lipid classes using solid phase extraction disposable cartridges. Whilst the impact of fire and grazing on vegetation will be assessed using the descending point method along a 50 m transect line at each site. The vegetation present will be investigated in terms of: (a) total vegetation cover, (b) total species richness, (c) indices of plant diversity, and (d) vegetation cover per life form. Fire may promote soil microbial diversity, which in turn promotes botanical diversity, eliciting a change in the response of the community to future disturbance. Therefore microbial diversity is an important factor when seeking to promote, sustain or manage both biodiversity and pasture productivity.

Keywords: Succulent Karoo, Renosterveld vegetation, fire, grazing, agrobiodiversity

How does burning, mowing and high-intensity grazing affect tuft and seedling dynamics of key species in the tall dry grassveld in KwaZulu-Natal, South Africa?

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Persistence and recruitment of new plants via seed germination and tiller production contribute to the biological productivity of a rangeland. Therefore studies focusing on the response of individual tufts and seedlings, as well as their micro-environment, will contribute to the development of sustainable rangeland management practices. Ukulinga Research Farm at the University of KwaZulu-Natal, Pietermaritzburg, provides an opportunity to study the long-term effects of burning and mowing on tuft dynamics and seedling success in trials established in 1950. We hypothesise that (1) long term burn/mow treatments will affect tuft and plant morphology of grass species and seedling germination; (2) water and light availability will affect *D. eriantha* seedling germination and growth rate; and (3) *D. eriantha* tuft response to defoliation will vary under different water and light availability treatments. In order to determine the physical differences between tufts under different intensities of burning and mowing, we will record tuft diameter, plant height, specific leaf area and number of tillers per tuft. Similarly to the burn/mow study, we will investigate the effects of high intensity grazing on the tuft dynamics of the same key species. To determine seedling success, we will plant *Digitaria eriantha* seed within the same treatments used for the tuft morphology study, record germination success and compare this between defoliation treatments. In the burn, mow and graze trials we will record the following micro-environment characteristics; soil Nitrogen, moisture and organic matter. In addition to field trials, we will conduct two greenhouse trials to determine the effect of light intensity and water availability on (1) seedling germination and (2) tuft response to defoliation. Seedlings and tufts will be studied under combination effects of high, medium and low water availability and high, medium and low light intensity. we will record germination and growth rate of *D. eriantha* seedlings and the effects of burning and clipping on tufts under the same water/light treatment combinations.

Keywords: tuft morphology; seedling germination; seedling growth rate; water and light availability.

Pastures

Effects of cultivar selection, planting date and cutting frequency on dry matter yield of *Raphanus sativus*, in the North West Province, South Africa

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Japanese radish (*Raphanus sativus*) is a cool-season, fast-maturing, easy-to-grow crop. The crops are utilised once, in a highly mature state when nutrients are known to be declining. Therefore, the study will concentrate on selecting a champion cultivar, planting dates and cutting frequency most suited in Potchefstroom area, North West Province. Japanese radish is highly valuable since it contains a higher crude protein percentage than most cultivated pastures and the lifespan is short so as to provide quick abundant feed for livestock, especially sheep. Japanese radish is also important in that they are frost resistance and they tolerate dry periods. The trial will take place in Potchefstroom (Department of Rural, Environment and Agricultural Development). The lands are characterised by loamy to clay soils, with the mean annual rainfall of 621 mm. Three radish cultivars, viz. Geisha, Star 1650 and Nooitgedacht, will be planted on three separate dates, March, April and May. Each plot will consist of three rows of 10 m long, with inter-row spacing of 700 mm. The three rows in each plot will represent the sub plots (split plot) were the different cutting treatments will be applied randomly. Seeds will be planted by hand in shallow furrows of ~3 cm with no distinguished inter-row spacing. In order to determine the dry matter yield of the above ground vegetative material, data will be collected at the different cutting frequencies. The above ground biomass will be cut approximately at 5 cm as anything lower will reduce the ability to produce re-growth material. Harvesting will take place at three different frequencies at 10 weeks + regrowth, 14 weeks + regrowth and 18 weeks. Tubers will be harvested at 18 weeks, weighed and oven dried at 70 ºC to constant weight.

Keywords: Japanese radish, cutting frequency, dry matter yield, planting dates, cultivar

Assessing the potential of tagasaste for forage improvement in Eastern Cape Thornveld

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tagasaste is an evergreen leguminous shrub that grows 3-4 m high. It is a member of the Fabaceae (pea) family and is indigenous to the Canary Islands, but it is now grown in many parts of the world as a fodder crop. Across the whole of South Africa it is estimated that 28% of the total ruminant livestock are owned by people in the "second economy" (the subsistence sector), but that their share of the commercial meat and fibre market is less than 5%. Specifically, the rural communities of the Eastern Cape Province principally produce livestock products, with the province carrying 50% of the goats, 85% of the sheep and 40% of the cattle within the "second economy" of South Africa. About 4 million people are dependent on 5 million ha of communally managed land, which comprises veld (for grazing), abandoned arable land (used for grazing), cropping lands and homestead gardens and residential areas. The abandoned arable lands, which are the primary focus of this project, occupy ca. 750 000 ha of the communal lands of the Eastern Cape. The objectives of this project is to determine if tagasaste shrubs do influence the protein content and dry matter (DM) production of the surrounding grass plants and establish if a correlation exists between size of the shrub and the distance from the shrub that the quality and quantity of the grass is influenced. The experiment will be carried out at the Bathurst Experimental Farm in the Eastern Cape province of South Africa, in a tagasaste plantation that was established in 1992. Nine treatment combinations will be assigned to 27 plots in a complete randomized block design, with each treatment replicated three times. Forage yield and quality will be determined at three intervals vz. endof winter, mid summer and end of summer. The forage quality parameters to be determined include crude protein content, metabolisable energy, neutral detergent fibre and acid detergent fibre. The present low turnover and inefficiency of the livestock sector within the community flocks/herds is primarily caused by inadequate feeding, both quantity and quality. This study will help to determine whether it is possible to improve the quantity and quality of the forage available to the animals on the old lands by establishing tagasaste on these lands.

Keywords: tagasaste, abandoned arable land, protein content, forage yield

Legumes from the Northern Cape Province of South Africa and their potential use as forage crops

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In order to meet the growing demand for livestock products in South Africa (SA), livestock production has to increase in areas with marginal climatic conditions. Currently there are few, if any, commercially available forage legume species suitable for dryland livestock production in areas that receive less than 300 mm of rainfall per annum in SA. Therefore, to meet this growing demand for livestock products, new forage species that can tolerate these marginal climatic conditions need to be identified. The Northern Cape Province (NCP) has a mean annual precipitation of 200 mm, ranging from 20 mm in the west to 540 mm in the east with winter temperatures as low as -10 °C and summer temperatures often greater than 40 °C. However, according to PRECIS records, the NCP houses a total of 399 legume species in 66 genera. Our work will therefore aim to identify legume species with forage potential from the NCP by comparing the PRECIS list of species for the NCP to a list of priority legume species in southern Africa compiled by the Agricultural Research Council in 2013. Those legume species that occur on both lists will further be evaluated using plant functional traits suitable for these marginal climatic conditions and those traits beneficial for forage production. These functional traits include plant regenerative traits, seed traits, plant height, traits that reduce water loss and traits that aid in water uptake. The final list of species will be evaluated for their pasture and forage potential by evaluating their nutritional quality, drought tolerance, breakdown of seed dormancy, their ability to grow in phosphate limited environments and to regenerate and persist after defoliation.

Keywords: native legume species, pastures, forages, Northern Cape Province, livestock

The reinforcement of aged *Digitaria eriantha* cultivations

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The mismanagement of, especially, dryland cultivation can leave a big gap in the production of feed for animals, which forms part of the chain of food security. Further repercussions can lead to soil being depleted and neglected to a point of no return. Within the agricultural environment there are substantial land portions that is either lying fallow or under neglected dry-land fodder cultivations, resulting in more underutilised resources, which in the end may effect animal production. Similar land portions have been identified at the New Machavie research farm of the NW READ, in Potchefstroom. A large portion of land has been under cultivated dryland *Digitaria eriantha* (Smuts finger grass) since the 1970s. Over the years, these portions have on and off been utilised as foggage and for building up the fodder bank, but in the later years these portions have been neglected due to budget constraints being the biggest reason. As the Pasture Division is responsible for fodder provision on the farm, the need for reinforcement of earlier cultivated *D. eriantha* has emerged. Time and money always play a great role in approaching any endeavour. Therefore several pilot reinforcement strategies, old and new, will be examined. These strategies will include active reinforcement, such as ripping at various interval levels using a tractor and ripper plough, different fertiliser products form different nitrogen sources, based on currently running related fertilisation trials, sowing in of the relevant seed and combinations thereof. The better reinforcement outcome thereof will then be applied to the bigger areas, therefore being cautious of over expenditure on the larger areas.

Keywords: Smuts finger grass, dry land cultivation, fodder, *Digitaria eriantha*

Nutritional impact of supplementing tree lucerne (*Chamaecytisus palmensis*) on dry season productivity of growing goats

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Dry season feed shortage is a problem in drier zones of South Africa. Most ruminants in rural areas of Limpopo Province survive on meagre and low quality roughages on rangelands during the dry seasons. Supplementary rations of grass and lucerne (*Medicago sativa*) hay that are managed through the provincial drought relief programs contribute insignificantly to needs of the large ruminant populations in Limpopo province. Productivity of lucerne under dry land farming is low and hay has less digestible fibre, hence the current drought relief program will not improve the nutrition rural livestock. Alternative climate smart forages that are also protein rich sources such as tagasaste (*Chamaecytisus palmensis*) commonly known as tree lucerne were established at the Towoomba and Madzivhandila research stations for augmenting supplies of high quality fodder. The forage, although used widely for improving nutrition of ruminants in Oceania and East Africa, has not been evaluated as drought relief protein source for small ruminants in Southern Africa. Tree lucerne is an evergreen leguminous fodder shrub that is also drought tolerant. It reaches 6 m in height with over 10 m root depth, hence the plant relies mostly on deep underground water. Edible components have over 20% crude protein and is low in indigestible fibre. It is clear from literature that the chemical composition of tree lucerne and lucerne are relatively similar, there is however stronger evidence that the herbaceous lucerne is a premium forage in livestock productions, but it is costly to produce relative to tree lucerne. Incorporating tree lucerne and upscaling its production of the forage from the provincial fodder banks will impact productivity of small ruminants during the dry seasons. The nutritional impact of supplementing tree lucerne (*Chamaecytisus palmensis*) on dry season productivity of growing goats will be evaluated

Keywords: tagasaste, fodder shrub, lucerne

Introduction of tree lucerne (*Chamaecytisus palmensis*) on an existing *Eragrostis curvula* pasture stand.

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Eragrostis curvula continues to be an important cultivated grass pasture on the highveld of Mpumalanga province, and continuing research efforts on optimum herbage production remain a priority. Investigations on legume and grass mixed pasture research has showed a significant improvement in herbage production with reference to the mutual relationships of pasture species. An effort to introduce *Chamaecytisus palmensis* (tree lucerne) was sought at Nooitgedacht ADC where tree lucerne will be introduced on existing *Eragrostis curvula* pasture stands with the following objectives: (1) evaluate the adaptation ability in the province; (2) improve fodder flow; and (3) improve carrying capacity of veld**.** The study will initially be conducted on three farms within Province's three agro- ecological zones on experimental plots. A total of 12 plots, which comprise 4 treatments (one species x four row spacing treatments) with three replications (blocks) will be laid out in complete randomized block design (CRBD). The field experiment will be planted under dry land conditions during October 2014. The existing *Eragrostis curvula* hayland will be mown and then worked with a disc harrow to remove previous season *E. curvula* canopy cover where five tree lucerne seedlings will be planted at four meter intervals per sub-plot. Each individual plot will be 4 x 6 m, 4 x 8 m and 4 x 10 m and will consist of one rows of 16 m length. The total trial size is 1 440 m^2. Tree Survival, growth rate, animal production and herbage production ability will continuously be determined from this study sites**.** Benefits of this study include development and establishment of sustainable quality fodder and guideline throughout the province in 2027.

Keywords: *Chamaecytisus palmensis*, *Eragrostis curvula*, dryland, highveld, production, seedling, survival

Seasonal effects on pasture establishment of three grass-legume seed mixtures used for coal mine rehabilitation

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The global increase in demand for minerals is the reason for the rapid increase of coal, gold and platinum mining in South Africa. By law, all mined areas are required to be rehabilitated. In the process of rehabilitating open cast coal mines in Mpumalanga, a mixture of five grass species is conventionally used in the re-vegetation phase. This mixture consists of a nurse crop *Eragrostis teff* together with *Digitaria eriantha*, *Eragrostis curvula*, *Chloris gayana* and the legume *Medicago sativa*. Each of these species can differ in terms of their optimal growing conditions (i.e. soil surface temperature or daylight length) as well as season of establishment. Pasture establishment in the mining industry is done as soon as mining of the area is concluded and the soils are replaced and leveled. In practice, the same specific mixture of species is planted in order to try and establish pastures, without considering the current season and its possible effect on establishment success rate. Consequently, poor germination results, and a poor stand of pasture is established. The aim of this study is to develop a guideline for mines on the optimal grass-legume seed mixture to plant in the respective seasons. These improved pasture stands will be of high quality, ensuring an improved agricultural potential on rehabilitated coal mines, which contributes to food security by means of red meat production from pastures. The study objective is to identify the optimal soil surface temperature at which each of the seven test species will germinate. This study will include coated and non-coated seeds of the perennial species. The study will entail three different experiments conducted on the Hatfield experimental farm in Pretoria. All experiments will be conducted in a randomized block design. The first experiment will determine the germination of the different species (coated and non-coated) at four different predetermined controlled temperature ranges using a Thermogradient table. The temperature ranges will be 10 – 15 °C, 15 – 20 °C, 20 – 25 °C and 25 – 30 °C. The second experiment will determine the effect of environmental soil surface temperatures on the germination of each species. This experiment will be a pot trial where each species (coated and non-coated seed) will be planted in seed trays every month of the year. The seed trays will be left outdoors and exposed to environmental conditions. Daily soil surface temperature readings will be taken using a Thermochron iButton data logger. The third experiment will look at the effect of planting season on the establishment of different grass-legume seed mixtures, and will be conducted in field. In the study, the effect of competition (intraspecific vs interspecific) and management (cutting vs no cutting) on the species composition, basal cover and forage quality of the different mixtures will be examined. It is hypothesized that the success rate of pasture establishment on rehabilitated mines is largely affected by seasonal climate variations and will reflect in different mixtures. Finally, mines will need to consider season or soil surface temperature as a key indicator when choosing the species mixture when re-vegetating an area.

Keywords: mine rehabilitation, grass mixtures, soil surface temperature, nurse crop, germination

Session 4: Communal range I

Chair: Brigid Letty

The impact of green innovations on sustainable livestock systems in communal rangelands

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The green village concept, whereby people have sustainable and affordable access to quality food, fodder, water and energy within a well-managed and functioning ecosystem, has the potential to provide basic services in remote and degraded areas of South Africa. As livestock production is already an important component of many smallholder farming systems, farmers need to develop innovative ways to capitalize on the use of low-cost natural resources to increase production. The aim of the current project was to develop technological alternatives for resource-poor farmers to promote better resource use through synergies between livestock, crops and water. This was achieved through the implementation of biogas (for energy and liquid fertilizer for food and fodder crops) and rainwater harvesting (for domestic use, fodder production and use in the biogas digester) at selected sites in the Upper Thukela. The primary domestic water source (34%) of 135 households interviewed in KwaZulu-Natal was a community tap stand, while 22% of households collected water from a stream. Firewood was the primary energy source (47.5%) followed by paraffin (25.8%) and electricity (21.7%). Biogas digesters were installed at four households in KwaZulu-Natal and were fed 20 l of water from roof-top rainwater harvesting and 20 kg of cow manure day^{-1}. This provided approximately two hours of burn time day^{-1} during summer (maximum production 37 l.kg^{-1}) and less than one hour in winter (minimum production 4 l.kg^{-1}). Experimental trials that were set up to estimate the effect of the bioslurry on maize yield indicated that there were no significant differences between the control (3.8 ton.ha^{-1}) and the bioslurry treatment (4.0 ton.ha^{-1}) compared to the fertilized treatment (7.2 ton.ha^{-1}). One option to reduce the severe degradation caused by daily livestock movement to high lying grazing areas is the implementation of a semi-zero grazing system. Here animals are kraaled for some of the time and allowed outside to graze at other times. Forage, which is grown near the homestead, is harvested and fed to the livestock to supplement their diet. Results of fodder trials showed no significant differences in the bioslurry, fertilizer and control treatments in cowpea and sorghum yield which ranged from 4.97 – 6.73 ton.ha^{-1} and from 3.75 – 5.47 ton.ha^{-1} respectively. However, Napier grass treated with bioslurry yielded 55% more herbage (25.9 ton.ha^{-1}) than the control (11.9 ton.ha^{-1}) and therefore had the most potential for a semi-zero grazing system. This project has demonstrated the potential for integrated natural resources management at the household level to be up-scaled for the development of a green village.

Keywords: semi-zero grazing, bioslurry, fodder yield

Assessing livestock farmers' understanding and adaptations to climate change in arid regions of South Africa

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African farmers are currently facing challenges of poverty, land use changes, land degradation, inappropriate local and national government policies, land ownership and finances, all of which affect their productivity and survival. Over the past few decades, the climate has been reported to be rapidly changing, thus adding to the already existing challenges that farmers experience. Climate change is known to mostly affect people who are dependent on natural resources for their livelihoods and live in remote areas. Communal livestock farmers in these remote areas are perceived to be uninformed about climate change. Furthermore, the applicability of the local ecological knowledge used by these farmers to adapt to change is noted to be slower than the rate at which climate is changing, thus posing an additional threat. This study attempts to examine these statements by assessing climate change knowledge, and adaptation strategies practised by communal livestock farmers in semi-arid regions of South Africa. The Leliefontein Communal Area in Namaqualand was chosen as the study site. Communal farmers have used these rangelands for centuries to raise livestock to sustain their livelihoods. To assess the farmers' knowledge, a focus group discussion (n=10) followed by in-depth semi-structured interviews with livestock keepers of different levels of farming experience (n=20) were conducted. Farmers reported that the term 'climate change' is new to them, but they are aware of the phenomenon and have been experiencing its effects for a long time. To provide a better explanation of their understanding of the phenomenon, farmers prefer to make use of the term 'seasonal change'. Farmers mentioned that their observed changes include shorter rainy winters with intense cold temperatures, while summers are prolonged with higher temperatures than in the past. Some adaptation measures to the observed changes include herd movements down the mountain during winter to evade cold conditions; and supplementary feed for livestock during extended dry summers and drought periods. However, the major finding of this study was that there are other threats apart from climate change farmers view need more urgent attention. The majority of farmers (70%) indicated that finances, access to land and water, road maintenance and youth involvement in agriculture seem to be immediate threats to their existence as communal livestock farmers; and thus need to be addressed immediately. For them to continue farming successfully in the future, they say climate change needs to be addressed in conjunction with these threats that hinder successful adaptation.

Keywords: climate change adaptation, communal rangelands, livestock farmers, local ecological knowledge, farmers' perceptions

Evaluating holistic management in Hwange Communal Lands, Zimbabwe: An actor-oriented livelihoods approach, incorporating everyday politics and resistance

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Rangelands in the semi-arid and arid regions of the world support livelihoods through their provision of multiple goods and services. Livestock production, for example, occurs in rangelands both as extensive ranching under freehold tenure and as collective ranching under communal tenure systems. However, the sustainability of rangelands is threatened and has been a major concern this century, leading to a variety of interventions. Holistic management (HM) is one such example, designed by its proponents as a panacea to halt degradation and, recently, climate change effects in the rangelands of Africa and beyond. HM has been implemented in the Hwange Communal Lands (HCLs) of Zimbabwe since 2010. In principle, the programme is aimed at restoring degraded watersheds and croplands through utilising properly managed livestock. To achieve this, two principles are promoted under HM, namely (i) holistic planned grazing (HPG) and (ii) animal impaction of crop fields. However, the effects of HM on the livelihoods of its beneficiaries currently are poorly understood. In order to address this lacuna, this study aimed to determine both the intended and unintended effects of a community-based land restoration programme called Holistic Land and Livestock Management (HLLM) in the HCLs of Zimbabwe on the livelihoods of its beneficiaries through a conceptual framework that combined an actor-oriented livelihoods approach with concepts of everyday politics and resistance. This was done by exploring the impact of HLLM on the six types of farmers' assets, adoption patterns, farmers' reactions to the introduction of HLLM, and challenges preventing farmers from adopting HLLM. Case studies employing a qualitative and exploratory research design were undertaken in three communities that were selected purposively from a total of 18 communities in which the HLLM programme had been promoted by the Africa Centre for Holistic Management (ACHM) in order to discover different perspectives on the effects of the programme on the livelihoods of its beneficiaries. The study employed qualitative Participatory Rural Appraisal tools, focus group discussions, participant observation, document analysis, and key informant and semi-structured interviews. The study showed that adoption levels were disappointingly low across all the study sites. Several challenges, including livestock diseases, predation, cultural stigma, labour constraints and witchcraft fears, were among the barriers explaining the low rate of adoption in the HCLs. The findings reveal that the farmers were concerned more with immediate problems, especially lack of water, than with land degradation, which is the primary focus of HLLM. Thus the farmers responded by complying, accommodating and covertly resisting the ACHM's efforts to implement HLLM in order to suit their needs, using creative everyday politics and resistance. The study concludes that, although HLLM is required in such semi-arid environments, it is not sufficient to sustain rural livelihoods in its current state. While the main focus of HLLM is to improve the natural capital (i.e. restoring degraded watersheds), it should be complemented by and aligned with the farmers' other development priorities, especially those relating to water.

Keywords: actor-oriented livelihoods perspective, Africa Centre for Holistic Management (ACHM), everyday politics and resistance, holistic management, Holistic Land and Livestock Management (HLLM), Zimbabwe

Promoting the use home-mixed supplements as alternatives to commercial supplements in smallholder beef production systems of the sub-humid region of Zimbabwe

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Two trials were conducted in Goromonzi and Murehwa districts during 2013 and 2014 with the objective of demonstrating the economic viability of using alternative feed supplements in smallholder beef-fattening enterprises. In Experiment 1 (2013), 12 beef cattle were divided into four treatment groups, randomly assigned to four dietary treatments: mucuna hay-based supplement (MHS), lablab-cowpea hay-based supplement (LCH), commercial beef concentrate (CC) and farmer practice (CO). Each treatment was assigned three cattle which were fed individually. In experiment 2 (2014), 39 beef cattle were randomly assigned to five dietary treatments: mucuna hay-seed-based supplement (MHS), lablab hay-based (LH) supplement, groundnut stover-based supplement (GS), poultry litter-based supplement (PL) and a commercial beef concentrate (CC). Diets were formulated to be iso-nitrogenous (14% CP) and iso-calorific (12 MJME.kg^{-1}) and were offered at 1.5% of body weight (BW) daily for 60 days. Maize stover was offered *ad libitum* to pen-fed cattle in both experiments. Cattle in the CO treatment (farmer practice) were left to graze the veld with occasional supplements as normal practice. Body weight was measured weekly and fortnightly in Experiment 1 and 2 respectively. Supplementary feed and water intake was measured daily. In Experiment 1, BW was significantly ($p<.05$) high for animals on MHS (60.33 kg) and least for animals on CO treatment (16.10 kg). In Experiment 2, animals fed GS had significantly higher weight gain (42.7 kg) and those on PL (28.0 kg) were least. In both experiments, males had a significantly ($p<.001$) higher BW gain than females on the same diet. Generally, feed costs were highest on commercial ($0.26 kg^{-1} in Experiment 1 and $0.37 in Experiment 2). Poultry litter based supplement cost the least ($0.19 kg^{-1}). Cattle on MHS achieved the highest gross margin ($460.42 and $121.87, in Experiments 1 and 2, respectively). Experiment 2 showed that GS is superior to LH in terms of BW gain and economic return. The results indicate that MHS and GS supplementary diets are the most viable in smallholder beef fattening enterprises.

Keywords: substitute, beef cattle, forage, gross margin

The potential of replacing conventional dairy supplements with forage legume-based diets in Zimbabwe's smallholder dairy sector

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The viability of supplementing crossbred dairy cows with forage legume based-diets in crop-livestock integrated smallholder farming systems was investigated over two consecutive dry seasons. The objective of the study was to determine the effect of replacing commercial supplementary feeds with iso-energetic (12 ME MJ.kg^{-1} ME) and iso-nitrogenous (16% crude protein) *Mucuna pruriens (var. Utilis)*-based supplements (MPBS), *Vigna unguiculata (var. CBC3)*-based supplements (VUBS*)* and *Lablab purpureus (var. Highworth)*-based supplements (LBPS*)* on milk yield, milk quality and economic returns. In a two-step process, using 3 x 3 Latin square designs, nine multiparous Red Dane, Guernsey and Holstein-Friesian crosses that were in mid-lactation (130±19 days), were offered legume-based supplementary feeds for 63 days at 0.5 kg.l^{-1} of milk produced. MPBS and VUBS were compared against a commercial supplement (NF Pastulac 16% Dairy meal) in the 2013 dry season. In the subsequent 2014 dry season, MPBS and LPBS were compared against the same commercial supplement. The cows were hand-milked twice daily and level of supplementation was adjusted weekly based on milk yield of the previous week. Daily milk yield was significantly different among all supplements ($p<.05$) in both seasons. Cows on commercial supplement had consistently higher milk yield (6.7 kg.cow^{-1}.day^{-1} in 2013 dry season and 6.8 kg.cow^{-1}.day^{-1} in 2014 dry season) than cows on LBPS (6.4 kg.cow^{-1}.day^{-1} in 2014 dry season) and MPBS (6.1 kg.cow^{-1}.day^{-1} in 2013 dry season and 6.0 kg.cow^{-1}.day^{-1} in 2014 dry season) while cows on VUBS had the least milk yield (5.7 kg.cow^{-1}.day^{-1} in 2013 dry season). Milk fat content was also significantly ($p<.05$) higher in cows fed commercial supplements (2.65% in 2013 dry season and 2.72% in 2014 dry season) in both seasons, but was however significantly ($p<.05$) lower than fat content in milk from cows fed LPBS (2.97%). Milk protein content of cows on commercial supplements was significantly ($p<.05$) higher than those on forage-based supplements in both seasons, but was similar to cows fed LPBS in the 2014 dry season. Total solids and lactose contents were significantly ($p<.05$) higher on both commercial and LPBS than in milk from cows fed MPBS and VUBS. Dietary return kg^{-1} of supplement was of the order MPBS >LPBS>commercial>VUBS. The results indicate that lablab-based supplements (LPBS) can complement or even substitute commercial supplements in smallholder dairy feeding systems.

Keywords: smallholder dairy, milk production, forage legumes, Zimbabwe

Improving market participation and competitiveness of communal area beef farmers in Zimbabwe's Mashonaland East Province through better feeding and value chain initiatives.

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A three-year collaborative Research for Development project (ZimCLIFS) funded by the Australian Centre for International Agricultural Research (ACIAR) in Zimbabwe and managed by ILRI (International Livestock Research Institute) is improving market participation and competitiveness of communal area beef farmers in two districts of the Mashonaland East Province through initiatives on beef value chains that are conceived at Ward-level Innovation Platforms (IPs). The project commenced in 2012 and serves farmers who own 3.47 ha (s.d. 2.79) of inherently infertile granitic sandy soils that are of low pH (3.8 – 5.5 $CaCl_2$). Baseline studies indicated that most farmers were investing in field crop production during the wet season and stream-bank horticulture during the dry season. Only 52.5% of the farmers owned cattle. Average herd size was 5.22 (s.d. 3.89), consisting mainly of indigenous types. Through several activities that included on-farm livestock feeding experiments on use of improved varieties of pulse and forage legumes as hay and farmer training on live-beef-cattle grading and pricing, cattle fattening gained popularity. Among four dietary treatments that were tested, mean growth rates of 0.74 and 0.73 $kg.day^{-1}$ and superior carcass grades were achieved with cattle on home-mixed (14% CP) rations of *Mucuna pruriens*:maize:soya meal:vitamin (40:14:45:1) or groundnut tops:maize:soya meal:vitamin (43:40:16:1). The supplements were fed at a rate of 4 $kg.day^{-1}$, with *ad libitum* maize stover as basal forage during the dry season. The rations significantly ($p<.05$) out-performed a standard commercial supplement which achieved 0.64 $kg.day^{-1}$ at the same feeding level. In addition, *Mucuna* and groundnut–based supplements were cheaper than the commercial supplement, each costing \$0.27, \$0.31 and \$0.37.kg^{-1}, respectively. Competitiveness was also achieved through training of IP stakeholders to work collectively in input/output market research and lobbying to obtain economies of scales when reaching out to nearby abattoirs. The area under improved pasture in the project area increased by over 121% from 14.6 ha (67 farmers) in 2012/13 to 32.28 ha (215 farmers) in the 2014/15 wet season. The number of farmers involved in pen-feeding increased from 1 in 2013 to 18 in 2014 and will continue to increase since practising farmers have demonstrated that they now have better incomes and livelihoods. In 2014, forage markets began to develop as several crop farmers sold legume hay to their livestock-rearing neighbours. There are efforts to out-scale this work to other districts. Outputs from this project will be used to identify key research areas and develop impact pathways for the future.

Keywords: Conservation agriculture, beef, pen-fattening, innovation platform

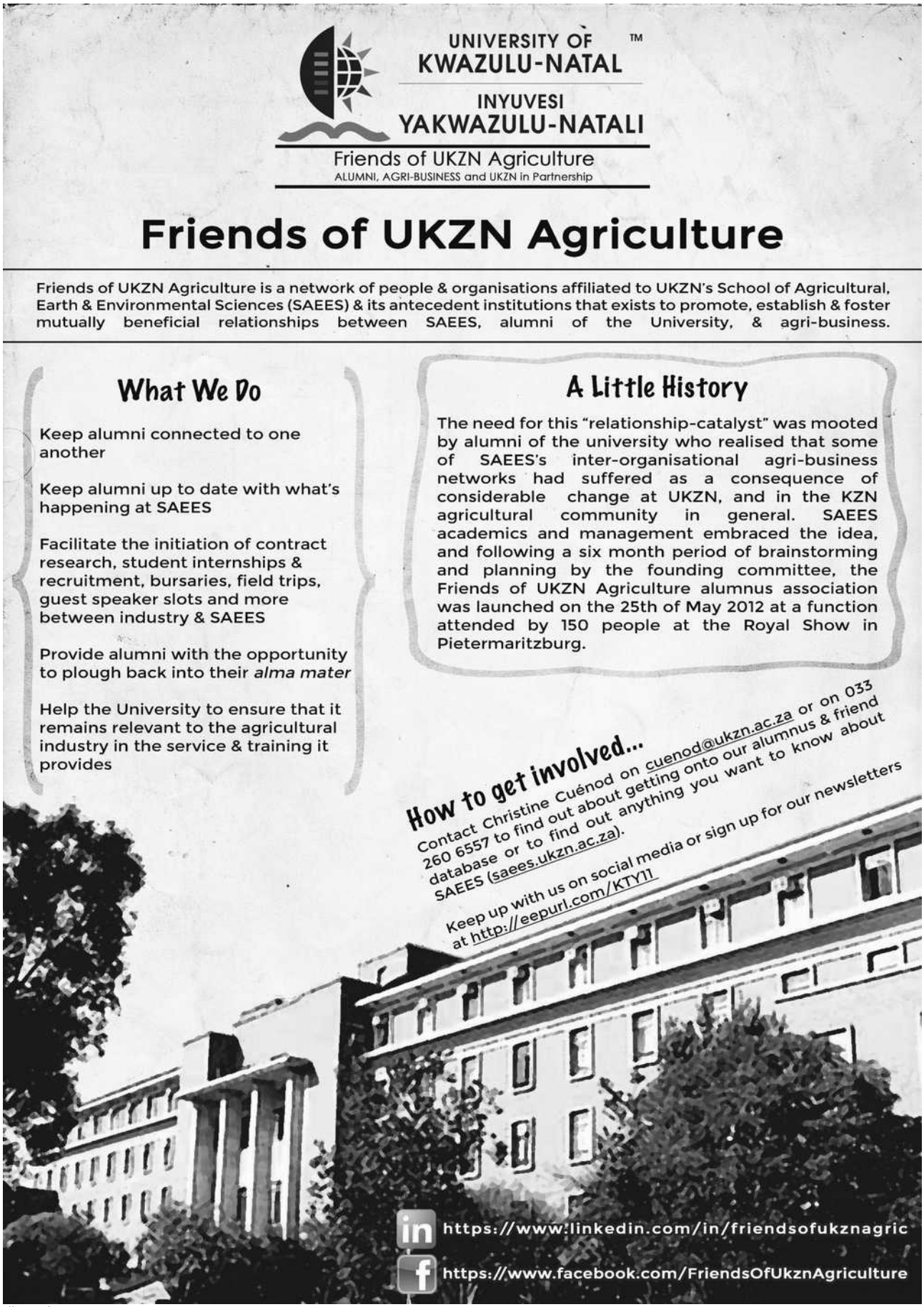

Illustration 4: FoUKZN

Session 5: Communal range II

Chair: Susi Vetter

Forage seed production and trade as a pathway out of poverty in the smallholder sector: Lessons from the Zimbabwe Crop Livestock Integration for Food Security (ZimCLIFS) Project

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The major challenge to adoption of improved forage technologies in the smallholder farming sector is poor accessibility of seed of improved varieties and inferior quality of seed on the market. Since 2012, the Zimbabwe Crop Livestock Integration for Improved Food Security (ZimCLIFS) project set out to address challenges associated with accessibility of high quality forage seed through research for development initiatives on production and marketing. The main objective of this exercise was to demonstrate the level of improved livestock production that can come out of adopting improved pastures on smallholder farms and the potential viability of pasture seed business for a communal farmer. Over the past three years, adoption of new pastures species in Goromonzi and Murehwa districts of Mashonaland East Province was achieved through lead farmer approach, farmer-to-farmer technology dissemination, innovation platforms and field demonstrations. Snapshot surveys, product mapping and analysis of income sources were used to map forage seed marketing pathways within and outside project areas for the same period. Data for forage seed and fodder production, feeding trial demonstrations, marketing channels and income were collected periodically. Results obtained so far indicate that from 2012/13 season to 2014/15 season, total land area under pasture increased by 121% from 14.6 ha to 32.3 ha. In 2013, *Mucuna pruriens* (Mucuna), *Lablab purpureus* (Lablab) and *Vigna unguiculata* (Cowpea) seed produced was 2 250 kg; 120 kg and 4 450 kg respectively and the following year, yields were 4 450 kg; 1 160 kg and 2 980 kg respectively, showing a total increase of 50%. There was a large diffusion of forage seed within and beyond project boundaries over the past 3 years, with 67 % of mucuna seed (3 000 kg) and 43 % of lablab seed (500 kg) produced in the 2013/14 wet season being distributed outside the project area. Two farmers, one from Murehwa sold 200 kg lablab seed and realised $800, whilst the other from Goromonzi realised $750 from sale of 250 kg mucuna seed. It was concluded that there is scope to develop formal pasture seed companies operated by communal area farmers as a way to increase rural industrialization and to provide a pathway out of poverty.

Keywords: forage legumes, seed, marketing, income, Zimbabwe

Rehabilitation of degraded grassland systems through reseeding improved forage legumes using ecologically-sound techniques for enhancing productivity

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In the rangelands of southwestern Uganda, pastoralism is being transformed into an agro-pastoral system. The agro-pastoralists are crossing their indigenous Ankole cattle with Holstein Friesian to obtain hybrids with higher milk production potential. Natural pastures are the main feed resource for livestock. However, their productivity in terms of forage quantity and quality is low due to the nature of the climate and soils in the area. Overgrazing is occurring due to high stocking rates, reduced grazeable areas as a result of increased croplands and lack of well-adapted and persistent forage plants, especially legumes in the system. This has in turn resulted in the loss of grazeable forage species, creation of extensive bare areas leading to increased soil erosion, and consequently to reduced livestock productivity, especially for the Ankole x Friesian crosses which are less adapted to large variations in forage availability and quality. Thus, a study was undertaken to determine the effect of forage legume incorporation into the natural pastures on forage yields and quality. Forage legumes, namely centro, desmodium, siratro and stylo were over-sown in strips dug in the natural pastures using hand hoes on four farms, while stylo was planted on two farms due to lack of enough seed to cover the four farms. Germination of centro, desmodium and siratro on all the four farms was fairly good (60-70%) despite the prolonged dry weather with scanty rainfall that was experienced immediately after planting. Siratro performed best, followed by desmodium and centro. The performance of stylo was good (75%) on both farms where it was planted. Siratro and desmodium showed better persistence and were rated as the best legumes for over-sowing in the natural pastures in the study area. Forage dry matter yields were significantly higher ($p \leq .001$) in the over-sown (improved) pastures as compared with unimproved pastures (control). The crude protein contents of improved pastures were higher ($p \leq .05$) than that of the unimproved pastures.

Keywords: agro-pastoralism, crude protein, degraded rangelands, forage legumes, natural pastures, rehabilitation

Voluntary intake and palatability indices of Pedi goats fed different levels of *Acacia karroo* leaf meal by the cafeteria method

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Acacia karroo is regarded as a multipurpose tree with high potential for increasing goat productivity and can be considered as a cheap source of protein in communal goat production despite the presence of condensed tannins in the leaves. A study was conducted to determine preference intake and relative palatability indices of *A. karroo* fed to 5 growing male Pedi goats with an average body weight of 19.81±1.83kg. Five feeding troughs were provided to each goat and each animal was exposed to all the experimental diets. A cafeteria feeding approach was used, thus, permitting goats free access to the diet of their choice. The position of the troughs was randomized each day to avoid "habit reflex". *Acacia karroo* (K) was offered in a mixture with *Setaria verticillata* (S) hay at five different levels: Diet 1: S80K20, Diet 2: S75K25, Diet 3: S70K30, Diet 4: S60K40 and Diet 5: S50K50, for a period of 23 days. The daily relative palatability indexes (RPI) obtained for each diet were subjected to analysis of variance with feeds as treatments and individual animals as replicates in a completely randomized design. Significant differences ($p<.05$) in RPI among the diets were observed. Preference rankings for the diets produced the following order: Diet 5> Diet 4> Diet 3> Diet 2> Diet 1. Diet 5 appeared to be the most preferred by goats with an RPI of 96.91%. Palatability indices were positively and significantly ($p<.05$) predicted from dry matter intake of goats ($R^2=0.71$). Similarly, intake and palatability indices of the diets related positively ($p<.05$) with the nutrient and tannin contents. Results of this study indicate that tannin-rich *A. karroo* leaves when fed as a mixed diet can influence preference and intake by Pedi goats. Palatability studies could be used in designing supplemental feeding programs for ruminant livestock during the dry season.

Keywords: *Acacia karroo*, goats, palatability index, preference, cafeteria method

Apparent digestibility, microbial protein supply and nutrient supply kinetics of selected forage legumes in goats

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The study examined the effects of feeding forage legumes as protein supplements to poor quality natural pasture (veld) hay offered to goats on microbial protein yield and nitrogen metabolism. Four indigenous Nguni type goats were used in a 4 x 4 Latin cross-over design experiment. The goats were randomly allocated to four dietary treatments comprising commercial goat feed alone (GF), veld hay supplemented with either Cowpea (CW), Velvet bean (VB) or silverleaf desmodium (SD). Microbial protein yield was determined using the purine derivatives technique and nitrogen retention was calculated from the difference between nitrogen intake and nitrogen excreted. Total nitrogen (N) intake was significantly high in the GF followed by CW, SD and VB respectively ($p<.05$). Microbial protein supply, the calculated microbial true protein and the digestible microbial true protein were all affected ($p<.05$) by legume supplementation. Animals on poor quality forages tended to show the most efficient microbial protein synthesis. However, supplementation of poor quality veld hay failed to meet the maintenance requirements of the animal as evidenced by negative nitrogen balances in VB and SD. The efficiency of utilization of the nitrogen in the supplements could have been limited by unavailable fermentable metabolisable energy in the diets. Therefore, poor quality veld hay can be supplemented with forage legumes to improve utilisation and these forage legumes could help the communal farmers provide feed for their goats mainly in the dry season.

Keywords: apparent digestibility, microbial protein, nutrient supply kinetics, forage legumes

The effect of herbage conditioning and natural aeration methods on rate of moisture loss and crude protein content of *Lablab purpureus* herbage during hay-making

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The objective of this on-farm study was to develop an effective way to cure *Lablab purpureus* cv. Rongai that is harvested for hay-making at early bloom. It normally takes 4-6 weeks to sun-dry fully matured Lablab forage to hay of 20% moisture content. The study was conducted in Ward 11 (31°29'E; 17°29'S)of Goromonzi District, in Zimbabwe, between 2013 and 2014. A pilot experiment conducted over 28 days in 2013 indicated that conditioning of the forage by laceration and pressing tended to increase drying rate much more than aerating the herbage on wooden tripod (TP) or dry ground (DG). In 2014 the main experiment was conducted to test three conditioning treatments *viz.*, pressing with plain 200ltr steel drum filled with water (PD); pressing with 200 l steel drum filled with water and covered with 14 gauge wire mesh (WD); unconditioned (UC) and three natural aeration methods *viz.*, A-frame (AF); raised platform (RP); dry ground (DG).The experiment had a randomised complete block design with a factorial arrangement of treatments and four replications. Lablab herbage for the trial was harvested 150 days after sowing and spread to a swath density of 25 $kg.m^{-2}$ to cover 3 m^2 per treatment. Dry matter and crude protein content of the different forage treatments was determined at days 1, 2, 3, 7, 14, 21 and 28. The latter experiment again showed that conditioning of forage was significantly ($p<.01$) effective in improving drying rate. Aeration treatments did not have any significant effect ($p<.05$). Laceration and pressing (WD) and M5 were equally most effective but significantly superior to UC, which had the least mean DM of 54.9 compared 59.4 and 57.8% respectively for the former treatments (s.e. 0.531). In general, moisture loss was most rapid in the initial 7 days (-4.1% per day) and progressively lower in the subsequent weeks, at an average of -1.92%, -1.51% and -0.79% day^{-1}, respectively. Leaves under WD dried faster ($p<.01$) and reached 20% moisture within the first 8-9 days of curing, compared to stems that took about 25 days. Crude protein content was not affected by treatment ($p>.05$). Therefore, laceration and pressing or chopping are recommended as conditioning methods for mature Lablab forage.

Keywords: Hay-making, conditioning, moisture, laceration

Fine-scale modelling and mapping of soil functional characteristics and vegetation across landscapes: A case study from communal lands of Bushbuckridge

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High-resolution data on key ecological traits at the landscape scale are important for spatially-explicit assessment of rangeland health. However, sampling intensity and spatial extent of field-based ecosystem assessments usually preclude extrapolation to the landscape scale. This study utilized field-based inventories to develop statistical predictions of ecosystem health indicators across landscapes. A spatially balanced sampling design was applied to survey two 100 km^2 landscapes in the communal rangelands of Bushbuckridge, Mpumalanga in 2013. Indicators of ecosystem health included soil organic carbon, herbaceous cover, tree and shrub densities, soil erosion, root depth restrictions, land-use history, and infiltration capacity. A total of 320 composite topsoil samples (0-20 cm) and 318 composite sub-soil samples (20-50 cm) were collected. Mean organic soil organic carbon was 12.2 and 8.1 $g.kg^{-1}$ in top and sub-soil, respectively. Mean soil pH values were 6.5 and 6.7 for top and sub-soil, respectively. Fine resolution maps (~5 m) of soil organic carbon, pH and soil erosion were produced using RapidEye imagery from 2013. Validation results for land degradation indicators were 80% (kappa=0.58) for erosion prevalence and 79% (kappa =0.52) for root depth restrictions. Validation results for the soil property maps were: R^2 =0.83 for soil organic carbon and R^2=0.78 for pH. These results can be used to inform strategic land management decisions on rangelands and protected areas.

Keywords: ecosystem health; soil; vegetation; modelling; fine spatial resolution

Session 6: Communal range poster viewing

Early growth performance of dolichos (*Lablab purpureus*) fodder banks for communal dairy cattle in the Eastern Cape Province

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Dolichos bean (*Lablab purpureus)* is a herbaceous and annual legume cultivated as food for humans or as a fodder crop with main effects in biological nitrogen fixation and as ruminant protein source. Communal area dairy businesses are mostly sustained on high quality fodder and Dolichos bean, a versatile and climate smart fodder crop that has potential for closing the nutrient gap. A large proportion of these herds in communal areas experience annual cycles of nutritional stress, low productivity, low numbers of saleable stock, low income, poor cash flow, limited investment into the herd. The aim of the study was to assess germination and early seedling growth of Dolichos beans in frost free, high rainfall (1 075 mm) and warm (32.2 °C summer and 5.8 °C winter) Pondoland-Ugu Sandstone coastal sourveld (CB 4) and a small area of the Eastern Valley Bushveld (SVs 6) of Mngungu villages in Alfred Nzo, Eastern Cape. This area consists of hard, white coarse-grained, siliceous quartz sandstones of the Msikaba Formation of the Devonian Period giving rise to shallow, nutrient-poor skeletal, acidic sandy soils. *Lablab purpureus* seed was inoculated by a *Bradyrhizobium* species bacterial legume inoculant for effective nitrogen fixation. Ten prospective smallholder dairy farmers in a dairy value chain system and with no prior experience in fodder crop production were selected. Ten garden pasture plots of 16 to 110 m^2, one per farm, were prepared by hand implements and soils were sampled for nutrient analyses in January 2015. The Dolichos bean was planted in furrows ~3 – 5cm deep and the rows were 90 cm apart. For fertilization, KCL (50) and Superphosphate (14) were applied. Germination, plant height and plant health and pests were assessed after two months. There was over 60% germination in 50% of the plots; 20% of the plots had germination below 30%. Seedling vigour was observed in only 30% of the plots, which were also weed free. In 40% of the plots seedlings were spindly and less than 20 cm in height, covered by weeds and appeared yellowish. Three plots had crop heights of 15 – 45 cm, and darker leaf material; four plots had height ranges of 10 – 35 cm whilst in one plot germination occurred but seedling vigour was low and differed significantly ($p<.01$) from the other plots. One plot had a high infestation of aphids and also a high occurrence of moles. There was moderate to no pest damage at the rest of the plots. Poor management due to language barriers and poor communication, and the lack of knowledge and skills among the prospective communal dairy farmers impacted negatively on early seedling development. *Lablab purpureus* has potential as fodder crop for the smallholder dairy value chain system and for amelioration of soil nitrogen deficit. Skills development in fodder production is recommended for farmers involved in the dairy value chain system. Further research on growth performance and effects of dolichos bean on soil organic matter and nutrient quality will be conducted.

Keywords: communal dairy, dolichos bean, germination, pests

Early growth performance of spineless cactus pear (*Opuntia* spp.) fodder banks for communal dairy cattle in the Limpopo Province

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Investments in climate smart dryland pasture is critical to the sustainability of the smallholder dairy value chain businesses in the Comprehensive Rural Development Programme (CRDP) nodes of South Africa. The aim of the study was to determine the establishment and seedling performance of exotic spineless varieties grown under semi-arid and moderate-high rainfall conditions. Dryland pasture of the spineless *Opuntia* species was established in two sites i) Semi-arid zone Ward 11 of the Makhuduthamaga Local Municipality and ii) sub-tropical Highveld Njhakajhaka village, Vhembe District, Makado Municipality Ward 8 in the Limpopo Province during September to October 2014. The fallow lands were cleared of weeds and no ground tillage was done. Cladodes weighing 800 g to 1 kg collected from a 10-year-old cactus orchard (Waterkloof) in Bloemfontein were cleaned thoroughly with a disinfectant and hand planted at a spacing of 2.5 x 2.5 m and depth of 10 cm, east/west direction in single rows. No fertilizer or supplementary irrigation was provided. Four varieties and 80 plants were planted on 1 ha on each site. Regular scouting for pests and land clearing was done to control weeds. Six months after planting the plants were assessed for new cladodes, plant height, cladode size and pests. In both sites, all cladodes rooted and no cladode death has occurred. Plant height differed ($p<.05$) ranging from 20 to 80 cm in Ward 11, a semi-arid area while the height range was narrower at 19 to 64 cm in Njhakajhaka. Length of Ward 11 cladodes was 20 to 50 cm and width 11 to 22 cm and larger ($p<.05$) compared to the crop in Njhakajhaka with longest size at 32 cm, about 35% smaller. The width did not vary. The number of new cladodes was also highest ($p<.01$) in Ward 11, with up to 12 new leaves and mode of 6 compared to mode of 4, and median of 5 in Makhado. There was better early growth performance of cactus fodder in the semi-arid zone, which also had less than 1% cochineal infection recorded. Early establishment tended to be slower in the higher rainfall site. Further research will be done to determine site variations in annual biomass yield and fodder value and the effects on milk productivity of dairy cows on smallholder farms.

Keywords: communal, dairy, cactus pear, cladodes, fodder

Do nutrients alleviate the negative effect of defoliation on decreaser and increaser grasses?

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The compensatory continuum hypothesis (CCH) predicts plants will be better able to replace tissue lost through defoliation (i.e. compensate) when soil nutrients and other resources are abundant. A pot trial (6 replications) was used to test the effect of nutrients on the compensatory growth of two grasses sensitive to grazing (decreasers) and four species with a higher resistance to grazing (increasers). Plants were severely defoliated to 50 mm five times during the growing season and the accumulated shoot yield and final root mass were used to measure growth performance. Shoot and root growth of increasers, *Sporobolus africanus*, *Eragrostis plana* and especially *E. curvula* (but not *Aristida junciformis*), were stimulated by nutrients more than were roots and shoots of decreasers, *Themeda triandra* and *Tristachya leucothrix*. The mean negative effect of defoliation on shoot yield was: *S. africanus* (-39%), *A. junciformis* (-64%), *T. triandra* (-66%), *E. curvula* (-68%), *T.* leucothrix (-74%) and *E. plana* (-76%). The defoliation effect on top and below-ground growth of all species depended on nutrients (p<.05). Plants were more sensitive to defoliation under high than low nutrients, contrary to the CCH but in accordance with the predictions of the limiting resource model (LRM) of exacerbated defoliation-induced carbon limitation of growth in fertile soils. However, additional nutrients did allow increasers (except *A. junciformis*) but not decreasers to better withstand severe defoliation. This differential alleviation of defoliation stress by nutrients possibly explains the dominance of increaser grasses such as *E. curvula* and particularly *E. plana* and *S. africanus* in continuously heavily stocked communal rangelands, where nutrients are assumed to cycle faster and be more available than in lightly grazed grassland.

Keywords: communal rangelands, compensatory growth, defoliation tolerance, grazing resistance, soil fertility

Practical implications of introducing a rotational rest-based grazing system into a communal area near Matatiele, Eastern Cape

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Rotational resting is seen as a mechanism to restore the vigour of grasslands and compensate for the negative impacts of the defoliation of preferred species. Through a project implemented at Mafube, near Matatiele, by Lima and funded through the Department of Environmental Affairs' (DEA) Land-user Incentives Programme, the practicalities of introducing a grazing system based on rotational resting were explored. The grazing system was based on resting portions of veld for a full growing season (October – May) once every four years. The area was not fenced and the system relied on a combination of strong traditional institutions that support the system and payment of rangers through the project, who complement the traditional system, ensuring that non-herded animals were kept out of the 'closed camps' that were being rested. The community was responsible for deciding on areas to close each year, with guidance provided by the project team. The system has been implemented relatively successfully for two years thus far but some institutional and environmental challenges were encountered which should be shared with others as it may inform application of similar systems elsewhere. The grazing system, as it has been implemented, does not address the issue of grazing pressure being much higher in areas adjacent to settlements and relatively light in the more remote areas. While the system was initially designed so as not to require collective action which requires strong social capital, it became clear that there was a need for more controlled utilisation of the open areas. Other factors that interfered with the implementation of the system include out-of-season burning of rangeland, as well as social conflicts affecting a portion of the grazing area. The implementation of the grazing season has also led to some farmer experimentation focusing on the provision of protein licks that allow for effective utilisation of rested sourveld during the winter months as an incentive to discourage burning of the veld. Lessons that have emerged from the two year implementation period will be shared with other researchers and practitioners to allow for refinement of the system for application elsewhere.

Keywords: communal grazing, rotational resting

The herbaceous yield and soil nutrient content contribution of various leguminous pastures planted in two communal areas of the Eastern Cape Province

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Legume plants are plants which belong to the Fabacae or Leguminosae family with a special ability to fix atmospheric nitrogen. Nitrogen fixation takes place in the nodules which are small swellings on the roots of leguminous plants in association with bacteria known as *rhizobia. Rhizobia* are Gram negative bacteria, which fix nitrogen by forming nodules on the roots of plant and they belong to genera which include *Rhizobium, Bradyrhizobium, Sinorhizobium* and *Azorhizobium* which are symbiotic nitrogen fixers that can be found in the roots of legume plants. Atmospheric nitrogen fixation is estimated to contribute about 10% of the total annual yield of fixed nitrogen. The study investigated the total dry matter (TDM) production and the soil organic carbon contribution of the four forage leguminous pasture species. These legume species were *Lotus corniculatus, Lespedeza cuneata, Trifolium repens and Trifolium vesiculosum.* These legumes were planted in the old lands at Dudumashe and Lushington communal areas. Dudumashe and Lushington communal areas wherein the study was conducted are located at 32°12'S; 27°56'E and 26°82'S; 32°64'E at an altitude of 874 m and 846 m, respectively, in the Eastern Cape province of South Africa. Both communal areas are situated in the Döhne sourveld and receive mean annual rainfall of 600 – 700 mm. The soils in both communal areas are categorized as the Wesley soil form. The study was done at a one hectare area that had not been planted at least for the previous five years in both communal areas. In each one hectare area, there were a total of 30 plots measuring 5 x 0.2 m with 2.5 m interspacing planted to legumes and areas without legumes which were used as control plots. Fourteen legume species were planted and replicated twice in a randomised complete block design (RCBD). Data collection was done over four seasons which are: spring (November) 2013, summer (February) 2014 and autumn (March) 2014 and winter (May) 2014. All data were analysed using analysis of variance (ANOVA) of the Generalised linear model of procedure of SAS (2001) statistical program. Preliminary results depicted that the highest overall TDM yield production ($p<.05$) was reached in the *L. cuneata, T. vesiculosum* and *L. corniculatus* plots while the control plot had significantly lower TDM yield production ($p>.05$) than all other plots. The soil organic carbon content was significantly highest in the *L. cuneata* and control plots ($p<.05$) during the first season. The *T. vesiculosum* plot had a significantly lower soil organic carbon content ($p>.05$) than all other plots. These results show that legume introduction had a positive impact on the overall TDM yield as the yield had increased in the plots where legumes were planted.

Keywords: legumes, nitrogen, biological nitrogen fixation, total dry matter, soil organic carbon and old lands.

Community leadership enhances rural development

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The leadership hierarchy in communal lands is under tribal authority and SANCO. Community leaders work hand in hand with extension advisory services. The more proactive the extension services, the more enthusiastic the community leaders become. The objective of the study was to compare leadership ability at a community level using a scoring system. The study observed approaches to projects that involved a participatory learning method. The strengths of community leadership were evaluated in three projects namely: Biogas project in Machubeni, Eastern Cape Communal Arable Lands (ECCAL) project in six communities, and livestock survey project in the Qutsa Community. The qualitative data collected was ranked in scores of 1 to 3, 3 being the best score and 1 the lowest score. The score 3 means that the traditional leaders work proactively to ensure development occurs in the community, and evidence of this is seen through youth involvement and projects implemented. Under the ECCAL project, the six communities rankings are: Nyandeni 3, Allanwaters 3, Rockliff 3, Roxeni 3, Dudumashe 2 and Lushington 1. In the Qutsa livestock survey project, Taleni and Shweni both scored 1; neither traditional leaders nor ward councillors make changes, only individuals make a contribution, and there is no partnership between our department and the leaders. The Biogas project had four communities involved and scored: Tshamazimba 2, Boomplaas 1, Nkenkulu 1 and Platkop 1. It is therefore concluded that leaders that prioritize peoples' interests become famous, due to evidence seen on the ground. All the communities with a score of 3 generally did not focus just on agricultural projects, but also on sanitation and electricity projects, and community projects like hatcheries, bakeries and water provision. It is therefore concluded that most communities with strong leadership are more successful, because their patriotic behaviour attracts more development facilitators and funders. This is why they enhance development where they live.

Keywords: rural development, livestock

Veld condition assessment of the grazing areas used by emerging farmers in the Gauteng province, South Africa

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Little information is known on livestock grazing systems practiced by the emerging farmers in the Gauteng Province. This inhibits development and/or adoption of suitable grazing systems that improve livestock productivity without negatively affecting rangeland condition. We randomly selected farms in the province and assessed their current grazing capacity, stocking rate, veld condition score, species composition and species basal cover, using the ecological index method. Since the farms that were surveyed used different grazing systems (i.e., continuous, herding, and rotational), we also compared these systems on basis of the measured vegetation parameters. Although no information was available on the historical grazing systems, starting conditions and duration of treatment, there were significant differences between farms that used different grazing systems. For example, species composition ($p<.046$), veld condition score ($p<.001$) and basal cover ($p<.036$) of grazing areas under different grazing systems significantly differed. The number of species were significantly higher for farms that use herding (8.27±0.69) compared to those that use rotational grazing (6.32±0.49). Interestingly, species composition for farms that use continuous grazing was not significantly different from the herding and rotational grazing systems ($p>.05$). There were significant differences among herding (47.7± 5.28%), rotational (37.28±3.26%) and continuous (25.00±1.88%) grazing systems on veld condition score. Rotational (21.71±1.64%) and herding (20.93±1.38%) systems showed significantly higher basal cover than the continuous system (16.35±1.44%). Under herding grazing management system, overall veld ratings were higher. Rotational and continuous management systems have not resulted in improved species composition, veld condition score and basal cover. Although more research that will incorporates historical data or experimentally compare different grazing systems is still warranted, our results indicate that herding grazing management system might have a positive effect on the veld condition of grazing areas in the Gauteng province.

Keywords: emerging farmers, grazing systems, herding, livestock production, species composition

Plenary

Chair: Ian Rushworth

SAEON Cathedral Peak global change monitoring platform: Update on activities

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In 2011 the South African Environmental Observation Network, under the National Research Foundation, initiated the Grasslands Forests Wetlands (GFW) Node. Mandated with performing long term environmental observation aimed at detecting and understanding Global Change impacts, the GFW node undertook to revitalize historic long term streamflow and weather monitoring systems initiated in the 1950's at the Cathedral Peak Research Catchments in the uKhahlamba Drakensberg Park, World Heritage Site. In a water scarce country, determining the impacts of Global Change on key water catchments of the country is important for informing a sustainable development trajectory juxtaposed with increasing demand. We report on the progress made on research infrastructure, the instrumentation network, data being generated and the contextual framework within which this is being grown. Two automatic weather stations and a network of rain gauges have been deployed on historic sites and four of the original weirs have been refurbished and instrumented. In addition to the historic monitoring network, an eddy covariance system, COSMIC ray probe and large aperture scintillometer have been deployed to collect detail data on energy, carbon and water fluxes. In conjunction with data on physical parameters generated by the instrument array, significant progress has been made on biodiversity monitoring including the resampling of historic vegetation plots and initiating invertebrate surveys. Collaboration with universities and government plays a vital role in bringing added value to Cathedral Peak Monitoring platform, ensuring relevance, assisting with transforming data into useable outputs as well as providing additional support to the platform's activities. Outputs from student projects covering paleo, hydrological, carbon and vegetation studies demonstrate how this platform is serving as a living laboratory for student advancement and knowledge generation.

Keywords: Global change, long-term, weather, climate, land-use

International Livestock Research Institute (ILRI) in Southern Africa

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The International Livestock Research Institute (ILRI) is one of the 15 Centres of the Consortium of the Consultative Group for International Agricultural Research (CGIAR). ILRI is a not-for-profit CGIAR Centre employing about 600 staff from over 40 nations, including over 120 internationally recruited staff representing some 30 disciplines. ILRI has its headquarters in Nairobi, Kenya, a principal campus in Addis Ababa, Ethiopia, and offices in other countries of East Africa (Tanzania, Uganda), West Africa (Mali, Nigeria), southern Africa (Mozambique, Zimbabwe), South Asia (India, Sri Lanka), Southeast Asia (Laos, Thailand, Vietnam) and East Asia (China). ILRI seeks to improve food and nutritional security and to reduce poverty in developing countries through research for efficient, safe and sustainable use of livestock—ensuring better lives through livestock. ILRI works in strategic partnership with others – CGIAR Centers, national livestock research institutes and veterinary services, advanced research institutes and universities, public, private and civil society development organizations and community leaders - to generate and synthesize knowledge and approaches that can help poor people cope with economic and environmental vulnerability and take advantage of growing livestock opportunities. Through such partnerships, ILRI seeks to influence changes in processes and technologies, which support innovation at all levels. The research questions in southern Africa are at the core of ILRI's global strategy which seeks "better lives through livestock" by addressing poverty and food security in ways that are productive for human health and nutrition, sustainable and equitable. Key development challenges to which ILRI can meaningfully contribute in Southern Africa are as follows:

Productivity: To improve food security, human nutrition and health, incomes and rural livelihoods of the peoples of this region

Sustainability: To decrease vulnerability and enhance resilience of people, communities and systems (especially in marginal areas)

Rangelands management: Rangelands form the base from which production occurs, the continued neglect of this fact in research and development has seen implementation of unsustainable livestock production practices premised on the genetics of livestock with limited regard to the contribution of the environment of the expression of that genetics. Most rangelands in Southern Africa are considered to be degraded or deteriorating; needing significant attention to rehabilitate or reverse deterioration. ILRI has the capacity to map and characterize the rangeland for livestock production with ability to assist in the management that will ensure sustainability of use and production.

Keywords: rangelands, food security, global, livelihoods, southern Africa

IPBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

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A new platform has been established by the international community -the 'Intergovernmental Platform on Biodiversity and Ecosystem Services' (IPBES). IPBES was established in April 2012, as an independent intergovernmental body open to all member countries of the United Nations with the overall objective to provide policy relevant knowledge on biodiversity and ecosystem services to inform decision making. The members are committed to building IPBES as the leading intergovernmental body for assessing the state of the planet's biodiversity, its ecosystems and the essential services they provide to society.

IPBES provides a conceptual framework recognized by both the scientific and policy communities to synthesize, review, assess and critically evaluate relevant information and knowledge generated worldwide by governments, academia, scientific organizations, non-governmental organizations and indigenous communities. The four agreed functions include knowledge generation, assessment, policy support tools and capacity building. The implementation of the IPBES work programme involves a global pool of experts conducting assessments of such information and knowledge in a transparent and collaborative way. IPBES is unique in that it will aim to strengthen capacity for the effective use of science in decision-making at all levels. IPBES will also aim to address the needs of Multilateral Environmental Agreements that are related to biodiversity and ecosystem services, and build on existing processes ensuring synergy and complementarities in each other's work.

Illustration 5: ARC

Session 7: Bush encroachment I

Chair: Ntuthuko Mkhize

Effects and use of multiple ignitions for controlling encroaching shrub species in north-eastern KwaZulu Natal

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Bush encroachment in natural grasslands and savannas has become a serious problem for domestic livestock ranchers and wildlife managers in South Africa. In this regard a major problem is the alien invasive shrub species chromolaena (*Chromolaena odorata*) and the indigenous shrub species sickle bush (*Dichrostachys cinerea*) which have and continues to invade extensive coastal forest and thornveld areas in Zululand in north eastern KwaZulu Natal. Chemical and mechanical means of controlling these encroaching species are very costly and fire is an alternative and economically attractive method. However, burning requires extreme weather conditions for generating high intensity fires required to have a significant effect in reducing the extent and degree of this bush encroachment. This translates into applying prescribed burns under dangerous conditions with a high fire risk. As a possible solution to this problem experience gained with prescribed burning in the Kruger National Park during 2010 led to the conclusion that high intensity fires may be achieved under less extreme weather conditions by using multiple ignitions. This hypothesis was tested in field trials during 2012 using multiple aerial ignitions applied as Spiral and Race Course ignitions versus Perimeter ignitions to four hectare plots with a helicopter. The trials showed that the multiple ignitions resulted in fire intensities measured with an infrared camera were approximately three times more intense than perimeter ignitions which is currently the standard ignition procedure for applying prescribed burns. These results were tested on a field scale using 30 hectare plots in Zululand in KwaZulu Natal in areas severely encroached by chromolaena and sickle bush. The effects of the multiple and perimeter ignitions were assessed in terms of percentage kill of the two encroaching species and the reduction in phytomass of the shrubs expressed in tree equivalents per hectare. These initial results have shown that the multiple ignitions have caused a significant reduction in the phytomass of both encroaching shrub species but in terms of mortality only the chromolaena was highly susceptible to fire in contrast to the low percentage kill of sickle bush similar to results found in burning trials in the Kruger National Park. These results are providing practical guidelines for using integrated fire management for assisting with the control of chromolaena using fire alone and/or in combination with spraying with herbicides.

Keywords: bush encroachment, alien plant, fire

Local vs. landscape effects of bush encroachment on abiotic conditions and herbaceous composition and productivity

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Bush encroachment is a global phenomenon that has important impacts on grassy ecosystems, causing potentially rapid shifts to functionally distinct forest or thicket. Key to the regime shift between grassland and forest appears to be the loss of a flammable C_4 grass layer, as C_4 savanna grasses generally have low shade tolerance. As the canopy cover of woody plants increases in grasslands and savannas, abiotic conditions including light, soil moisture and nutrient availability change, resulting in altered grass species composition and productivity. These changes have important ecological and economic consequences. Individual large trees often have a net positive effect on herbaceous productivity and quality at the local (i.e. subcanopy vs intercanopy) scale. Bush encroachment, on the other hand, has generally been found to have a negative effect on herbaceous productivity at the landscape scale. Despite this apparent contradiction, research at the two scales has had surprisingly little integration. We quantified light availability, soil moisture, frost occurrence and herbaceous basal cover (total and by species) at 800 transect points representing sub- and intercanopy microhabitats at four sites (open, and approximately 25, 50 and 75 % canopy cover), and determined how the local "tree" effect (i.e. differences in the inter- vs. subcanopy) scaled up to the landscape scale with increasing tree cover. Herbaceous productivity was measured in paired exclosures in the sub- and intercanopy microhabitats at the sites with 25, 50 and 75 % tree cover. Compared to the open, the subcanopy habitat had lower light availability, but increased shading of the intercanopy at higher tree density resulted in a greater than expected overall light availability at encroached sites. Tree canopies reduced soil moisture, though this effect was not consistent and appeared primarily after lighter rainfall events. Frost was significantly reduced under tree canopies and at higher tree density. Herbaceous basal cover and productivity was lower in the subcanopy microhabitat, which was dominated by the C_3 species *Panicum aequinerve*. The four most common C_4 species became less dominant in the subcanopy, and the abundance of *Themeda triandra* in the inter-canopy decreased significantly with increasing tree cover, but the dominant C_4 grass species were still commonly encountered under the lowest light conditions (< 20 % transmittance). There was thus no evidence for the exclusion of flammable C_4 grass species under bush encroachment in this study site, although their basal cover and biomass did decrease under dense tree cover. Overall, we found that the local tree effects were generally negative (reduced light, equal or lower soil moisture, lower ANPP) and that this scaled up to the landscape scale, though in some cases to a greater degree than would have been predicted based on the subcanopy/inter-canopy differences alone. We attribute the greater than expected persistence of sun-loving C_4 grasses under even fairly dense bush encroachment to the very low stocking rates at our study site. If further research confirms this, it has important implications for managing areas that have become encroached by savanna trees.

Is there an ecological and cost-effective answer to controlling bush encroachment?

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The problem of bush encroachment is widespread throughout southern Africa and affects not only the livestock industry but also the game industry resulting in extensive areas becoming less productive and therefore economically less viable. The conventional and more popular methods of controlling bush encroachment are the use of herbicides and/or mechanical clearing of the bush, both of which are costly. Fire is a natural factor of the environment and has fewer long term negative effects on ecosystem functioning so is more ecologically acceptable. Since the income from the Game Industry alone in South Africa is estimated to be R16 billion per year, cost effective, environmentally sensitive, effective prescribed burning programmes for controlling bush encroachment can be of benefit not only to the game sectors but the same technology can benefit the agricultural sector too. Two very simple and repeatable vegetation survey techniques used to assess the condition of the herbaceous and woody vegetation, quantifies the condition of the veld using ecological criteria to assess whether the vegetation qualifies to withstand the disturbance of a prescribed burn. Similarly the assessment techniques, a step-point full species grass survey technique to assess the condition of the grass sward, as well as an adaptive point centred quarter technique to assess woody vegetation, quantitatively assess the ecological status and response of both the herbaceous and woody vegetation pre and post burn. The veld condition assessment data on Phinda Private/Mun-ya-wana Game Reserve and adjacent wildlife areas, provides scientific evidence that prescribed burning programmes can in fact cause a shift in vegetation from a bush encroached scenario to open grassland. This data also provides evidence that ecologically based burning programmes change the ecological status of the grassland from less palatable Increaser dominated sward to a more palatable Decreaser dominated sward. The Phinda Private/Mun-ya-wana Game Reserve has been applying ecologically based prescribed burns since 2001 resulting in a significant improvement in veld condition, and a 114% increase in numbers of game animals as reflected in the trends in the annual game census conducted from 2004 to 2010. The data also clearly shows a significant reduction n density and phytomass of woody species.

Keywords: bush encroachment, veld condition assessments, prescribed burning

Session 8: Bush encroachment II

Chair: Julius Tjelele

Does it pay to reduce *Acacia karroo*? A cost-benefit standoff.

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We compared the impact of various tree densities of *Acacia karroo* encroachment throughout different rainfall regimes on grass production and grass quality, and how this influence the cost-benefit economics of agriculture in the Eastern Cape Province, in South Africa. Tree density reduced grass production, at the same time having a positive impact (increased crude protein) on grass quality. Tree density impacts were strongly influenced by rainfall amount. Increased rainfall showed opposite impacts compared to tree density for both grass production and grass quality. High rainfall increased grass production while negatively influencing grass quality. Grass quality had a positive effect on pasture value. In all sites tree density encroachment reached densities where the cost of removal over-rode the pasture value benefits gained. Site variation in tree density and rainfall amongst the five sites, required that four different models for early prediction are compulsory. Further encroachment will affect the economic viability of bush control to be less profitable. Bush control should be maintained early on before dense stands of *Acacia karroo* are a reality. Initial encroachment of trees should be avoided.

Keywords: encroachment; influence; benefits; prediction; economic viability

Nutrient supplementation enhances shrub use by free-ranging goats: Implications for bush control in semi-arid savannas

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Large herbivores are purported to continue consuming toxin-containing forages as long as their capacity to neutralize, detoxify and excrete dietary toxins is not exceeded. This capacity depends on the availability of liver enzymes, energy and amino acid precursors. While this may explain increased intake of toxin-rich forages by herbivores supplemented with nutrients, a different effect may emerge in rangelands dominated by forages that are rich in condensed tannins which are not as degradable and readily absorbable as toxins. In a field experiment, we investigated the effects of supplementing animals with a high-energy source (yellow maize grain) and a high-protein source (soybean meal) on browse intake, foraging behaviour and diet composition of goats in a semi-arid savanna. Results confirmed our prediction that nutrient supplementation increased the proportion of time animals spent browsing and subsequently enhanced browse intake. Supplemented animals consumed more condensed tannins than animals that were not supplemented. Animals from supplemented groups tended to compose different diets from animals that received no supplement. We contend that supplements replaced the nutrients that are routinely bound and rendered indigestible by condensed tannins. Therefore, supplemental nutrients likely increased the intake of tannin-rich forages through delaying a negative post-ingestive feedback (aversion) from dietary tannins. We concluded that nutrient supplementation increased browse consumption by goats. Given that chemically defended woody plants are predicted to continue encroaching in the semi-arid savanna rangelands, these results suggest a potential for browsers and mixed feeders to serve as biological bush control agents.

Keywords: farming systems, ruminant, ungulates, nutrient-toxin interactions, livestock production

Illustration 6: Zuluwaters

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Session 9: Wildlife

Beanélri Janecke

Tree trends in protected areas adjacent to the Kruger National Park

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We accept that the aesthetic value of large trees is as valid an aspiration as the more 'concrete' objectives like preventing biodiversity loss. The potential decline in tall trees due to elephant and associated potential knock on effects such as fire is therefore a concern and forms the focus of this study. Elephant can modify habitats rapidly and extensively, and as such may precipitate a cascading effect through the ecosystem, affecting many co-existing plants and animals. It is contended that a manifestation of high elephant densities and fire is a loss of large trees and perennial grasses which could lead to bush encroachment, and a concomitant loss of sensitive grazing species, so that the vegetation is replaced by short closed woodland with an increasing number of mixed feeders and browsers.

To investigate the impact of elephant and fire we examined 22 years of tree data (response variable) from the Sabi Sand Wildtuin (SSW). We focused on *Acacia nigrescens* to determine the impact of elephant and fire that may lead to elevated mortality through direct impact or be magnified by attributes that affect selection and the manner of utilisation which render the trees vulnerable to higher mortality rates (e.g. fire).

There was a decline in overall woody density throughout the SSW. This was reflected in the *Acacia nigrescens* population (22 years) where an examination of the trends per height class showed declines within the 0 – 1 m and >5 m layers, a stable 1.1 – 2 m layer and an increase in density within the 2 – 5 m layer. We argue that the declines were linked to fire and herbivory and herbivory and fire respectively. There is evidence that the increase in the density within the 2 – 5 m layer was a response of the tree layer to a weakened grass layer following a drought which resulted in this class escaping the fire trap. These findings may have longer term implications for these savannas where structural homogenisation is a concern.

Keywords: elephants, fire, physiognomy, species composition, woody component

The diet and ecology of introduced giraffe in Subtropical Thicket vegetation within the Little Karoo region of South Africa

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The existing controversy surrounding the benefits and risks of introducing giraffes outside their natural ranges have led to contradicting conclusions on the impact these mega-herbivores have on the environment within the scientific, agricultural and land management communities. Thus, appropriate management is crucial and can only be done with the implementation of appropriate policies formulated with the support of quantifiable research. Research would give us an understanding of the behaviour of these introduced species within the receiving ecosystems, and how to mitigate possible impacts these species have on the environment, as well as how the environment influences the species. Little research has been conducted on the introduction of giraffe into Thicket biome areas within the Little Karoo region of South Africa. This study attempted to understand and discuss the diet and feeding ecology of these giraffes. The feeding habits of giraffe were observed on two private game reserves within the Oudtshoorn and De Rust areas located in the Little Karoo. Direct observations were conducted on all individuals in a herd, occurring for four days every season (summer, autumn, winter and spring). Activities were recorded every five minutes from sunrise to sunset, which included the foraged plant species, level of feeding, specific location and other behavioural activities. In total, 16 different plant species were consumed. *Pappea capensis* and *Euclea undulata* formed the majority of the diet (>50%) of all giraffes for the Oudtshoorn private game reserve irrespective of sex, age and season. This occurred also for the De Rust private game reserve, however, *Acacia karroo* was observed to be dominant within the diet of adult males in summer. The height of the majority of the forage species found within the Thicket biome varies between two and three metres, and as a result, the level of the giraffe feeding was observed to be mostly at shoulder height (level 3) and below (level 2). Our preliminary findings indicate that introduced giraffes have adapted to take advantage of forage resources available in ecosystems outside their natural ranges. However, their continuous lower levels of feeding compared to when they are in their natural range, point to niche overlaps with other browsers present on the farms. This may result in increased competition (interspecific competition in addition to intraspecific competition) for food when it becomes limited during the drier summer months. These arguments show the need for long term ecological monitoring of introduced giraffes, as well as appropriate management options to avoid the displacement and degradation of indigenous fauna and flora within the Little Karoo, and possible mortalities amongst the giraffe populations.

Keywords: behaviour, diet, introduced giraffe, thicket.

Variation between seasons and height strata in availability of browse to browsing game species

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Knowledge of vegetation composition and of available browse (leaves and shoots of woody species) to browsing game species that include browsers and mixed feeders, combined with knowledge on these animals' diet preferences is essential in management of game species. This knowledge is also important when determining carrying capacity, especially in smaller fenced areas where large distance animal migration to other food sources is limited. Availability of food is a determining factor of the acceptability of habitat to wildlife. Thus, the objectives of this study were to: determine browse production and capacity in total and at different feeding heights; indicate factors that influence browse availability during different seasons; and determine if small migrations occur in search of browse resources. The study was done on a small game ranch (437 ha), north of Bloemfontein. The BECVOL model (Biomass Estimates from Canopy Volume) was used to calculate browse production in total and at different feeding heights. Browsing animals were observed while they were feeding to determine the accessibility of the total browse available to them. Habitat preferences of the animals during different seasons were also noted during observation of browsers. Browse production varied from 59 to 400 $kg.ha^{-1}$ between vegetation units with increasing woody density. In summer, the <2 m height stratum could sustain 7 browser units (BU: metabolic equivalent of kudu cow) and the <6 m stratum could sustain 20 BU. In areas ranging from being dominated by medium (<2.5 m) to large trees (>5 m), between 27% and 86%, respectively of available browse was out of reach of kudu and smaller browsers. Total browsing capacity of the study area in summer was 3 $ha.BU^{-1}$ and in late winter 60 $ha.BU^{-1}$ due to dominant leafless deciduous food species. Several factors influence the availability of the total browse quantity of an area, e.g. leaves that are out of reach, limited accessibility of trees in dense stands, growth form of the plant, habitat preferences of animals that exclude potential browsing areas, competition for resources, preferred food species being leafless in winter, etc. Even when restricted by fences in the study area, browsers seasonally moved to areas with denser vegetation and where other browse resources occurred. Browse in specific height strata proved to be a better indicator of availability to browsers of different sizes than total browse production of the area. Available browse in winter should determine numbers of browsers that can be stocked on game ranches during the critical period of browse shortage brought on by deciduous plants, rather than total browsing capacity as calculated in the summer.

Keywords: browse production, carrying capacity, habitat preferences, plant height, woody density.

Session 10: General poster viewing

The effect of high density livestock grazing on a mesic grassland in South Africa

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Short duration high density stocking is currently gaining popularity amongst farmers in the South African mesic grasslands, but little is known about its potential impact on these grasslands. The aim of this study was to assess the effect of short duration, high density stocking of cattle on the plant species composition and soil physical and chemical properties of a mesic grassland near Kokstad, KwaZulu-Natal. This study was conducted on a fence line contrast between two properties. One that has been stocked with cattle in a short duration rotational system at a high density (HDG) and the other rotational grazing system at a much lower density (LDG) for >17 years. Veld condition assessment was conducted by means of 100 paired points along the fence to determine plant species composition. Basal cover was calculated using the distance to the nearest tuft and tuft diameter measures. Ten 10 x 10 m paired plots were located along the fence. Soil compaction was measured inside each plot using a dynamic cone. Soil samples were collected from the plots and analysed for chemical properties. The veld condition of HDG (61.6%) was lower than that of LDG (87.8%) because of fewer palatable, grazing sensitive grasses (e.g. *Themeda trianda,* 24% vs 47%) and more increaser II species (e.g *Eragrostis curvula,* 9% vs 0%) in the former. Basal cover was also markedly lower under HDG (22%) than LDG (33%). Soils were 44.4% more compacted (p=0.014) under HDG than LDG, but did not differ in any of their chemical properties (total nitrogen, total carbon, total phosphorus and pH). These results indicate that short duration high density stocking has a negative impact on mesic grassland swards, and an examination of their forb populations will reveal whether HDG is also inimical to plant species diversity.

Keywords: mesic grassland, grazing systems, veld condition assessment

Vegetation cover is critical for faunal diversity in moist highland grasslands

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The South African highland grassland system is second only to Fynbos in species diversity. In these grasslands fire and grazing interplay at the landscape level, directly influencing biodiversity. Fire and grazing can be managed to influence ecosystem health. Moist highland grassland (MHG) systems in South Africa are naturally maintained by winter and spring fires (naturally every four years or more) and by summer grazing by small migratory herds of small to medium-sized antelope. Currently, the majority of the system is managed by livestock farmers who burn annually at the onset of the rainy season, coinciding with the beginning of the breeding season for grassland-nesting birds and the emergence of arthropods. In order to assess faunal and floral responses we selected eight management treatments for comparison. We collected data describing ten vegetation structural indices; plant species richness and abundance were quantified (for 114 species); >32 000 arthropods were collected and sorted to order level; 160 km of transects were walked to assess bird species abundance (for 127 species); and 404 grassland bird nests of 12 species were located and monitored to completion. Both nest success and nest-site selection are driven by vegetation structure, which itself is driven by habitat management. Nesting success and abundance of Yellow-breasted Pipits *Anthus chloris* suggest that unconserved areas may house sink populations of this regionally and globally Vulnerable species. Overall Field Metabolic Rate and Biodiversity Intactness Index values both confirm the importance of conserved areas (and specifically the availability of vegetation cover) for plants, insects and birds in MHG systems and support the need for further conservation efforts in grassland systems as a whole by both private landowners and reserve managers.

Keywords: grasslands, birds, fire, grazing, arthropods, vegetation cover.

Degraded communal rangelands compromised by alien infestation: Is restoration possible?

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Land degradation in communal landscapes in the grassland biome is notorious, and often attributed to overstocking, lack of knowledge and poor management. Excessive pressure on the herbaceous component leads to the uncontrolled spread of opportunistic invasive alien woody species in these degraded areas, resulting in enormous loss of ecosystem service capacity, along with soil and land productivity. The erosion of landscapes leads to the erosion of livelihood opportunities. Interventions in the upper Umzimvubu catchment near Matatiele, Eastern Cape Province are showing a different understanding of the attributes and opportunities for effective restoration of grassland to improve ecosystem services. The focus is on enabling land users to restore basal cover for effective rainfall infiltration, erosion protection and stock productivity. Livestock production is viewed as an incentive for participation and buy-in by land users, especially in areas cleared of wattle infestation. The experience of a group of NGOs is showing encouraging results for community-based natural resource management initiatives which are set to work beyond the project stage. Community mobilization and packages of appropriate incentives for stock owners are showing tangible results for both landscapes and livelihoods. Cattle and small stock, which were formerly viewed as grassland destroyers through overgrazing, are now being tested as a tool for rangeland restoration through agreed grazing management systems. Managed use of stock for trampling coupled with exclusion and other techniques to catalyse the rejuvenation of natural plant succession in degraded post-alien cleared areas, is suggesting that inputs don't have to be expensive or high-tech. Livestock management may become a viable and essential part of the follow up strategy for management of alien infestation where restored basal cover in the first season provides a niche for local grassland species to recolonize. Managed grazing across the entire landscape may allow for succession and species composition improvement, which can eventually lead to productive natural grassland. This poster presentation provides a practical explanation of the observations from several sites, as well as recommendations for potential replication on a wider scale.

Keywords: communal grazing, rotational resting

Big trees and elephant in protected areas adjacent to the Kruger National Park

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This presentation serves as an update to a presentation made in 2009. In the reserves adjacent to the KNP, woody density and structure varies both spatially and temporally in response to among others 'wet' and 'dry' periods. With the removal of the fence between the KNP around 1993 the protected areas to the west there was a dramatic increase in the number of elephant in the area. There is ongoing concern that utilisation of tall trees sometimes in conjunction with bush thinning operations will have negative effects on various system components. To investigate the impact of elephant on >5m size class, we have marked in excess of 1 000 trees taller than 5 m in a number of protected areas with differing elephant densities. We report on 9 years of data and compare impacts with the elephant impact data collected during routine monitoring as well as focusing on tree species of concern. In addition to elephant density, it appears that elephant impact is related to rainfall and resulting veld conditions, e.g. wet 1999/00 low impact and visa versa during the 2002/03 drought. The challenge is to determine the rate at which impact occurs so that necessary management interventions can be implemented before a state is reached that compromises long term land use options.

Economic analysis of chemical bush control in Miombo woodlands

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Bush encroachment is a global issue that entails reduction in rangeland production. Bush control measures of the defoliation and stump treatment or foliar chemical application are recommended. However, these methods are capital intensive and their economic viability needs to be practically explored. An economic model was developed as a tool to evaluate the economic efficiency of chemical bush control. The model was based on gross margin analysis of bush control costs and livestock returns based on biomass produced in successive epochs over a period of 10 years in an experiment that was conducted in the miombo woodlands of Zimbabwe. This experiment included the integration of the cut-stump and follow-up foliar treatments where stumps were treated with picloram at various rates (0.0005, 0.000126, 0.00032, 0.0081 and 0.02049 gae.cm)$^{-1}$. The foliar treatment was applied on coppice at various rates (0.0119, 0.0356, 0.0356, 0.1067, 0.32 and 0.96 gae.plant^{-1}) 7 months after cut-stump treatment. Changes in biomass production were followed over 10 years. Biomass production reached peak production in the 5th year after which it declined to the original state as woody density reverted to the original state by 10th year. This model assumed that reduction in tree density results in increases in biomass production which would translate to increased grazing capacity. The production system used in the model was extensive rearing of cattle weaners that are weaned directly to the rangeland in September (at weight 250 kg) and sold at an age of 15 months (at weight 420 kg). The results of the study indicated that it is economic risky and highly expensive to use chemicals for bush control. It is therefore suggested that browsers should be used as a replacement for foliar treatments to achieve efficient utilisation of coppice while controlling encroachment.

Keywords: bush encroachment, stump treatment, biomass production, picloram, cattle weaners

Fire history and frost in an arid savanna woodland: Understanding its impacts on vegetation structure and diversity at the Waterberg Plateau Park, Central Namibia

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Fire is one of the major factors responsible for shaping vegetation structure and species composition in savanna and grassland biomes. Thus, fire cannot be disregarded when considering the management of rangelands for both domestic livestock and wildlife. The occurrence of fire in any area is dependent on many factors, including annual rainfall and grass biomass. Frost occurs during winter in the study area mainly in low-lying "interdunes". Frost like fire causes the top-kill of woody vegetation and may limit or prevent the establishment/growth of frost intolerant vegetation species. However, its effects on vegetation dynamics and especially as a synergistic effect with fire are not well known in the study area and in such an ecosystem. Therefore, the study aimed to provide insight and a better understanding of fire effects with frost. The research is focused on understanding how fire history [mean fire return interval (MFRI) and time since last burn (TSLB)] and frost affect vegetation structure and diversity in a savanna woodland at the arid end of the scale. The key research question being addressed was: How do different fire history and frost impact vegetation structure and diversity at the Waterberg Plateau Park? A total of four sites with different fire histories (site 1= MFRI is 18.5 years and TSLB is 26 years, site 2= MFRI is 9.3 years and TSLB is 16 years, site 3= MFRI is 9.3 years and TSLB is 3 and site 4= MFRI is 6.2 years and TSLB is 2 years) were surveyed in the study area. This was to test how fire history changes the vegetation structure and diversity. In addition, to test what frost does to vegetation structure and diversity a site with the same fire history (last burnt 25 years ago) that has some areas in low-lying areas (interdunes) and others on "dunes" was surveyed. The point-center quarter method was used to obtain vegetation structure, species composition and diversity data. The Bitterlich gauge was used to estimate woody cover and also provide additional height structural data and the visual obstruction reading (Robel pole) method and grass clipping was used to estimate grass biomass and grass species composition. The collected data has been captured and summarized, however statistical tests are yet to be done. Multivariate statistics such as ordination will also be used to explain if vegetation data conform to a pattern that could be explained by different fire history and occurrence of frost. The observed results show that fire history plays a role on vegetation structure in that site 4 has a higher mean density of <1 m woody plants and grass density. In contrast, site 1 and 2 have higher mean densities of >4 m woody plants and lower mean grass densities. Site 3 and 4 are more open as they have lower woody cover compared to less frequently burned sites (1 and 2). The most recently burned site 4 has the lowest grass biomass, followed by site 1, whilst site 3 has the highest grass biomass. Frost similarly affects vegetation structure in that the interdune sites have a higher mean density of <1 m woody plants and grass density. In contrast, the sites on the dune have higher mean densities of >4 m woody plants and lower mean grass densities. The interdune sites have higher grass biomass compared to the dune sites. The interdune sites have a higher woody cover of <2 m plants whilst the dune sites have a higher woody cover of >3 m plants.

Keywords: fire history, frost, arid savanna woodland, fire interval, time since last burn, Waterberg Plateau Park

Comparison of herbaceous plant species composition, diversity and rangeland condition between camps utilised by large and small stock at Neudamm Farm, central Namibia

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The study was conducted at Neudamm farm situated 30 km east of Windhoek in central Namibia. Neudamm is a University farm largely utilised for research purposes and it supports small and large stock, as well as small numbers of wild large mammalian herbivores, such as kudu, oryx and red hartebeest. Large stock and small stock utilize the rangeland in different ways, given the allometric considerations of energy requirements. This differential rangeland utilization is hypothesised to result in differences in rangeland condition, and over time would lead to changes in plant species composition and diversity. The overall aim of this study was therefore to assess and compare rangeland condition and plant species diversity between large stock and small stock camps on Neudamm farm. Sampling was done in two camps, one utilized by large stock (cattle) and another utilized by small stock (sheep and goats). A systematic sampling procedure was used where a total of 100 plots measuring 1 m^2 were sampled along transects in each camp. In each plot grasses and forbs were identified and the percentage cover of each species was visually estimated. A two-sample t-test was used to compare species diversity and richness between the camps while a Chi-Square test was used to compare proportions of increaser and decreaser species between the camps. Hierarchical Cluster analysis was used to compare species composition. Species diversity ($t=1.984$, $p<.01$) and species richness ($t=1.984$, $p<.05$) were significantly higher in the large stock camp than in the small stock camp, while species composition differed by only 17% between the two camps. However, there was no significant difference ($x^2=3.964$, $p>.05$) in the range condition between the two camps, measured by proportions of increaser and decreaser grasses. The proportion of perennials to annuals was also similar between the two camps ($x^2=0.320$, $p>.05$). These observations are attributed to the differences in feeding behaviour between cattle, goats and sheep where cattle and sheep tend to graze more while goats tend to browse more. Due to more feeding selectivity by small stock compared to cattle which tolerate rougher material, the small stock camp degenerates into lower diversity over time. However, this alone cannot fully explain the observed variation in the species data. Some of this is attributable to the inherent natural heterogeneity of the landscape. The overall rangeland condition for both the camps was classified as good due to the low occurrence of increaser species.

Keywords: large stock, Neudamm, rangeland condition, species diversity, species composition

Influence of *Acacia mearnsii* (black wattle) on rangeland production in semi-arid South African grasslands: implications for rangeland rehabilitation

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South African grasslands are under threat from woody encroachment by invasive alien plants (IAPs) such as *A. mearnsii*. The study sought to determine the effect of *A. mearnsii* invasion on soil quality and grass canopy cover. Replicated soil samples at two depths (10 and 20 cm) were collected in two treatments at four study sites in the north Eastern Cape and analysed for P, K, N, Mg, Ca, Zn, acid saturation, CEC, bulk density, pH and total cations. The treatments were i) recently cleared areas and ii) un-cleared areas inside the wattle thicket, with a control in the adjacent, un-invaded grassland. In addition, using a land systems approach, the influence of wattle's leaf area index (LAI) and terrain slope on grass cover was investigated. Wattle invaded sites were significantly different from uninvaded areas in terms of P, CEC, total cations, acid saturation and pH ($p<.05$). Nitrogen was 20% higher and Ca was 17% lower in invaded than the un-invaded grassland. Wattle's LAI ($p<.001$) had greater impact on grass cover than terrain slope, and when LAI approached 2.1, grass canopy cover dropped to <10% in heavily infested areas. In conclusion, for the north Eastern Cape, wattle adversely impacts rangeland productivity through influencing soil properties and by high canopy LAI. Rehabilitation of rangelands invaded by *A. mearnsii* should be informed by an understanding of soil properties. In addition, the results from the LAI versus grass cover study suggest that it will be possible to thin wattle stands in order to promote grass production without clear-felling and this may inform policy on current large scale clear-felling of wattle.

Keywords: soil properties, *Acacia mearnsii*, LAI, rangeland rehabilitation, grass cover

Vegetation composition of *Opuntia humifusa* invaded cattle and sheep grazing areas of western South Africa

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Vegetation profiles of the semi-arid rangelands of western South Africa consist of a mosaic of patches with high biomass cover that is inter spaced with patches of forbs, wild cactus pear or bare areas. The pattern seems to be moving toward all cactus and bare patches as *Opuntia humifusa* replaces forbs, palatable and unpalatable grasses and legumes decimated by intense grazing, frequent droughts associated with the El Niño Southern Oscillation, and the resultant asymmetrical distribution of water in the degraded areas. The objective of this study was to define the occurrence of common grass species in semi-arid areas invaded by *O. humifusa* and also grazed by cattle, sheep and goats. Vegetation across a 300 ha semi-arid site 150 km south-west of Bloemfontein was described using plant cover data from line transects. Plant surveys were done systematically at 1m intervals to assess species composition and 5 m intervals using a 1 x 1 m quadrat to assess species abundance, using four transects in 25 x 25 m area plots. Nine plots were sampled per site, with two sites grazed by either sheep and goats or beef cattle. The two sites were subdivided into three areas which were i) no *O. humifusa* (NIGA); ii) some invasion (TA) and iii) severely invaded (HIGA), each with three replications. The proportion of identified grass species revealed that the most abundant species in the NIGA cattle site were *Themeda triandra* (4%), *Heteropogon contortus* (7%), *Aristida stipitata* (30%), *Eragrostis rigidior* 15%, *Stipagrostis ciliata* (40%) and some forbs (10%). The proportion of *H. contortus* and *E. rigidior* in the HIGA was 70%. *Stipagrostis* species declined ($p<.001$) by 50%. *H. contortus* was more abundant in the TA (60%) followed by *Eragrostis* species; *T. triandra* was absent. In TA zones grazed by sheep, *T. triandra* was highly abundant followed by *Eragrostis* species. *T. triandra* was the most abundant grass species (90%) in NIGA zones grazed by sheep, with *Eragrostis* and *Stipagrostis* at 2 and 5% respectively. In the severely degraded sheep grazing area (HIGA), forbs and *Eragrostis curvula* dominated the area and *T. triandra* and *H. contortus* were similar in proportions at 0.68 and 0.8% respectively. The proportion of forbs were not categorized however the area was dominated by *Pentzia lanata* and *Salsola tuberculata*. The preliminary report demonstrates that landscape spread of *O. humifusa* shifts vegetation profiles and that cattle grazed sites are more prone to *Opuntia* invasion. Further research will be done to assess ecological trends of forbs and grass species, soil organic matter and exchangeable nutrients across all sites.

Keywords: *Opuntia humifusa*, invaded areas, *Themeda triandra*, degradation, semi-arid, vegetation composition

Morphology of the encroacher shrub *Seriphium plumosum* in Bankenveld grassland

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Seriphium plumosum is an indigenous pioneer plant invading large portions of natural veld and cultivated land in South Africa. The loss of valuable grazing due to encroachment by this dwarf shrub warrants further investigation. In this study, we investigate the morphology of *S. plumosum* in bankenveld at Telperion Nature Reserve, Mpumalanga. Above and below ground plant structures were examined to gain a thorough understanding of *S. plumosum*. Plant height, ground cover and root depth was estimated for all samples. Wet and dry biomass for roots and stems were determined at preordained depths and heights. Preliminary morphology investigations reveal an extensive tap root system for *S. plumosum*. As plant height increases, wet root weight decreases, indicating that robust roots develop early in *S. plumosum*; as the plants grow bigger/older, root development diminishes. We found a strong positive relationship between circumference and number of branches present, indicating that horizontal spread of *S. plumosum* results from the addition of stems, rather than increased stem girth. This study contributes towards an improved understanding of the management of the *S. plumosum,* as an encroacher species.

Keywords: encroachment, biomass, morphology, *Seriphium plumosum,* Bankenveld, Telperion Nature Reserve

Variation in grass morphological traits and their relation to fire in KwaZulu-Natal

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Grasses like other plant families are classified into groups based on their shared traits. Grasses use two possible photosynthetic pathways; C_3 and C_4 and this characteristic plays a role in determining species distribution. These grasses are found in environments with of varying altitudes and so may differ in physical traits. The differences in traits influence how these grasses will burn in the field. The study aimed to determine the relationship between rate of combustion of different grass species using different photosynthetic pathways and measurements of their physical traits. Grass species were sampled at three sites of increasing elevations, the Coast (159 m), Midlands (850 m) and Drakensberg (1850 m). Four questions were asked: 1) Is there a difference in physical traits of different grass species growing within the same area of the same altitude? 2) How do the physical traits of *Themeda triandra* and *Aristida junciformis* vary along an altitudinal gradient? 3) How do grass physical traits affect rate of combustion (flammability)? 4) Is the rate of combustion of C_3 and C_4 grasses different and what physical traits cause these differences? Results revealed that 1) there is a difference in physical traits of different grass species growing under the same area and same altitude and 2) physical traits for *Aristida junciformis* differed markedly in the Drakensberg relative to the two lower altitude sites and physical traits for *Themeda triandra* differed markedly at the Coast relative to the higher altitude sites. The Principal Components Analysis revealed that at the Coast, rate of combustion was highly correlated to specific leaf area and leaf wet mass, at the Midlands site, leaf dry matter and leaf area were the traits most highly correlated to rate of combustion and that the rate of combustion did not appear to be highly correlated to any physical trait at the Drakensberg. The Multiple Regression Analyses revealed that for all species, specific leaf area alongside other traits influenced rate of combustion. *Themeda triandra*, and *Aristida junciformis* had the slowest mean rate of combustion (seconds per gram for dry mass) at the Coast (lowest altitude) and Drakensberg (highest altitude) respectively. *Festuca costata* (C_3) had the fastest rate of combustion when compared to all grass species. Climate change could cause for a shift in vegetation structure resulting in changes in fire regimes.

Keywords: tuft traits, leaf traits, flammability, CO_2

The effect of fire histories on soil nutrients, soil carbon and soil respiration on the Waterberg Plateau Park, central Namibia

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Fire is a natural disturbance that occurs in grasslands, savannas as well as Mediterranean ecosystems, and has been occurring since time immemorial in African savannas. It is recognised as a key factor that shaped and continues to shape savannas for as long as lightning has existed. The use of fire in the management of vegetation and wildlife has been widely used in woodland savannas throughout the world. This concept has also been applied in the Waterberg Plateau Park, central Namibia as a management tool. The park is divided into fire blocks, and has a well-documented fire history. However, there is a knowledge gap on the effects of these fire histories on the soil resources. The key element in this research project was to investigate the effects of fire histories on soil nutrients, soil carbon and soil respiration. This project is part of a broader project looking at the impacts of fire on biodiversity and ecosystem processes in woodland savannas. Six transects (200 m) were randomly selected in four fire blocks with different fire histories (time since last burn ranging from 2-25 years and fire interval ranging from 6.2 – 18.5 years). Soil nutrients and soil organic carbon in the 0 – 10 cm soil layers were investigated by collecting soil samples at 40 m intervals along the transects and then performing standard lab tests. A LI-6400XT instrument was used to measure soil respiration by investigating the CO_2 efflux at different patch types; namely under grass, under shrub and bare ground patch in the blocks with different fire histories. Preliminary results show visible trends, but statistical analysis will be used to confirm that. Clay content has a positive relation with organic matter. The amount of P is controlled by organic matter and due to the relation between clay and organic matter; P tends to increase with higher clay contents. Bulk density reduces with an increasing amount of organic matter. Mean Na strongly decreases whereas mean C slightly increases as time since last burn increase. Mean CO_2 efflux varies between patch types; with shrub having the highest CO_2 efflux and bare soil with the lowest. CO_2 efflux does not differ in a fire block that burned 25 years ago among different patch types. The block that burned 2 years ago recorded the lowest CO_2 efflux on overall. A better understanding of the role of fire histories on soil nutrients, soil carbon and soil respiration will broaden our knowledge and can greatly improve the use of fire in the management of woodland savannas.

Keywords: woodland savannas, LI-6400XT, CO_2 efflux, fire interval, time since last burn, fire blocks

Large-scale foraging behaviour of free-ranging goats: influence of herd size, season and landscape quality

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For animals living in herds, competition between group members increases as herd size increases. Moreover, the intensity of this competition is likely greater across poor quality landscapes, and during the dry season. In contrast to wild herbivores, herd size in domestic livestock is not determined by the animals themselves, but rather by human owners. This then raises the question, how do domestic livestock, like goats, reduce competition for food within these defined herds? To explore this question, we recorded large-scale foraging behaviour of both small (12 to 28 individuals) and large (42 to 83 individuals) herds of free-ranging goats in the Tugela Valley, KwaZulu-Natal, South Africa. We conducted the study on three different landscapes that varied in both food quality and availability, during the wet and dry seasons of 2013. The goats were housed in kraals overnight and released in the mornings to forage on their own unattended. Thus, foraging decisions were made by the goats and not by herders. The large-scale foraging behaviours we focussed on included, (i) total distance travelled by goats while foraging, (ii) distance travelled before starting to feed, (iii) travel speed, and (iv) feeding duration. Using Garmin Foretrex 401 GPS devices harnessed to two goats per herd for five days per season, we found that irrespective of season, there was no significant difference in the total distance travelled by the different sized herds across the different quality landscapes. However, both small and large herds started feeding farther from the kraal in winter in comparison to summer. Despite this, there was no significant seasonal difference in total amount of time the herds spent feeding across the different landscapes. Finally, both small and large herds increased their travel speed across all the landscapes in winter, but large herds travelled faster than small herds. This increase was likely to maximise the time that large herds could spend feeding in good areas. Ultimately, our results indicate that both small and large herds were affected by declines in food quality and quantity during the dry season. However, as large herds made greater behavioural adjustments compared to smaller herds (i.e. feeding farther away from the kraal and travelling faster), it seems that they were more affected by the seasonal increases in intra-herd competition.

Keywords: food availability, food quality, distance, travel speed, feeding duration

Seasonal regulation of condensed tannin consumption by intermediate feeders in a semi-arid savanna

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Although condensed tannins (CTs) are known to reduce forage intake by mammalian herbivores in controlled experiments, few studies have tested these effects in the field. Thus the role of CTs on foraging ecology of free-ranging herbivores is inadequately understood. To investigate the effects of CTs under natural savanna conditions, we pre-dosed groups of goats with polyethylene glycol (PEG, a CT-neutralising chemical), CT powder or water before observing their foraging behaviour. While accounting for the effects of season and time of the day, we tested the hypothesis that herbivores forage in ways that reduce the intake rate (g DM per minute) of CTs. We expected pre-dosing goats with CTs to reduce CT intake rates by (1) consuming diets low in CTs, (2) reducing bite rates, (3) increasing the number of foraging bouts, or (4) reducing the length of foraging bouts. Lastly, (5) we expected CT to have no influence on the number of dietary forage species. In both wet and dry seasons, pre-dosing goats with CTs resulted in lower CT consumption rates compared to PEG goats which seemed relieved from the stress associated with CT consumption. During the dry season, the number of dietary forage species was similar across treatments, although goats that were dosed with PEG significantly increased this number in the wet season. Dosing goats with PEG increased the number and length of browsing bouts compared to goats from the other treatments. Pre-loading goats with PEG also tended to increase bite rates on browse forages, which contributed to increased consumption rates of CTs. Based on the behavioural adjustments made by goats in this study, we concluded that herbivores under natural conditions foraged in ways that reduced CT consumption.

Keywords: bite rate, intake rate, feeding bout, polyethylene glycol, herbivore

Condensed tannins increase the amount of time animals spend grazing

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Tannin concentrations fluctuate spatially and temporally within and among plant species, with consequences for forage quality of herbivores. The extent to which these fluctuations influence foraging activities of goats is not fully understood. While accounting for the effects of the time of day and season, we tested the hypothesis that goats exposed to high levels of condensed tannins (i) spend less of their foraging time browsing, (ii) spend more time grazing, and (iii) reduce their total foraging time, especially during the dry season when grasses dry out and deciduous trees lose leaves. We orally dosed 15 goats with (i) 20 g of condensed tannins extract dissolved in 50 ml of water (high tannin exposure), another 15 goats (ii) with 20 g of polyethylene glycol dissolved in 50 ml of water, which neutralizes the effects of tannins (low tannin exposure), and the last group of 15 goats (iii) with 50 ml of water (control). We recorded the time spent on grazing, browsing and these two activities together (i.e., foraging) for 30 days in the dry and wet season. As expected, dosing goats with condensed tannins reduced their browsing time and increased the time spent grazing. Goats dosed with polyethylene glycol increased their browsing time and lowered their time spent grazing. Animals dosed with polyethylene glycol foraged for longer than other treatment groups in the dry season, whereas the goats dosed with condensed tannins increased their foraging time in the wet season. Overall, all treatment groups spent a similar amount of time foraging, indicating an instinctive drive by goats to maintain high total foraging time while avoiding over ingestion of tannin-rich forages. We concluded that tannins did not suppress total foraging time for free-ranging goats. Instead, they influenced the amount of time animals spent either grazing on herbaceous plants or browsing on woody plants.

Keywords: feeding behaviour, herbivore, polyethylene glycol, foraging

Insect predation on *Dichrostachys cinerea* (Sickle bush) in Limpopo Thornveld

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Sporadic die-out of *Dichrostachys cinerea* populations has been noted throughout the Limpopo Province. While various theories exist why population crashes of this specific species occur, it was never thoroughly investigated. A study was conducted at the Syferkuil Experimental Farm, Polokwane (Pietersburg Plateau False Thornveld), to identify species specific insect predators and determine their effects on *D. cinerea.* One hundred *D. cinerea* trees were randomly selected at a site that appeared infested with stem-boring insects. Each randomly selected tree was inspected for insect infestation. Stems were cut open to determine if predator insects were present and damage to trees quantified. Sixty nine percent of *D. cinerea* plants inspected were infested. Damage occurred to both old (dry wood; 58%) and green stems (42%). In total 13% of the plants inspected were dead, 56% damaged and 31% undamaged. On average, 10.9 holes were counted stem^{-1} on young growth (green stems and branches), while 11.2 were counted on dry growth (woody stems and branches). The Slender-snouted weevil *(Balaninus valens)* occurred, tunnelling in fresh stems of *D. cinerea* as a primary predatory wood-borer, damaging its vascular system. *Bantua spp,* as secondary predatory insects, increased holes and tunnels created by *Balaninus valens,* thereby increasing damage to the host plant. It appeared as if the tunnels are used as refuge while these insects feed on *D. cinerea* leaves. Minor infestations by *Phryneta spinator* (fig-stem borer) larvae were also recorded, while other insects that utilize leaves (*Homoeoceris auriculatus, Oxyrachis spp* and *Harmonia virgintiduomaculata*) and bark (*Himatismus* spp.) also occurred in the widened tunnels, where they were preyed on by ants (*Gyponyx signifier*). Termites (*Neotermes spp.*) appeared as a tertiary infestation, attacking dead wood that occurred due to stem borer damage. Insect damage to plants varied from a few small holes visible in stems and branches (new infestation) to a top-kill with weak coppice regrowth (old infestation).

Keywords: *Balaninus valens*, *Bantua spp*, *Phryneta spinator*, stem borers, tree mortality

The effects of associated pod quality on seed recovery and germination of *Dichrostachys cinerea* and *Acacia tortilis* fed ruminants

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Pods of different plant species form an important part of the diet of livestock during the dry season due to their high nutritional value compared to grasses. Therefore, herbivores browsing pods of certain woody plants may disperse intact seeds that can potentially germinate. The quality of associated diet such as pod chemistry (i.e. protein and tannin concentration) is one of the most important determinants of success of livestock faecal seed dispersal. The objective of this study was to determine the effects of associated pods quality (i.e. nutrients and tannins composition of *Dichrostachys cinerea* and *Acacia tortilis* pods) on seed recovery and germination of *D. cinerea* and *A. tortilis* fed to goats and sheep. Both animal species were offered *D. cinerea* and *A. tortilis* pods at 2.5% of their body mass. Seed recovery for *A. tortilis* (38.37±1.79%) was significantly higher than for *D. cinerea* (12.37±1.02%). There was no significant difference found between animal species ($p>.189$). There was no significant difference in germination found between the seeds that passed through the gut of animals ($p>.227$). *A. tortilis* and *D. cinerea* seeds that passed through the gut of goats and sheep had a significantly higher germination percentage than the seeds that had not passed through the gastro-intestinal tract of animals. The results suggest that passage through the gut and associated pod quality may facilitate seed dispersal and thereby germination of woody plant species.

Keywords: associated diet quality, germination percentage, seed dispersal, seed viability, tannins, woody plant encroachment

Impacts of high density of small farm dams on evapotranspiration and catchment water balance

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Small farm dams in semi-arid landscapes are thought to significantly contribute to evaporation particularly if the dam density is high, although research in this area is limited. Water lost through small dams is due to their high surface to volume ratio (which equates to shallow depths and a warmer water body) and seepage losses. Evaporation estimates for small dams in India, Zimbabwe and Australia are in the range of 20-97% with values as high as 4-10 mm per day, which forms part of the total evapotranspiration losses from the landscape. Evapotranspiration (ET) estimates for landscapes in South Africa are about 90% of the Mean Annual Precipitation (MAP). This paper presents comparisons of actual evapotranspiration (ET) derived from MODIS-ET (MOD16) in selected catchments in the Eastern Cape and KwaZulu-Natal regions of South Africa, where grassland is one of the two major biomes. The research presented here is part of a Water Research Commission funded project on rehabilitating grasslands after eradication of alien invasive trees in the Eastern Cape. The project aims to estimate the evapotranspiration rates between different land cover types and evaluate the contribution of different cover types to the catchment water balance. This research explores the effect of land use on ET values for comparable areas with similar mean annual rainfall (one-way ANOVA) in the catchments of the Mzimvubu (p=.58) and Mzimkhulu (p=.71) rivers. Polygons covering approximately 5 x 5 km areas (or 9 pixels of MAP provided by Schulze 2004 dataset) were chosen in similar quaternaries but with different dominant land covers for two different secondary catchments (T35 and T51). The four different land cover types were areas with a high density of small dams, wetlands, grasslands, and plantations. Results indicate that areas with plantations have highest average annual MODIS ET values irrespective of wet or dry year (2001 versus 2010), while grasslands had the lowest average values, although significance was not consistent in the two catchments (Kruskall-Wallis one-way ANOVA by ranks). Small dams and wetlands do not cover the full area of the nine pixels and they are potentially having an indirect effect on the MODIS ET values through the seepage of water to bordering vegetation. These results have implications for water allocation, for stock watering, production from natural vegetation, water balance, and decisions at a higher level for catchment management and policy.

Keywords: catchment water balance, small farm dams, evapotranspiration, land cover

Reciprocal transplanting demonstrates local adaptation in *Acacia karroo* populations from Zululand, South Africa

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Acacia karroo (alternative name *Vachellia karroo*) is the most widespread tree in southern Africa, and exhibits wide morphological variation. At Richards Bay (RB) and Empangeni (EMP), individual trees grow to ca. 40 m and 5 m, respectively. We sought to determine whether local adaptation was occurring in two neighbouring *A. karroo* populations in South Africa by examining seedling and sapling performance of genotypes grown in reciprocal environments. We collected seeds from the two populations, germinated them in a greenhouse and reciprocally transplanted the seedlings to two field sites that were about 30 km apart, RB and EMP. We measured total height, stem diameter, thorn length, leaf area, leaf weight, plant aboveground dry weight and specific leaf area (SLA) after 4 months and 16 months for greenhouse and field grown plants, respectively. For greenhouse-grown plants, root dry weight was also measured. Greenhouse-grown plants showed lower root allocation for RB than EMP (0.20±0.01 vs 0.60±0.02). Phenotypes of seedlings and saplings from the two populations maintained their differences in the greenhouse and in the field. At RB, plants grew to 330±54 and 176±31 mm for RB and EMP genotypes, respectively. At EMP, plants attained heights of 1 386±62 and 946±72 mm for the RB and EMP populations, respectively. Aboveground biomass of RB plants was also greater than that of EMP plants both at RB (8.1±1.7 vs 0.8±0.2 g) and at EMP (371.2±39.3 vs 78.2±14.8 g). Thorn size showed a similar pattern of greater length for RB than EMP plants while SLA was similar between the populations. We found significant genotype-by-environment interactions for leaf area and leaf weight - two of the seven performance traits measured in *A. karroo* from the two populations for reciprocally-transplanted plants in the field. Consistency of morphological characters measured within populations indicates that differences between populations may have a genetic origin, which suggests local adaptation. We posit that the differentiation that has occurred over such a short distance is due to differences in soil types.

Keywords: Empangeni, local adaptation, morphological differentiation, phenotypes, Richards Bay, reciprocal transplant

Ordination of plant communities in the Nooitgedacht section of Loskop Dam Nature Reserve

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Spatial and temporal interaction analyses that look at plant communities and the environmental variables affecting such communities assist ecologists and reserve managers in understanding and managing the flora on reserves and in protected areas. In this study we investigated the effect of independent environmental variables, altitude, trampling, soil type, erosion and slope on the seven plant communities identified for the Nooitgedacht section of the Loskop Dam Nature Reserve. Using a Constrained Correspondence Analysis based on Chi-squared distances, we performed weighted linear mapping to generate ordination graphs for interrogation. Interpretation of combined ordination results for the various plant communities indicated a strong positive association between erosion and soil type, and weak positive associations between altitude and trampling, trampling and soil type, and trampling and erosion. A strong negative association was observed between altitude and slope. Interestingly, no associations were observed for altitude and soil type, altitude and erosion, soil type and slope, and for erosion and slope. Soil type, slope and altitude were the primary environmental variables influencing the various plant communities.

Keywords: Constrained Correspondence Analysis, ordination, plant communities, environmental variables, Loskop Dam Nature Reserve

Impacts of fire on resource utilization of grazers and browsers in the Waterberg Plateau Park, central Namibia

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Fire is regarded as an important driver shaping savannas, including improving forage quality. The perceived importance of fire to the management and conservation of Waterberg ecosystem has driven this research to focus on the effects of fire on herbivore movements and their forage resources on the Waterberg Plateau Park. This study aimed to determine how important fire history is in influencing resource use by different species of herbivores in arid woodland in Central Namibia. The study was done in 4 fire blocks with different fire histories. A: burnt four months before the study through lightning, B, C and D burnt 2, 14 and 24 years before the study respectively. Data were collected along 6 randomly selected 200 m transects in each fire treatment. Every 20 m, a 4 x 8 m quadrat was laid out. Within each quadrat, the dung of species was identified and counted. At every corner of the quadrat each nearest shrub and grass was identified and its utilization recorded. Roan and sable were combined in the analysis due to difficulties in distinguishing between their dung. A Kruskal-Wallis analysis was conducted, followed by *post hoc* comparisons to determine differences in resource utilisation.

Ten species of mammals were recorded altogether. A significantly higher abundance of mammals occurred in A, than in the other blocks. Five of the mammal species that utilized the four blocks were browsers, mainly giraffe, kudu, eland, duiker and steenbok and five were grazers namely sable, roan, scrub hare, warthog, oryx and buffalo. Of these eland, giraffe, sable/roan, warthog and oryx utilized a significantly more than other blocks. Buffalo utilization in A (slightly higher dung counts) might have been an underestimation, since buffalo dung was observed to be removed by dung beetles overnight. A significantly higher utilization of both grass and woody species occurred in A than in other blocks. Generally, browsers preferred *Acacia ataxacantha*, *Bauhinia petersiana, Combretum collinum, Grewia flavescens* and *Philenoptera nelsii*, particularly in the recently burnt area. Grazers preferred *Brachiaria nigropedata* and *Digitaria seriata* in A, B and D. In the recently burnt area, typically unpalatable grasses such as *Aristida stipitata* and *Eragrostis jeffreysii* were also utilized. Fire was shown to be important in providing good quality forage to mammal herbivores, particularly in a park which restricts seasonal animal movements. Fire is important in influencing the utilisation of available resources by mammals, and the inclusion of fire-herbivore interactions into ecological and conservation studies practices of fire systems will aid in better understanding and managing of conservation areas.

Keywords: fire, herbivores, forage, plants utilization, dung counts, fire histories

The movements of Cape Buffalo (*Syncerus caffer)* in a confined park, Waterberg Plateau Park, in relation to fire history

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The Waterberg Plateau Park, Namibia, is a fire-shaped Kalahari woodland at the arid end of the scale, with fires occurring at an interval of five to 20 years, depending upon the fire block, since the 1970s when the park was proclaimed. This pattern has developed mostly unintentionally as a result of lightning fires, accidental fires and a brief period of fire management. Recent policy has beento prevent any unplanned fire (lightning or accidental) to burn beyond the block (around 2000 ha in most cases) from which it initiated, by means of fire breaks and back burns. The park is approximately 40 000 ha in size, and thus represents a confined area for game which normally migrates seasonally in open areas. Fire and the associated regeneration of palatable grasses, herbs and shrubs can have an impact on large ungulate grazing practices. In order to understand the impacts of fire on Cape Buffalo (*Syncerus caffer*), four females were outfitted with GPS collars in September 2013, just prior to three lightning fires on the plateau – these fires occurred within the home range of two herds with GPS collared females. Although both herds utilized to some degree burned areas during the dry season (25 October – 22 November 2013), utilization of the burned area increased dramatically with the onset of the rainy season (23 November 2013 – 30 April 2014). For herd 1 the fire occurred within the core of their home range and served to concentrate their movements during the rainy season. Herd two appears to have nearly doubled their home range to include a distant burned patch, but only after rains began.

Keywords: GPS collars; home ranges; regeneration; palatable

Fate of rhino survivors in South Africa: A critical evaluation of the current literature on the conservation of the South African rhinoceros

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With an annual loss and a conservation management cost worth $70-213 billion and $135 billion respectively, it is clear that wildlife trafficking have thrown off billions of dollars that should have been used to develop economies. South Africa, which has a success record in conserving its two extant rhinoceros species *Ceratotherium simum* and *Diceros bicornis* with current populations of 20 405 and 4 500 respectively, is now faced with poaching where on an average it loses three of its rhino daily. Even though this trend still looks sustainable since the growth rate exceeds the death rate, should these current poaching rates continue to escalate unchecked a point will be reached where the rhino population will start declining down to extinction. Presently a number of governmental, non-governmental and private organisations are putting up strategies to put a halt to the rise in the rhino poaching rate, this work discuss the past and present conservation strategies and make suggestion on how it can improve rhino conservation.

Keywords: Rhinoceros, conservation

Plenary

Chair: Michelle Tedder

Reflections on land use in KwaZulu-Natal

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This presentation reflects changes in land use in KwaZulu-Natal over a period of 58 years during which the author worked for the Department of Agriculture in contrasting fields of responsibility.

A parliamentary resolution was passed on the 4th May 1934, after the devestating drought of the previous season, to investigate the problems causing the country to 'dry up'. The town of Estcourt was chosen as the site for a pilot national reclamation and conservation scheme, and became known as the Drakensberg Conservation Area (DCA). A great deal of conservation and extension work was conducted in the area.

It was the Midlands Region of KwaZulu-Natal, however, that was to experience the greatest change in land use. Initially an area well-known for its beef and dairy farming, it changed rapidly to extensive timber farming with pine, eucalyptus and poplar plantations being planted, later followed by sugar cane. At the same time there was a rapid deterioration in the grasslands with the T*hemeda triandra* dominated grassland being replaced by ngongoni grass (*Aristida junciformis*) with low grazing value.

In the Valley Bushveld of the Upper Thukela River, severe degradation occurred, probably going back to pre-colonial times. Later, colonial farmers used the “thornveld farms”, for both labour farms and winter grazing farms. Overgrazing with the resultant extensive erosion became an enormous problem with more than 18% of the area eroded down to bedrock.

In the 1800s both tribal people and colonists ploughed large areas of shallow duplex soils which, combined with unreliable rainfall, resulted in frequent crop faliures. These ‘old lands” remain as a scar today, with even the grazing being of poor quality., dominated by thatchgrass *Hyparhennia hirta* with low grazing value except for a few weeks after burning.

The threat of bush encroachment was already noted by Edwards in 1967, who concluded that 60% of the encroachment had occurred since 1900. *Acacia natalitia/A. nilotica* encroached into overgrazed, eroded and rocky dolerite areas and is seen to be advancing to the foothills of the Highland Sourveld. Various strategies have arisen to face these problems. The National Grazing Strategy was developed to take awareness and management courses to twenty different centres in the province. This had excellent impact in some areas where good support staff was available. A Cultivated Land Programme was also adopted to promote soil conservation in cultivated land. Again, where enthusiastic staff was available this proved of great value in reducing soil loss.

The Bioresource Programme was instituted to map ecological units which would supply information on climate, soil, vegetation, crop production potential and other information. 600 Bioresource Units (BRUs) were mapped and from these 23 vegetation types, referred to as Bioresource Groups (BRGs), resulted. The latter are now being revised with 41 BRGs, each named for the vegetation type it includes, being mapped with inventories that have details on the information used to map the BRUs.

Carbon cycling in dryland grasslands of the future: biotic and abiotic impact on litter decomposition

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Drylands are an important component of the global carbon cycle, accounting for approximately 30% of terrestrial net primary production and 20% of global soil organic carbon pools. Our understanding of dryland carbon cycling is limited, however, as factors controlling dryland carbon cycling differ strongly from controlling factors in relatively well-studied mesic systems. These differences are particularly apparent for litter decomposition, where abiotic processes appear to be of unique importance in drylands. Soil-litter mixing, photodegradation, and thermal degradation, individually and in combination, can influence carbon cycling processes. Furthermore, spatial heterogeneity of vegetation, which is much more pronounced in drylands than mesic systems, is an important influence on surface litter decomposition in drylands. This vegetative heterogeneity strongly influences decomposition by modifying the strength of abiotic drivers and by altering among-patch connectivity and transport patterns. This presentation will overview recent advances in understanding the relative contributions of abiotic and biotic processes to litter decomposition in drylands, with an emphasis on disentangling the interactions between photodegradation and soil-litter mixing. Photodegradation can accelerate decomposition, although this positive influence of solar radiation can be muted or negated by soil-litter mixing. The relative influence of photodegradation and soil-litter mixing varies with time and spatial position relative to spatially-heterogeneous vegetation. An enhanced understanding of the mechanistic controls over litter decomposition is crucial to improving our predictive capacity for carbon cycling processes in drylands. This is particularly important as we move toward the drier, warmer conditions projected for drylands of the future.

Keywords: decomposition, litter, dryland, abiotic, photodegradation, thermal degradation, soil litter; mixing, solar radiation, UV

A conceptual basis for rangeland management

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Experimental research has demonstrated that complex rotational grazing systems offer no clear advantages over continuous grazing systems. An examination of the conceptual basis for optimal rangeland management demonstrates that the supposed theoretical superiority of rotational grazing systems over continuous grazing systems is lacking. From a rangeland productivity perspective, grazing all paddocks across the ranch every growing season with only intraseasonal recovery periods, is unlikely to enable sufficient recovery of nutrients lost in grazed tissue and optimal root development, especially if the recovery period falls out of suitable periods for growth and nutrient uptake. Periodic grazing interspersed with recovery periods during the growing season may allow grassland to mature beyond the optimal stage for maximum growth rates, impacting on productivity and forage quality (lacks facilitation of short, actively growing, high quality grazing). Grazing all available paddocks during the growing season may also reduce forage quality for the dormant season as livestock remove the high quality components leaving less digestible forage for the dormant season. Optimal grazing management should set aside a significant proportion of the ranch as a reserve of ungrazed forage for the dormant season. Such approaches also focus grazing intensity on the grazed portion of the ranch, which enable livestock to maintain short, high quality grassland over the growing season. Finally, intensive rotational grazing systems fall short of conceptual correctness by forcing livestock to move in rotation across the ranch in small, restrictive paddocks, which eliminates the ability of livestock to forage adaptively to functional heterogeneity of resources distributed across larger landscapes. We discuss how these concepts can be incorporated into grazing management.

Keywords: rotational grazing, rotational resting, grass productivity, grazing facilitation, functional heterogeneity, stocking rate

Illustration 7: AgriHandbook

Session 11 & 12: HRM Special Session

Chair: Ian Little

A farmer's perspective

Robert Rawlins

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I bought my farm in 1993. It is situated in the Eastern Cape, near the town of Cedarville. The carrying capacity is 2.5 ha per LSU. The farm is 1 070 ha with 150 ha of ploughed lands, the rest being indigenous grassland comprised mostly of red grass (*Themeda triandra*). I used to burn a third of my farm every year until 1999 and then followed the grazing pattern that was recommended by Cedara. I noticed during that period that the camps that were burnt did not have a similar carrying capacity as the camps that were not burnt.

This piqued my interest. We only used to burn after we had 25 mm of rain and this was sometimes as late as the end of October. The grassland birds had already started nesting and I could not handle burning the eggs, chicks and sometimes the adults.

I now have a 15 camp system, as I started following a high stocking rate and quick rotation form of grazing. I divided my bigger camps along a contour line. The animals remained in a camp for a maximum of 7 days, depending on the size of the camp.

I noticed the following since starting this grazing regime:

- I can carry more stock per hectare;
- More birds and different species of birds on the farm;
- More earthworm castings all over my farm;
- Less algae in my water;
- Legume plants in the veld;
- An increase in plant diversity (palatable and unpalatable);
- Quicker recovery rate after grazing
- More resilience during times of drought/dry spells;
- Grass starts growing quicker after the dormant season;
- Grass remains productive later in the season;
- I only dip my cattle once a year as opposed to several times;
- I use 2/3 less summer licks;
- Clearer/cleaner run-off on my farm;
- Increased number of and different types of dung beetles.

Conserving Afromontane grasslands through fire and grazing in remnant ecological networks in a timber production mosaic

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Afromontane grasslands have been shaped by fire and grazing. In South Africa, these grasslands occur extensively in protected areas (PAs), but also in large-scale ecological networks (ENs). ENs are landscape-scale, remnant, set-aside tracts of land composed of corridors and nodes of mostly indigenous grassland among exotic timber plantations. Their ability to offset the adverse effect of plantation forestry on biodiversity depends on certain management practices. The aim here is to determine how the plant communities of Afromontane grasslands are affected by time since last fire and grazing intensity.

We identified areas that differed in 1) time since last fire (recently-burned: burned <12 months ago vs. unburned: burned > 12 months ago), and 2) grazing intensity (light grazing in the PA, and moderate or heavy grazing in an adjacent EN). After accounting for the effect of abiotic variables, we found that plant species richness was greater in recently-burned than in unburned areas, which indicates a natural decline in richness with age. We only observed a response in plant species richness to grazing intensity in unburned grassland, not in recently-burned areas. In these unburned areas, plant species richness increased from lightly to moderately-grazed grassland, and decreased from moderately to heavily-grazed grassland. In addition, heavy grazing caused a significant effect on plant species composition.

We recommend that burning and grazing should be part of grassland management, but that grazing intensity should be controlled to prevent permanent loss of plant species due to heavy grazing. Although this study was conducted in Afromontane grassland in South Africa, the findings have far-reaching consequences for the rest of the African continent where overgrazing is a major cause of land degradation.

Response of vegetation, soil, animals and water cycle to different management regimes: Victoria Falls area, Zimbabwe

Mike J S Peel

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The levels of extreme poverty that are endemic to the drylands of Africa are well documented. There is however tremendous potential for development in these drylands. The overall aim of this programme will be to improve livelihoods of and increase opportunities for development for poor people living in the drylands of Eastern and Southern Africa. This will be achieved by reviewing and analysing a selection of successes in land rehabilitation and natural resource management, and using the knowledge obtained to stimulate the significant up-scaling of successful practice.

The holistic resource management (HRM) philosophy has caused controversy in rangeland science circles for over forty years. HRM has had a major influence on governments and ranchers globally, yet with contradictory evidence that some of the theories actually work. The Agricultural Research Council's Animal Production Institute (ARC-API) plan to thoroughly test the claims of the holistic management approach by comparing the state of Dimbangombe (Africa Centre for Holistic Management – ACHM) to neighbouring rangelands with different approaches to management.

By training people in ecological monitoring activities, the recipients of such training can in turn train others and using the knowledge thus generated to implement effective management regimes the ultimate goal of which is to alleviate poverty in the drylands of Africa.

(In)compatibility of scientific and holistic resource management

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Scientific research is based on empirical evidence acquired from experimentation, measurement and observation, underpinned by principles of replication, repeatability and statistical robustness. Research outcomes are subjected to peer review and published. Scientific management recommendations are based on credible, published science. Grazing system research at a farm scale is difficult, and as a consequence resource management research is focused on components. The resultant scientific resource management (SRM) recommendations incorporate principles and results from local and international literature. In South Africa, SRM recommendations focus on animal numbers, type and movement, recognizing fire as an important variable. Recommendations vary regionally, and the incidence and role of fire is related to rainfall. Holistic Resource Management (HRM) is an approach focused on animal numbers, and with the main emphasis placed on animal movement. Fire is regarded as undesirable and unnecessary. Scientific results are generally not regarded as important and there is frequently an impatience with the perceived slow pace of science. Scientists usually dispute the claimed advantages of the HRM approach, have difficulty measuring differences in grazing system performance at a farm or landscape scale and raise questions about sustainability. An analysis of similarities and differences between SRM and HRM reveals more similarities than realized, explains some differences, but also highlights some important concerns, including the impacts of soil disturbance in sensitive environments, and the impacts of withholding fire in high rainfall environments.

Grass, animals and people: A global dilemma

Peter Ardington

. Veterinarian and farmer, Mandeni, South Africa. Email: marding1@iafrica.com

The historic (pre-pastoral) and present states South Africa's grasslands are briefly reviewed. These include accounts of massive, migrating herds on grasslands in South Africa in the 19th century, elimination by hunting and the ecosystem disruptions caused by livestock farming, fencing, urbanization, roads, mines, dams and cities. The heavy research emphasis over the past six decades on non migratory grazing strategies with light stocking densities and regular use of fire is contrasted with the paucity of research on higher density grazing strategies, higher stocking rates, shorter grazing periods and less use of fire. The necessity for more research investigating a wide variety of different grazing and burning strategies being practiced currently is emphasized. The investigations should include not only productivity and biodiversity issues but also soil erosion dynamics under different management strategies.

Managing the ecological role of fire in mesic grasslands

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Fire is a very controversial issue in grassland ecology, primarily due to a shortage of sound long-term data and a high degree of complexity associated with varying responses between ecosystems and management co-variables, especially grazing. However, fire remains one of the major tools and responsibilities for grasslands management. However, misguided application of fire (including the no-burn scenario) has lead to degradation of some grasslands from a biodiversity, ecosystem services and animal production perspective.

The purpose of this talk is to present a brief overview of the ecology of fire in grasslands, aiming to provide a foundation for the discussions on holistic grassland management. This review of published and anecdotal evidence regarding the role of fire in grasslands emerged from the development of the Biodiversity Friendly Grazing and Burning Guidelines (SANBI 2014); and the management guidelines represent the synthesised viewpoints of many experienced grassland ecologists, both scientists and farmers.

Holistic management

Wayne Knight

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Holistic Management is challenging to define. It is part theory, part philosophy, part practice and part way of life. By its very nature Holistic Management successfully attempts to embrace complexity in the non-linear nature of the world; the interwoven fabric of nature and the multi-faceted world of business and the complexity of human relationships. It is much more than a grazing system.

The theory lies in wild herd migrations being the architects and basis for healthy grassland biomes.

The philosophy centres on the realization that all interactions relate to one another – change one thing and everything else changes – holism.

The practice, comprising knowledge of ecosystem processes (theory), understanding the interconnectedness of life and the impact of our management decisions (the philosophy), within planning and monitoring processes, that will lead us towards a life and environments that we aspire to achieve (the practice).

The panel discussion proposed is aimed at grass lands. I have 20 years of experience in the practice of holistic management on the Springbok flats. This area was certainly a grass land, although it is no longer classified as such. Holistic management theory has a clear and unconventional explanation for the reasons this change happened. This theory is extremely important in our understanding of ecosystem management. This theory offers explanations for why we are facing ongoing ecological degradation.

Holistic Management offers insights, planning tools and support in changing practices and understanding processes that grasslands need for health and resilience.

I offer ecological data, photographs and knowledge from my many mistakes, to support my talk.

Savory or Unsavory: The Application of Holistic Resource Management in Mesic Grasslands of KwaZulu-Natal

Cobus (J) O Botha[1] and Greg Martindale[2]*

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In recent years many farmers in Southern Africa have converted to the doctrine of Holistic Resource Management. This management paradigm has also gained support in the mesic grasslands of KwaZulu-Natal. HRM is sold to land users as a panacea for all problems relating to desertification and rangeland degradation while in truth the main reason for adoption is the hope of escaping the cost-price squeeze that has been hamstringing the red meat industry for a number of years together with the claims made by HRM practitioners of nearly doubling stocking rates while improving the grass sward and simultaneously lowering input costs. It promises a balanced life, through happy and healthy people and country with enough money for all desires. It provides for a decision making framework whereby goals are set and participants are encouraged to manage towards the achievement of these goals by using a set of predetermined tools. The tools are based on the philosophy of Alan Savory where 'herd effects' of concentrated livestock grazing, including the impacts of hooves on soil surface and uniform use of plants are positive tools for restoration, whereas lack of disturbance could constitute 'overrest' that would result in declining soil conditions and undesirable competition among plant species.

The purpose of this study is to evaluate management tools as proposed by proponents of HRM at the hand of conventional sound rangeland and biodiversity management principles for mesic grasslands. Some case studies from the Kokstad and Midlands areas will be presented to illustrate differences between the approaches. It is concluded that while evidence suggests that HRM generally has a deleterious impact on mesic grasslands, its reported improved successes probably stem from better management effectiveness, infrastructural investment and closer attention to detail by the land user.

Keywords: Holistic Resource Management, mesic grasslands, sound principles

A meta-analysis: Does short duration grazing work in the grasslands?

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The time-controlled/forage offtake element of Holistic Management® (called Holistic Planned Grazing (HPG)) is the main feature of the adaptive management within HM, and is testable. Many studies testing short duration grazing are completely synonymous with HPG. Allan Savory claims that most rangelands are desertified, and that to reverse desertification and climate change, our main tool is livestock as a proxy for the apparently non-selective grazing/browsing of former herds bunched by predators. Animals contribute nutrients while trampling apparently promotes grass germination, biological decay of grasses and increased soil infiltration.

Here we conduct a meta-analysis using a quality effects model to determine whether short duration grazing (SDG) results in increased production, profit, biodiversity, and soil 'health' compared to other grazing systems at the same stocking rate. On balance studies indicated that SDG had a neutral effect on plant and animal production. Forest plots of actual data showed that there were no differences between continuous and SDG in terms of plant basal cover (p=0.36) but animal condition was reduced ($kg.head^{-1}.d^{-1}$, p=.01, Fig. 1A, B). There was however, a relative increase in plant biomass production ($kg.ha^{-1}$; p=.0001) and animal production ($kg.ha^{-1}$; p=.0001, Fig. 1C, D). Stocking rate emerged as the most important factor determining plant and animal production, regardless of grazing system. Short duration grazing resulted in increased animal production to the detriment of animal condition with no improvement in plant basal cover. There were too few studies on biodiversity, soil aspects or profit to conduct analyses. These aspects as well as trampling and grazing selection within SDG remain areas for research.

Key words: time-controlled, animal production, plant production, biodiversity, soil health

See Figure 1 on the next page.

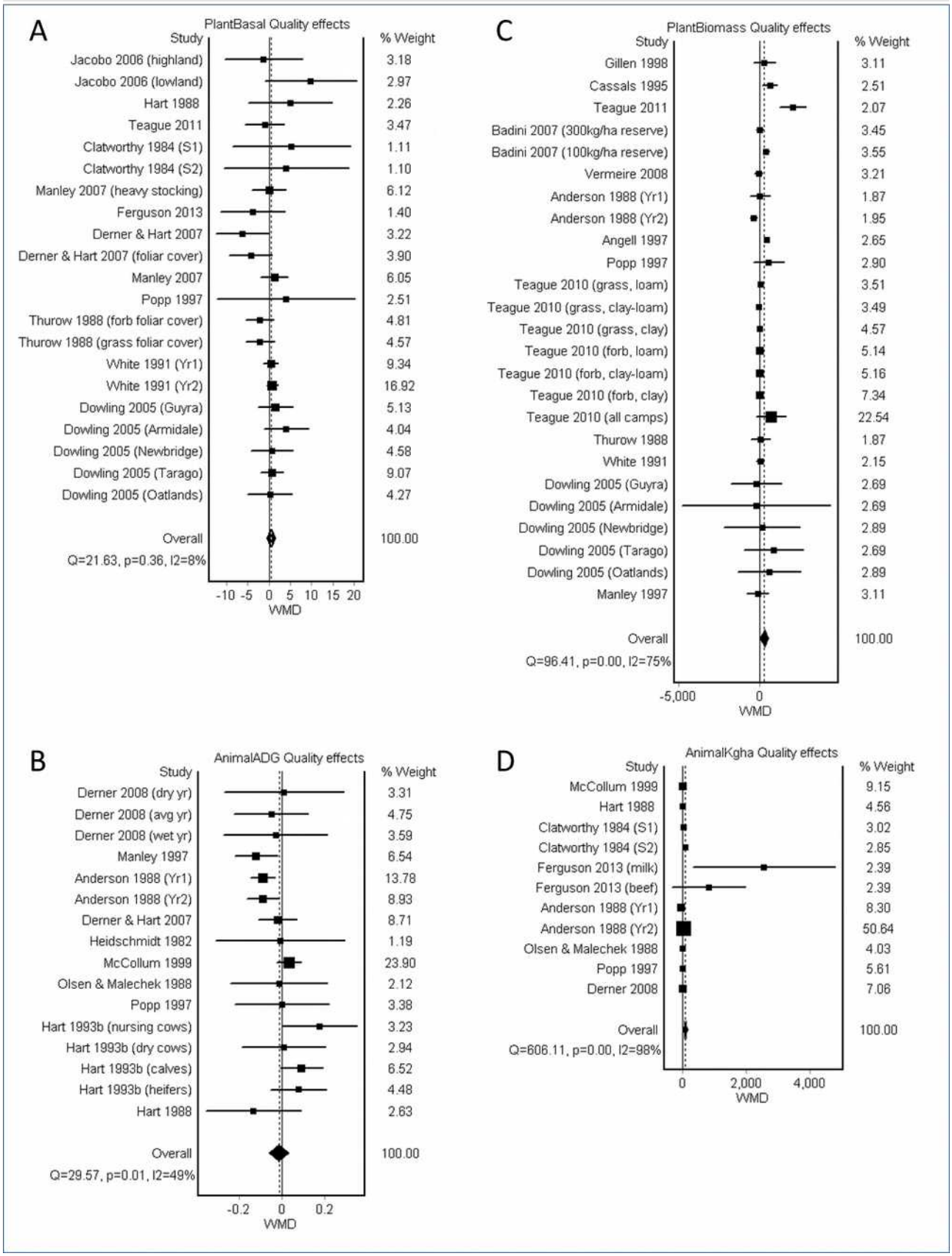

Figure 1: Forest plots of weighted mean differences (WMD) in plant basal cover (A), animal average daily gain (B), plant biomass (C) and animal production (D) using the quality effects model. Studies >0 and <0 showed a positive or negative effect of short duration grazing compared to continuous grazing, respectively. Weight shows the percentage weight that the study was given based on the quality score.

Session 13 & 14: WWF workshop

Chair: Augustine Morkel

Conservation Fundraising Workshop

Augustine Morkel

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Introduction

WWF is one of the leading environmental conservation organisations globally.

WWF South Africa has positioned itself to contribute to the South Africa Sustainable Development agenda through its mission of securing priority ecological assets, working to ensure ecological systems and process underpin social and economic well-being and address the risks and opportunities posed by climate change. WWF SA has a long history of being a reactive conservation funding organisation that rose funding and funded other conservation organisations work.

In 2012, WWF repositioned itself to be a proactive environmental conservation organisation, which through a broad but focussed strategy, co creates environmental outcomes solutions that are catalytic and have impact at scale. However, there are remnants of the reactive nature of the WWF business model. This takes the form of the Associated Trusts (WWF Nedbank Green Trust, Table Mountain Fund, Leslie Hill Succulent Karoo Trust, National Parks Trust, and the Southern African Wildlife College Trust) where WWF acts at the Management Agency for these Trusts. The oldest Trust started in 1986 (NPT) and to date the Associated Trust are estimated to have invested >R400 million, over 29 years, for conservation in South Africa.

In recent years, WWF has noted that the quality of the applications for funding has deteriorated, for various reasons. This deterioration has resulted in either a poor quality of applications being considered (and therefore rejected on the basis of process not being followed or superiority of the few well written projects) which results in the Trusts having a poor pool to choose from. Further, possibly very good projects that can catalyse real change are often not considered as they are poorly written.

This workshop is the first of an annual campaign to build the capacity of applicants to Trusts to write better proposals providing the Trust with great project gems to pick from to ensure that funding is directed to well thought through and planned projects to be invested in. In so doing, the project portfolios of the Trusts then become robust as a portfolio of projects that are having impact at scale…rather than just impact.

Workshop Programme

1. Introduction to the world of fundraising (15 min):
   a) Funding sources
   b) Funding strategy
   c) Impact at scale
   d) Proposition development
   e) Applying
2. Workshop Exercise (35 min): We will review a few projects looking at the quality of the projects and why they were successful through Q&A.
3. Reflection (10 min): The workshop will be closed out with a round of reflection and closing comments.

The workshop is open to all participants at the GSSA 2015 Conference.

Session 15: Pasture posters viewing

Evaluation of tillage effects on soil quality of kikuyu-ryegrass pastures

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Agricultural management practices modify soil in one way or another. Poor management practices can lead to soil degradation, while sound management practices can sustain or enhance soil condition. Soil quality describes the ability of soil to function and encompass physical, chemical and biological processes in soil, which are equally important for to maintain a healthy agro-ecosystem. One of the farming practices which usually degrades soil is excessive soil tillage. Although most farmers in the southern Cape region of South Africa have adopted minimum-tillage practices, there are still farmers who till soil regularly. This, amongst other injudicious management practices, has resulted in concerns about kikuyu (*Pennisetum clandestinum*)–ryegrass (*Lolium* spp.) pasture systems in the southern Cape. The aim of this study was to assess tillage effects on soil quality with indexing methods. Pastures were identified throughout the southern Cape and divided into five groups of tillage according to the degree of soil disturbance. The soil management assessment framework (SMAF) and soil quality index for pastures (SQIP) were used to assess the impact of tillage on soil quality. Overall soil quality were assessed along with physical quality, chemical quality and biological quality. Soil physical quality was affected by tillage. Although this was dominantly as a function of the inherent pedological characteristics, the effects were aggravated by tillage. Reduced tillage alleviate compaction of these soils. Tillage did not affect the soil chemical quality, except for slight redistribution of nutrients to a maximum depth of 300 mm. Soil tillage severely affected soil biological quality. Deep tillage resulted in the lowest soil biological quality. Minimum-tillage with a permanent kikuyu-base was the most beneficial management option to maintain soil biological quality. Different indices or assessment tools exist, but because soil quality is site- and land-use specific, any soil quality assessment tool will not necessarily be adequate. The SQIP is an appropriate tool to assess soil quality for pastures in the southern Cape. The SQIP could facilitate adaptive management by using it as a tool to assess soil quality and enhance the understanding of processes affecting soil quality.

Keywords: land degradation, land-use effects on soil, pasture management, soil disturbance, soil health.

The monthly growth rate and total dry matter production of annual ryegrass cultivars in the southern Cape of South Africa

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Annual ryegrass (*Lolium multiflorum*) is a major contributor to fodder-flow programs in pasture based systems for dairy and beef production in the southern Cape of South Africa. Italian (*L. multiflorum* var. *italicum*) and Westerwolds (*L. multiflorum* var. *westerwoldicum*) ryegrass are sown as pure swards, in mixtures and over-sown into existing pastures to provide high quality, palatable forage to animals. The large number of annual ryegrass cultivars commercially available necessitates continuous evaluation to assist producers in selecting the most suitable cultivar based on dry matter (DM) production and the specific requirements within a fodder flow program. The aim of this study was to determine the monthly growth rate and total annual DM production of commercially available annual ryegrass cultivars. The study was carried out on the Outeniqua Research Farm near George in the Western Cape in the form of a small plot cutting trial under irrigation. The trial consisted of a randomised block design with three replicates established in March 2014. Diploid varieties were sown at a seeding rate of 25 kg.ha^{-1} and diploids at 20 kg.ha^{-1} into cultivated soil. Plots were harvested to a height of 50 mm at an approximate interval of 28 days or when the growing points of grasses were being overshadowed to determine DM yield. Treatments were terminated when they failed to recover after a harvest. Plots received 50 kg N.ha^{-1} after each harvest. The mean monthly growth rate varied between 8 and 44 kg DM.ha^{-1}.day^{-1} and was affected by month and cultivar. The annual DM production of the cultivars evaluated was between 3 441 and 7 789 kg DM.ha^{-1}. The Italian ryegrass cultivar Elvis had a similar total annual DM production to Italian ryegrass cultivars Tabu, Enhancer, Supreme Q, Sukari, Udine, Barmultra and Barmultima; the Westerwolds ryegrass cultivars Lolan and Hogan and the intermediate type Super T, but higher than the rest. Cultivars that obtained a high total annual dry matter production remained productive from May to December, while cultivars that only remained productive until October tended to have a lower total annual DM production. The selection of an annual ryegrass cultivar should be based on the specific requirement within a fodder flow program, the distribution of monthly growth rate and the total annual dry matter production .

Keywords: Lolium multiflorum, pasture, cultivar

Germination and seedling establishment of indigenous legumes seeded on degraded mine soils

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Open cast mining operations disturb the structure of many soils and the accompanying vegetation cover, which includes both native grasses and many forb species. Amongst the forbs, indigenous legumes are most important for ensuring some form of nitrogen (N) fixation, which often contributes to a more sustainable vegetation cover. Rehabilitation programmes are imperative to reinstate the productivity of degraded areas. Grass species are, however, easier to establish, whereas native legume species establishment is often restricted by hard seed coats. This study aimed to find the most suitable scarification technique to facilitate the germination and establishment of indigenous native legume species. The efficacy of different scarification treatments on the germination of six indigenous species of herbaceous nitrogen fixing legumes, namely *Indigofera melanadenia*, *Indigofera arrecta*, *Tephrosia elongata*, *Tephrosia longipes*, *Tephrosia cordata* and *Rynchosia adenoides* was compared to the commercial dryland lucerne, *Medicago sativa* which is the most commonly used in rehabilitation seed mixtures. Scarification treatments included: (1) seed soaked in 98% sulphuric acid for 30 minutes, (2) mechanical scarification by removing the seed coat with a nail buffer, (3) seed soaked in boiling water for 15 minutes and (4) non-scarified seed (control). Sterile petri-dishes with moistened filter papers and seeds were placed in a growth chamber at 25 °C, for a germination period of 21 days and time to germination recorded. The first germination was observed after five days of sowing. Acid scarified seeds of *I. arrecta* and *T. longipes* had the highest germination success of 56%. Hot water scarified seeds of *T. cordata* and *T. elongata* had a germination of 76%,and *R. adenoides* had a germination percentage of 72%. For all indigenous species, scarification increased the success of germination. *Medicago sativa* had an expected germination percentage of 62%. Subtropical indigenous legumes have the potential to germinate when subjected to different scarification techniques, hence their potential to establish when seeded after treatment. The preliminary results indicate that indigenous legumes can possibly play an important role in the rehabilitation of vegetation if seeds are scarified. The inclusion of these legumes can ultimately reduce the dependence on costly fertilisers and improve the forage quality of vegetation covers on rehabilitated mine soils.

Keywords: open cast mine, rehabilitation, indigenous legumes, scarification

Evaluation of four cultivated pasture species in different agro-ecological zones of Mpumalanga province

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Mpumalanga is the highest beef producing province in South Africa and contributes to 25% national beef production (DAFF, 2012). It is also true that an enormous fraction of beef produced is mainly on rangeland. However, planted pasture is known to contribute significant amount of fodder during dry season in the province. Thus evaluation of pasture species in different agro-ecological zones of Mpumalanga province was investigated for establishment of pasture for subsistence farmers. Four different varieties of perennial pastures, namely *Cenchrus ciliaris, Eragrostis curvula*, *Cynodon dactylon* and *Digitaria eriantha,* were laid down in a complete randomized block design with three replicates and were evaluated under dryland conditions in two agro-ecological zones of Mpumalanga province to quantify their adaptation and production ability. Mpumalanga Province is divided into three different agro-ecological zones, Highveld, Midveld and Lowveld; the study was carried out on Highveld and Midveld. The Highveld zone was represented by Zamakunzima Farm and Athole Research Farm situated near Piet Retief and Amsterdam Towns in Mkhondo Municipality, respectively. In the Midveld the study was carried out at Fundamlimi Agricultural Training Centre in Thembisile Hani municipality. Grass species were planted between last quarter of January 2014 and first quarter of April 2014.

Table 1: Production of pastures on different localities and different planting season

Localities	**Planting Season**	***Cenchrus ciliaris***	***Cynodon dactylon***	***Eragrostis curvula***	***Digitaria eriantha***
		Biomass(kg/ha)			
Zamakunzima Farm	January 2014	7 000	8 000	6 000	7 000
Fundamlimi Farm	February 2014	12 000	6 000	7 000	7 000
Athole Farm	April 2014	867	2 670	2 096	733

There was no significant different (p=.7) in biomass production between localities that were planted between January and February and biomass production was severely low at locality planted during early April 2014 (p=.037) when compared to the other months.

Keywords: agro-ecological zones, biomass production, cultivated pasture, highveld, midveld

Calibration of a disc pasture meter to estimate the differences in standing forage biomass in an oat (*Avena sativa*) trial in the Roggeveld region with three fertilization treatments: Preliminary results

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The Roggeveld Region in the Northern Cape Province of South Africa encompasses a vast area in the south western corner of the Karoo plateau that extends from Calvinia southward along the Roggeveld Escarpment to the foothills at Matjiesfontein. This region produces some of the finest wool from the Merino sheep which are extensively farmed in the region. The Roggeveld Karoo vegetation has a rather low average grazing capacity potential of only 39 hectares per large stock unit (ha.LSU^{-1}). Land owners and –managers are forced to invest time, money and energy in establishing planted pastures in order to increase the available forage for their livestock in this semi-arid Karoo region. The aim of the study was to determine the differences in the standing forage biomass produced in an oat (*Avena sativa*) trial where three fertilization treatments were applied. The three fertilization treatments applied included a) a compost tea solution only, b) Fertilizer 4:1:1 (39) only, c) and in the last treatment both the Fertilizer 4:1:1 (39) and compost tea solution. The disc pasture meter (DPM) was calibrated during the study to determine whether it will be an applicable assessment tool for current and future estimations of the standing forage biomass in the dryland oat trails in the Roggeveld region. The DPM ensures more rapid assessments of the above ground forage biomass and is a less destructive sampling method compared to the clipping of 1 m^2 quadrants. The successful calibration of the DPM for estimating the above ground forage biomass in oat fields for grazing purposes was a particularly useful result. The coefficient of determination indicates that the disc height accounted for 85.3% of the variation in the standing forage biomass production. From the results obtained the DPM is recommended as a rapid assessment tool for scientist, extension officers, and land users to determine the standing forage biomass production on planted dryland oat fields in the Roggeveld region. From preliminary results the highest forage biomass yield was recorded under the fertilization treatment where both the fertilizer and compost tea solution was applied together. This will be expected due to the benefits gained from both fertilization treatments. The lowest forage biomass yield for the three fertilization treatments was produced under the compost tea solution only treatment. The results indicated that both the compost tea solution and Fertilizer 4:1:1 (39) applied together had a definite positive effect on the standing forage biomass produced. However, to apply both fertilization treatments would not be very applicable in the Roggeveld region. Land users plant additional pastures to increase the carrying capacity of the land and for the land users to apply both the fertilization treatments would not be timely and economically viable. Results from soil analyses are required before a final conclusion can be made on the most beneficial fertilizer to apply.

Keywords: Roggeveld, planted pasture, oat, disc pasture meter, compost tea solution

The production of different lucerne cultivars in the Fish River Valley of the Eastern Cape, South Africa

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Lucerne (*Medicago sativa*) is the most important crop grown in the Fish River Irrigation scheme. More than 25 000 ha is planted to lucerne in the valley. This crop plays an indispensable role in stabilizing the stock farming enterprises in the region. The aim of this study was to evaluate the production potential and persistence of 21 different lucerne cultivars over a five year period. The study was carried out at the Cradock Experimental Station outside the town of Cradock as a small plot cutting trial under irrigation. Plots were cut to a height of 50 mm before second regrowth reached cutter bar height. A Fisher's protected LSD (least significant difference) test, at 5% level, was used to compare the treatment means. SA Select was the cultivar with the highest total dry matter (DM) production for the trial period (90.4 ton.ha^{-1}) while DS598 produced the most DM (12.0 ton.ha^{-1}) with the last cut (totalled over 5 seasons). KKS 7000 was the least dormant cultivar producing a total DM yield for the first cut of 16.3 ton.ha^{-1} (totalled over 5 seasons).

Table 1 The total dry matter production (ton DM.ha^{-1}) for the first cut, the last cut and all cuts for the trial period compared within cut. Values in the same column with the same superscript letters do not differ significantly according to Fisher's LSD test (p≤.05)

Cultivar	First cut (total over 5 seasons)	Last cut (total over 5 seasons)	All cuts (total over 5 seasons)
SA Standard	14.0^{bcd}	11.9^{de}	85.0^{bcd}
SA Select	15.4^{bcd}	10.8^{bcde}	90.4^{d}
WL 711	15.9^{cd}	10.7^{bcde}	82.6^{abcd}
WL 525 HO	14.2^{bcd}	9.7^{ab}	78.1^{abc}
WL 414	9.9^{a}	10.1^{abc}	79.5^{abcd}
KKS 9911	14.7^{bcd}	9.6^{ab}	77.3^{abc}
DS 598	14.2^{bcd}	12.0^{e}	82.9^{abcd}
DS 788	12.0^{ab}	9.7^{ab}	77.9^{abc}
WL 903	14.6^{bcd}	10.5^{abcd}	85.9^{cd}
KKS 7000	16.3^{d}	10.8^{bcde}	84.0^{abcd}
Super Star	13.8^{bcd}	10.7^{bcde}	81.7^{abcd}
Super Aurora	11.9^{ab}	9.2^{a}	73.6^{abc}
Icon	12.4^{abc}	10.1^{ab}	77.8^{abc}
Super Siriver	12.8^{abcd}	9.4^{a}	77.0^{abc}
Super CUF	13.8^{bcd}	10.6^{abcd}	78.8^{abc}
Haymaster 10	14.1^{bcd}	10.1^{ab}	76.5^{abc}
Haymaster 9	15.3^{bcd}	10.9^{cde}	83.2^{abcd}
Magna 995	13.8^{bcd}	9.3^{a}	74.2^{abc}
Sardi 7	14.8^{bcd}	10.1^{abc}	80.8^{abcd}
Sardi 10	12.4^{abc}	9.8^{ab}	75.7^{abc}
Minerva	11.7^{ab}	10.1^{ab}	81.0^{abcd}
LSD_F (0.05)	2.67	0.99	7.74

Keywords: lucerne; production; irrigation; cultivar

Quantitative characterization and fodder value of structural polysaccharides in maturing hybrid maize

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Maize (*Zea mays*) contributes millions of metric tonnes of grain, stems and cobs annually, which partly alleviate energy deficits of ruminant herds subsisting on rangelands often under harsh environments of low rainfall and poor soils. The increased frequency in mid-summer droughts due to the El Nino Southern Oscillation is affecting production and quality of mostly structural components, nutrient value and metabolic energy supply and increasing energy loss as methane. In drier regions the rate of dryland maize crop failure is increasing and severe, because the crop is inadvertently grazed by ruminants for energy supply and physical fill. There is limited on research on changes in structural polysaccharides, non-digestible components-lignocellulose, and rumen fermentation of this "circumstantial" forage as mid-season drought would dictate alternative crop use. The aim of the study was to determine the changes in spatial accumulation of structural polysaccharide in failed maize crops and the disappearance rates of nutrients. One forage maize hybrid planted under conventional tillage system in 2013/14 season was harvested at two wilting stages: stage A: 60 to 75 days (assuming total wilting at 70 days) and stage B: 85 to 100 days, from planting. Samples were collected at daily intervals. At each stage, eight whole maize plants were randomly selected and harvested 30 cm above ground level. Plant parts were divided into cob with kernels, leaves, sheath and stems. Samples were oven dried at 60 °C for 7 days and analysed for nutrient content and in vitro disappearance of organic and fibre components in a daisy Ankom system for 4, 8, 18 and 24 hours. There were no differences at both stages in dry matter (DM)content of leaves, sheath and stems, but proportions of neutral detergent fibre (NDF), acid detergent fibre (ADF), hemicellulose, cellulose, and soluble components increased with plant maturity; acid detergent lignin (ADL) and ash levelled at 50 and 110 $g.kg^{-1}$ DM. The cob and kernels and leaf had the highest dry matter. The cob kernel mixture was least in ADF, ADL and cellulose and inversely correlated to dry matter disappearance; in vitro dry matter degradability (IVDMD) was 740 $g.kg^{-1}$ DM within 24 hours compared to 380 $g.kg^{-1}$ DM for stems. Throughout the wilting periods the leaf and sheath showed the greatest increase in dry matter whilst the stalk and cob had lower rates of increase. Organic matter content was low in stems, sheath and leaves, and did not seem to change rapidly with crop wilting, at any stage. Acid detergent lignin of all parts of the plant was high during stage B; cob (12.5%); leaves (11.8%); sheath (10.5%); stems (16.3%). Although farmers who face the greatest challenge of producing maize under severe drought conditions are selecting hybrids adaptable to abiotic stress with earlier grain filling, the risk of failure with global warming continues to increase. There is opportunity to immediately graze the maize during the early stages of wilting to salvage nutrients in fibre components. Further research is ongoing to fractionate the fibre components.

Keywords: forage, fibre fractions, wilting, degradation, nutrition

Growth characteristics and fodder production potential of *Sorghum bicolor*

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Rainfall in the Coastal savanna of Ghana is erratic and irrigation and fertilizer application to pastures uncommon, causing dry season feed deficit. *Sorghum bicolor* is drought resistant and adapted to marginal soils. This study was to investigate the effect of harvesting *Sorghum bicolor* at 3, 6, 9 and 12 weeks after emergence (WAE) on Dry Matter (DM) yield and nutritive quality. Dry matter yield increased with advancing age. The whole plant DM yield ranged from 0.65 ton.ha^{-1} to 12.40 ton.ha^{-1}. Plant height and NDF increased with advancing maturity. Crude protein (CP), RGR (relative growth rate) and leaf to stem ratio decreased with age. A mean RGR of 0.05 g.g^{-1}.d^{-1} was recorded. Results showed that for optimum quality fodder, sorghum should be harvested at 9 WAE with whole plant DM yield of 9.6 ton.ha^{-1}, leaf CP of 97.85 g.kg^{-1} DM and stem CP of 73.7 g.kg^{-1} DM.

Keywords: *Sorghum bicolor*, relative growth rate, chlorophyll content, dry matter yield, crude protein

Relating canopy cover to water use of kikuyu pasture over-sown with temperate grasses or legume

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Irrigated pastures play an important role in dairy production in the southern Cape region of South Africa. Irrigation scheduling guides managers to determine the timing and amount of water to apply. Irrigation scheduling is based on soil water conditions, crop water requirements and climatic variables. Scheduling is critical for optimising production and water use (WU) efficiency. High input cost, due to the high price of energy for irrigation, put strain on profitability and economic sustainability of irrigated pasture systems for dairy farming. Despite the latest irrigation application equipment and scientific guidelines, there is still a lack of reliable data and information pertaining to water requirements and irrigation scheduling guidelines of over-sown pastures under grazing. Such information needs to be obtained and applied in order to increase WU efficiency at farm level. Water use by the crop is influenced by weather conditions, availability of soil water, crop type and growth stage. Full canopy cover is a growth stage at which the canopy intercepts most of the incoming radiation. A study on the WU of kikuyu pasture over-sown with temperate grasses or legumes was conducted on the Outeniqua Research Farm near George. The aim of this study was to relate the canopy cover to WU of these over-sown pasture systems. The hypothesis was that WU of grazed kikuyu pasture over-sown with temperate grasses or legumes, is dependent on the canopy cover, irrespective of the botanical composition of the mixed sward. Therefore, the objectives were to determine canopy cover [intercepted radiation and leaf area index (LAI)] and correlate it with WU. A permanent sprinkler irrigation system was used to irrigate pastures. Scheduling was performed according to tensiometer readings which were kept between -10kPa and -25kPa. Climatic, soil water and canopy cover data were collected for kikuyu/perennial ryegrass, kikuyu/cocksfoot and kikuyu/lucerne pastures. A soil water balance was used to calculate WU and a ceptometer was used to measure intercepted radiation and estimate LAI. Results showed that there was a strong positive relationship ($p<.05$) between WU and percentage intercepted radiation and LAI for all treatments. As canopy cover increase over time, WU increased. Water use is therefore dependent on pasture's canopy cover, irrespective of the botanical composition of the mixed sward. Irrigation scheduling guidelines can be predicted from canopy cover of over-sown pasture system.

Keywords: water requirements, over-sown pasture systems, photosynthetically active radiation

Water use of mixed grass (kikuyu, ryegrass, cocksfoot and tall fescue species) and legume (clover and lucerne) pastures

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The utilisation of mixed grass and legume pastures in livestock production has grown significantly in recent years. The value of incorporating legumes, particularly white clover and lucerne, in mixed grass pastures has been highly regarded because it has improved yield and quality of grasses. However, it is well known that water is a scarce resource in South Africa and has the potential to limit production of these mixed planted pastures. To date, little information is available on how much water is required to grow good quality and highly productive mixed pastures. High water use for a pasture could be due to a small canopy cover. At this stage, approximately 90% of the water loss is due to evaporation from the soil. In a well established pasture, the canopy cover is dense which shades the soil preventing high water loss from soil surface. The aim of this study was to compute water use of a monoculture- and mixed pasture in accordance to their developing canopy cover. The field experiment was conducted at the University of Pretoria Hatfield Experimental Farm. Pure stands of *Pennisetum clandenstinum* (kikuyu), *Lolium perenne* (perennial ryegrass) *and L.multiflorum* (annual ryegrass), *Festuca arundinaceae* (tall fescue), *Dactylis glomerata* (cocksfoot), *Medicago sativa* (lucerne), and *Trifolium repens* (white clover) were planted in addition to mixtures of the aforementioned species in a completely randomised block design. Growth cycles were set at a minimum of 28-day intervals (depending on pasture maturity) with biomass, soil moisture content and leaf area indices collected weekly (7 day) to monitor growth rates. Each plot was irrigated to field capacity using a drip irrigation system weekly. Water use (evapotranspiration) was calculated from the soil water balance equation using 503DR CPN hydroprobe to measure soil water content. Biomass was harvested by clipping samples in 0.09 m^2 quadrats. Percentage PAR was determined from the ceptometer. The tall fescue/white clover mixture showed the highest monthly biomass yield of 2 000 kg DM.ha^{-1} in May-August growth period. It was characterised by % PAR ranging from 21% in the early stages to 89% at maturity. The mixture of kikuyu/annual ryegrass/lucerne gave the lowest yield of 1 200 kg DM.ha^{-1} in the similar growth period with %PAR in the range of 15 – 35% in its growing cycle. Furthermore, monocultures of lucerne, white clover and tall fescue yielded between 2 500 – 3 000 kg DM.ha^{-1} and had %PAR ranging from 15 – 80%. tall fescue/white clover mixture exhibited monthly water use of 76mm as compared with kikuyu/annual ryegrass/lucerne mixture having the monthly water use of 84mm during their comparative dry matter production periods. Percentage PAR has been used as an indicator of canopy development. Lower percentage of PAR indicates low canopy cover, thus high loss of water through soil evaporation. High percentage PAR shows dense canopy with increased transpiration and yield production. It can be concluded monitoring canopy development in relation to dry matter production can be used to predict water use of mixed pasture.

Keywords: water use, mixed grass and legume pastures, canopy cover, soil water content, irrigation

The water use efficiency of irrigated SA Standard and Super Cuf lucerne varieties, in relation to dry matter yield and leaf to stem ratio.

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Lucerne is regarded as the most important pasture legume crop produced in the drier parts of South Africa for its high quality roughage (hay), when produced under irrigated conditions. Lucerne is renowned for its drought tolerance, but at the same time it is very responsive to water. This research sought to show the differences in the water use efficiencies of two irrigated lucerne varieties. This research was done under irrigated field conditions using Super Cuf and SA standard lucerne varieties. It is well known that SA Standard is not commonly used for hay making, whereas Super Cuf is and that farm management can significantly influence the varieties' performance. A total of 100 plots with 50 SA Standard plots and 50 Super Cuf plots were established in spring of 2010. The results discussed here were obtained in November of 2012 to June 2013. There were no significant differences ($p>.05$) between the mean seasonal dry matter yield, water use efficiencies and leaf area indices of the two varieties. The highest DM production of more than 2 tons.ha^{-1} for both varieties was achieved in the month of March while the highest leaf to stem ratio was achieved in May. With regards to yield, the highest water use efficiency was achieved in June. The water use efficiency of both varieties ranged between 6 and 21 kg DM.ha^{-1}. mm^{-1}. There was no correlation between the seasonal water use efficiency and dry matter production in both varieties. The mean dry matter yield over nine harvest cycles for SA Standard was 1.79 tons DM.ha^{-1}.month^{-1} and for Super Cuf 1.93 tons DM.ha^{-1}.month^{-1}. From the results of this study it is concluded that variety plays no role in either the seasonal dry matter yield or water use efficiency under the same management. Research is however continuing to establish the months when the quality of varieties becomes more important than dry matter production with regards to water use efficiency.

Keywords: lucerne, SA Standard, Super Cuf, water use efficiency, dry matter yield, leaf to stem ratio

Water use and bioenergy potential of subtropical Poaceae species as second generation field crops

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Edible crops used for bioenergy production are generally not sustainable or economically attractive due to their harsh demand on the environment or their short supply of the quantities of biomass necessary to meet large scale energy demand. Knowledge is lacking in the areas of water use, potential yield and management of non-edible (second generation) bioenergy crops under the climatic conditions of a water scarce South Africa. A study was consequently conducted with the aim to determine the water use efficiency of selected Poaceae species for bioenergy purposes, exposed to three different water regimes. Additionally, the aim was to determine how biomass production and corresponding calorific value are affected by different water regimes and harvesting intervals. The field trial was structured as a completely randomized block design, with water regimes and selected Poaceae species as treatments for the two factorial experiment. A drip irrigation system was used to impose three regimes of increasing available soil water, namely dryland, weekly and two weekly irrigation according to soil water content measurements. Eight different Poaceae species were included, resulting in 24 treatment combinations. The species planted vegetatively included *Pennisetum purpureum* (Napier), *Miscanthus gigantheus* (Miscanthus), *Chrysopogon zizanoides* (Vetiver), *Hyparrhenia tamba* (Blue thatch grass) and seeded species *Brachiaria brizantha* cv. Mulato II, *Panicum maximum* cv. Mombasa, and the two control species (first generation bioenergy crops); *Sorghum bicolor* (sweet sorghum) and *Sorghum* spp. (grain sorghum). Treatments were replicated three times giving a total of 72 plots. Monthly destructive biomass sampling was done for three months and then the same harvesting procedure followed for the next three months in order to impose two harvest cycles until species became reproductive (approximately 10% blooming stage). Fresh and dry matter yields were determined. A ceptometer was used to measure fractional interception of photosynthetically active radiation and a LI3100 leaf area meter was used to determine leaf area index. Preliminary yield data indicated that supplementary irrigation resulted in either increases or decreases of biomass production, depending on the species. However, in most cases more frequent irrigation resulted in higher biomass yields. *Brachiaria*, *Pennisetum* and *Hyparrhenia* spp. produced considerably more biomass compared to sorghum, the first generation bioenergy crop species (Controls).

It can be concluded from preliminary results that some second generation bioenergy crops show potential to produce a significant amount of biomass at a relatively low water requirement.

Keywords: bioenergy, *Poaceae*, second generation crops, South Africa

Germination response of coated *Digitaria eriantha* seed in soils/substrates with different pH and salinity levels

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Mining in South Africa is increasing rapidly due to the increase in the demand for minerals such as coal, gold and platinum. These mined areas need to be rehabilitated by law. Mining activities change the soil profiles and properties of the soil, resulting in poor growth conditions that hinder the establishment of grass species. These unfavourable growth conditions, both chemically and physically, in addition to the presence of potentially harmful elements in the soil/substrate, can often restrict germination and root development which complicates the establishment and rehabilitation process. The technology to coat seeds with herbicides, pesticides, nutrients, etc. have shown much potential in previous studies and can facilitate the establishment of grasses in these chemically or physically degraded soil/substrate (growth) environments. The aim of this study was to evaluate the effect of the seed coating on the seed germination and seedling establishment in soils/substrates with different chemical and physical properties. The soil/substrate mediums under investigation include; coal discard, gold mine tailings, kimberlite, andalusite, fluorspar, gypsum and a red sandy loam cover soil as control medium. The objective of the study was to determine the effect of the soil/substrate pH and salinity on the germination, emergence and growth of *D. eriantha*. The study was conducted in a growth chamber on the Hatfield experimental farm, Pretoria. The study entailed a comparative analysis between coated and uncoated seeds in three phases. The first phase evaluated the seed and seedling response in a control medium (physically uniform sand coir mixture) with different pH (3, 5, 7 and 9). The second phase evaluated the seed and seedling response in the control medium with different salinity levels (0.05 M and 0.1 M NaCl), with the third phase focussing on the actual mine substrates. Each substrate was placed in a container and planted to one hundred seeds where three different water regimes were maintained to determine how water, influences germination in these environments. These water regimes included (a) 75% of soil moisture capacity, (b) 100% soil moisture capacity and (c) 125% soil moisture capacity. The percentage of live seedlings was calculated at four time intervals. The first two counts were determined by the guidelines set by the International Seed Testing Association (ISTA) and the second two counts were included at 5 day intervals thereafter to account for germination delays. At pH 5 the germination of coated and uncoated seed remained the same, while at pH 3, 7 and 9, uncoated seed had the same germination percentage relative to coated seed. The salinity trials however, showed no significant results. These preliminary results concluded that the germination of coated and uncoated seeds in the actual mine soils/substrates, indicated that germination is rather influenced by other factors such as high levels of minerals. The seedling vigour and health is being investigated further for any indirect benefits of seed coating.

Keywords: *Digitaria eriantha*, germination, emergence, pH, salinity, mine soils and substrates

Session 16: Pastures I

Chair: Derryn Harris

Pasture plant breeding in South Africa: lessons from the past and future needs

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Pasture breeding in South Africa dates back to 1910 with the first research stations being established in South Africa specifically for the purpose of pasture breeding. The specific objectives for grass breeding were however only defined at a meeting in April 1959. From there on substantial programmes were developed especially at Cedara and Roodeplaat. Various tropical, sub-tropical and temperate species were worked on. Later, in 1992, the pasture breeding function was transferred to the ARC. The main species in that programme were at Roodeplaat *Medicago sativa, Vigna unguiculata* and *Digitaria eriantha* while at Cedara work was done on *Lolium multiflorum, Lolium perenne, Festuca arundinacea, Secale cereale, Raphanus sativus, Eragrostis tef* and *Trifolium repens*. For each of the species there was a specific set of improvement objectives. For the *L. multiflorum* for instance the initial work focused on seasonal yield improvement and developing varieties that are of the type Westerwolds and Italian as well as genetic mixtures. The flowering behaviour and the seasonal yield are linked. The yield increases that were achieved were significant. Later that programme expanded substantially to improve forage quality in terms of dry matter content and total non-structural carbohydrate content. This proved to be a very successful objective which resulted in increased animal production from these varieties. The next step was to combine the high forage quality characteristics with an extended growth duration to develop Italian ryegrass that would be able to compete with perennial ryegrass in terms of summer production. The *E. tef* programme resulted in changing the use of teff as a commodity to that of an improved seed and expanded the use of teff from improved hay pastures with a better leaf-to-stem ratio in the new varieties to also being used for grazing. The *F. arundinacea* programme had the objective of producing varieties with a lower leaf tensile strength (softer leaves) than the varieties that were available at that stage and to retain good persistence at the same time. Currently pasture breeding in South Africa is taking place only on a very limited scale due to lack of capacity. It is not a healthy situation for the future to have to rely on imported germplasm only. The value of locally adapted varieties should not be underestimated. It is important to combine local climatic and soil requirements with local farming system requirements in developing varieties. Together with pasture breeding comes the need for a strong capacity of variety evaluation trials in all the different climatic zones where these varieties are to be used to determine adaptability. Again this capacity has severely diminished.

Keywords: ryegrass, total non-structural carbohydrates, teff, rye, fodder radish, tall fescue

PASTURE AND FODDER CROPS

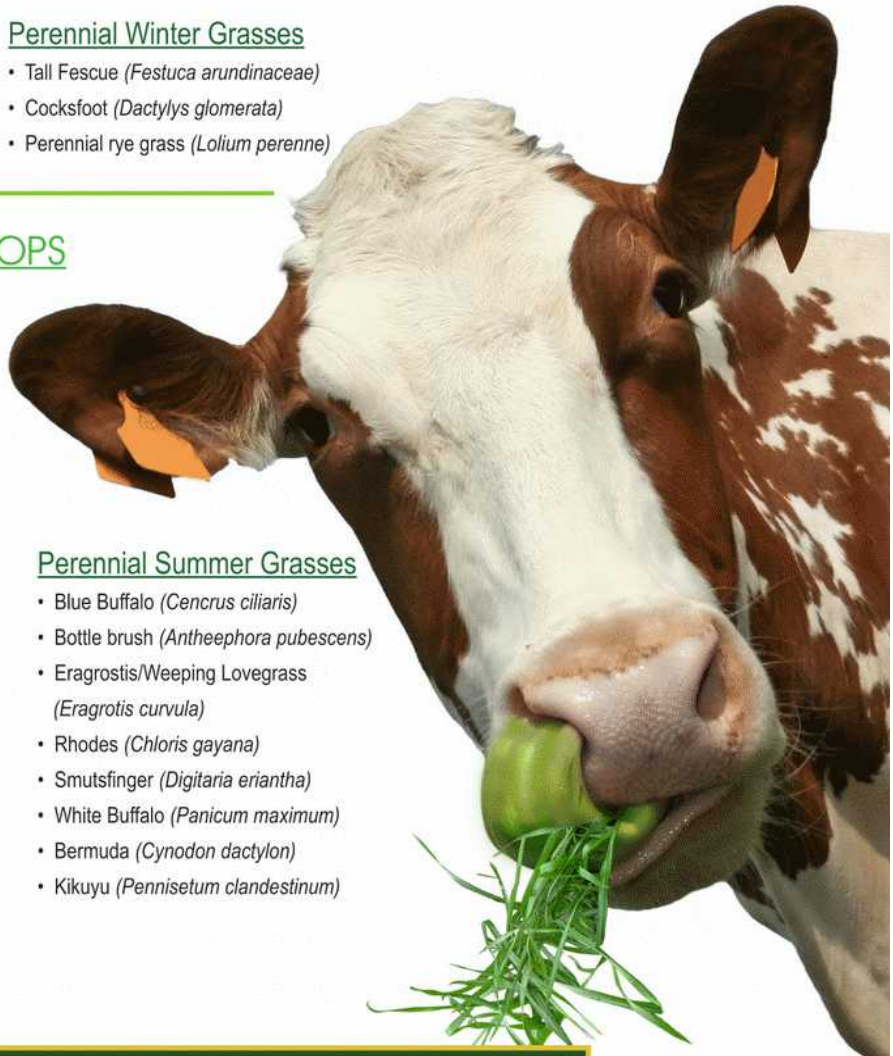
COOL WEATHER CROPS

Annual Winter Grasses
- Oats *(Avena sativa)*
- Stooling rye *(Secale cereale)*
- Annual rye grass *(Lolium multiflorum)*

Annual Winter Legumes
- Arrow clover *(Trifolium vesiculosum)*
- Grazing vetch *(Vicia dasycarpa)*
- Pink Serradella *(Ornighopus sativus)*

Perennial Winter Legumes
- Lucern *(Medicago sativa)*
- White clover *(Trifolium repens)*
- Red clover *(Trifolium pratense)*

Perennial Winter Grasses
- Tall Fescue *(Festuca arundinaceae)*
- Cocksfoot *(Dactylys glomerata)*
- Perennial rye grass *(Lolium perenne)*



WARM WEATHER CROPS

Annual Summer Grasses
- Teff *(Eragrotis teff)*
- Forage Sorghum *(Sorghum spp.)*
- Babala *(Pennisetum glaucum)*
- Hybrid Babala *(Pennisetum hybrid)*

Annual Summer Legumes
- Cowpeas *(Vigna unguiculata)*
- Sunhemp *(Crotolaria juncea)*

Perennial Summer Grasses
- Blue Buffalo *(Cencrus ciliaris)*
- Bottle brush *(Antheephora pubescens)*
- Eragrostis/Weeping Lovegrass *(Eragrotis curvula)*
- Rhodes *(Chloris gayana)*
- Smutsfinger *(Digitaria eriantha)*
- White Buffalo *(Panicum maximum)*
- Bermuda *(Cynodon dactylon)*
- Kikuyu *(Pennisetum clandestinum)*

Other Fodder Crops
- Japanese radish *(Raphanus sativus)*
- Fodder turnip *(brassica napus)*
- Fodder Beet

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Illustration 8: Hygrotech

Could 'mosaic' irrigation and strategic feeding be a better economic option than broad-scale pasture or infrastructure development for livestock production in semi-arid environments? A case study from northern Australia

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The beef industry dominates the northern Australian rangelands, but is in poor financial shape and few enterprises generate positive returns. Most fail to achieve productivity gains required to offset an ongoing cost-price squeeze (~2% pa). A major limit to productivity is the lack of high quality forages at critical times. Despite longstanding research to intensify production systems, the development of improved pastures, including irrigated pastures, remains limited compared to other major options (e.g. genetics, supplements, and infrastructure). There is a resurgent interest in tapping the high annual rainfall runoff, extensive land area and proximity to Asian markets for irrigation development. However, beyond a few large scale developments (e.g. Ord River, Douglas-Daly, Mitchell and lower Burdekin), there has been little development of irrigation for integrating sown forages into extensive beef production systems. There is scope for sufficient irrigation water to exploit 60 000 − 120 000 ha of rangeland which represents a 200-400% increase over the present irrigated area (NALWT 2009). Mosaic irrigation, small scale dispersed developments based on suitable soils and extraction sites, has been suggested as a technically attractive option to exploit the available water resources; especially by individual enterprises. Mosaic irrigation is largely untested and indications of economic benefits are scarce. The paper uses three regional case studies (Kimberley, Barkly Tableland, and Charters Towers) and simulation modelling to explore the scope for small scale irrigation developments to raise productivity of northern enterprises and deliver economic benefits. It also compares that scope with other options that might offer productivity gains (e.g. broad-scale sowing of legumes, fencing and stock water infrastructure). The individual case studies examine options of changing market orientation (e.g. retaining store weaners for feedlotting or live export, changing from live export to heavy slaughter bullocks) or meeting existing market specifications more quickly (reaching heavy slaughter weights 12 months earlier); identify forage options to meet the revised market criteria (e.g. irrigated cereal, grain legumes or grasses); establish an irrigation type and scale for each option; select the relevant stock classes and feeding duration, and determine the production and economic outcomes for each scenario. The assessment is conducted using the North Australian Beef Systems Analyser (MacLeod et al. 2013) for simulation periods of 20 years (1990-2010). The projected benefits from mosaic irrigation vary across regions and enterprise types and are typically higher and more reliable than for the dryland grazing baseline. However, the returns to the capital investment required for the irrigation infrastructure and pasture establishment are relatively small and generally below the threshold of acceptability (~30% return on capital outlays). Moreover, the projected returns from mosaic irrigation are similar to or lower than for broad-scale pasture development and provision of additional watering points and stock handling infrastructure.

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Keywords: North Australia, beef cattle, mosaic irrigation, sown forages, modelling, economics

The seasonal and annual dry matter production of *Festulolium* hybrids compared to *Festuca* spp. and *Lolium* spp. in the southern Cape

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The main focus within a pasture based dairy system is the production of sufficient high quality palatable fodder which can fulfil the nutritional requirements of animals. In the southern Cape of South Africa, annual and perennial ryegrass form an important part of fodder-flow program due its high palatability and nutritive value. Ryegrass shows a lower persistence in production over years compared to other species such as tall fescue. Plant breeders have bred hybrids between ryegrass (*Lolium* spp.) and Fescue (*Festuca* spp.) in an attempt to combine the high forage quality of ryegrass with the stress tolerance of Fescue. The resultant hybrids include *Festulolium pabulare* which is a cross between tall fescue (*Festuca arundinacea*) and Italian ryegrass (*Lolium multiflorum* var. *italicum*) and *Festulolium braunii* which is a cross between meadow fescue (*Festuca pratensis*) and Italian ryegrass. Both these crosses are back-crossed with their fescue or ryegrass parent species to obtain, respectively, festucoid and loloid varieties. The aim of this study was to determine the dry matter production potential of *Festuca* spp., *Lolium* spp. and *Festulolium* spp. The study was a small plot cutting trial conducted under irrigation on the Outeniqua Research Farm. The production potential of festulolium hybrids, tall fescue, meadow fescue, Italian ryegrass and perennial ryegrass cultivars was compared in terms of total seasonal and annual dry matter (DM) production over a three year period. Treatments were cut to a height of 50 mm approximately every 28 days or when the majority of treatments were ready for harvest to determine DM production and growth rate.

Table 1. The mean total annual dry matter production (t DM ha^{-1}) of *Festuca* spp., *Lolium* spp. and *Festulolium* hybrids (LSD at p≤.05 compares within column. Means with no superscript did not differ significantly).

Species	Year 1	Year 2	Year 3
Tall fescue	14.7^{bc}	13.3^{a}	9.76^{a}
Meadow fescue	13.6^{c}	9.84^{bc}	7.54^{b}
Festulolium pabulare festucoid	13.7^{c}	11.9^{ab}	9.11^{a}
Festulolium pabulare loloid	14.4^{bc}	9.92^{bc}	-
Festulolium braunii loloid	15.3^{ab}	10.1^{bc}	7.82^{b}
Perennial ryegrass	16.2^{a}	9.58^{c}	7.21^{b}
Italian ryegrass	16.0^{a}	10.7^{bc}	-
LSD (p≤.05)	1.057	2.234	1.267

Italian and perennial ryegrass had a similar total annual production to *Festulolium braunii* loloid, but higher than the rest in year 1. Tall fescue and *Festulolium pabulare* festucoid had maintained the highest and similar to the highest total annual DM production from year 2 to year 3. *Festulolium pabulare* loloid and Italian ryegrass did not persist in to a third year of production. If the aim, within a fodder flow programme, is annual seasonal production specifically focused on winter production, Italian ryegrass or perennial is the recommended selection. If the species is to be included as part of a perennial pasture system, Tall Fescue and *Festulolium pabulare* festucoid is recommended based on production and persistence.

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Keywords: tall fescue, ryegrass, growth rate, pasture

Methane yield from pregnant heifers grazing natural veld and forage sorghum as measured with a Laser Methane Detector

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Agriculture is responsible for 5% − 10% of global methane production, of which 80% - 90% comes from livestock. Enteric methane is produced by methanogenesis or biomethanation due to anaerobic fermentation of feed in the rumen and large intestine. Different methods used to measure methane production in ruminants in the past included: Respiration calorimetry chambers, Sulfur hexafluoride (SF6) tracer techniques, mass balance/micro-meteorological techniques and prediction equations based on fermentation balance or feed characteristics. The use of the recently developed, proprietary, Laser Methane Detector (LMD) to detect methane emission in dairy cows was first suggested and explored by Dr Chagunda in Scotland (Chagunda et al, 2008). Chagunda and Yan (2011) tested the level of agreement between the LMD and the indirect open-circuit respiration calorimetric chamber and found a high level of agreement between measurements of the LMD and the calorimeter chamber with a high (r=0.8) correlation coefficient. The ARC acquired a LMD and an experiment was done to measure the enteric methane emission from different breeds of pregnant heifers grazing either forage sorghum under irrigation, and natural veld (sour mixed bushveld) at the Roodeplaat experimental farm of the ARC-Animal Production Institute. Four pregnant heifers of the Bonsmara-, Brahman-, Jersey-, Nguni- and Red Poll breed were individually measured with the LMD while grazing natural sour veld and forage sorghum under irrigation respectively. The animals were adapted for 14 days on the specific grazing before the measurements were taken. Gas column density within 3 m was measured on individual animals by directing the auxiliary LMD targeting laser beam at the nostrils of the heifers. All measurements were taken late afternoon (18:00) as it proved to be difficult to see the laser beam in direct sunlight and no or very little wind is experienced this time of day. The measurements for each individual heifer were taken every 5 seconds over a period of 60 seconds to include different stages of the respiratory tidal cycle. Four 60 second repeated measurements were taken on 8 consecutive days on both natural veld and forage sorghum. Enteric methane production is reported in gram per day. As expected significantly less methane was produced when the animals were grazing on the forage sorghum under irrigation compared to the natural veld ($p<.0001$).

Acknowledgements: This work is based on research supported in part by Red Meat Research and Development South Africa and the National Research Foundation (NRF) of South Africa, under grant UID 83933. The Grant holder acknowledges that opinions, findings and conclusions or recommendations expressed in any publication generated by the NRF supported research are that of the authors, and that the NRF accepts no liability whatsoever in this regard.

Keywords: methane emission, laser methane detector, Bonsmara, Brahman, Jersey, Nguni, Red Poll, veld, sorghum

Direct anthelmintic effects of feeding *Lespedeza cuneata* hay (leaf material) on gastrointestinal parasites in sheep: *In vivo* studies

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The existence of livestock is closely bound to that of parasites. Increased concentration of livestock and grazing on monoculture forages has enhanced parasite populations to such a level that livestock production, to a large extent, has become dependent on anthelmintic chemotherapy. Increased public awareness of chemical drug residues in agricultural products, together with the increasing development of resistant strains of parasites to chemical anthelmintics, has required the search for sustainable alternative methods to complement or replace anthelmintics. Many calls are made for a more holistic management solution. Recent studies on the use of bioactive forages, especially *Lespedeza cuneata*, highlighted the potential of these to contribute towards holistic parasite control. The aim of the study was to determine the effect of *Lespedeza cuneata* leaf hay on an established gastrointestinal parasite infection in Merino sheep. Different dried herbage diets were offered to confined Merino ewes, with confirmed established gastrointestinal parasite infection, for 35 days. The leaf portion of *Lespedeza cuneata* hay and *Medicago sativa* hay was offered ad libitum to these sheep. *Lespedeza cuneata* is a tannin rich legume, while *Medicago sativa*, known for its very low condensed tannin content and zero anthelmintic properties, was used as control. Faecal egg count (FEC), Famacha©, live weight changes and rectal temperatures were monitored. The FEC of the sheep showed a significant reduction on Day 35, ($p<.05$), with FEC levels constantly lower in the *Lespedeza* group, compared to the control. Rectal temperatures tended to correlate with the FEC, but need further investigation. Famacha© scoring showed no significant ($p>.05$) differences in the data. The results from this study, despite some values that were not significant, indicated that dried *L. cuneata* leaves can reduce the GIN infestation in sheep. *L. cuneata*, therefore, can play a major role in reducing the contamination of pastures with infective larvae, thereby reducing the need for anthelmintics. The possibility of using the hay as a dewormer offers exciting possibilities to sheep farmers.*L. cuneata* has a tremendous advantage over many other plants with anthelmintic properties, because it can be used on farm by grazing animals or in hay form, since it is already established as a planted pasture with commercially available seed. With its many other agronomic advantages, including that it is relatively drought resistant, the inclusion of *L. cuneata* as bioactive forage, can play an invaluable role in a holistic GIN control programme.

Keywords: *Lespedeza cuneata*, *Medicago sativa*, anthelmintic properties, faecal egg count, rectal temperatures

Impact of fertilisation on the chemical quality of cultivated pasture soil

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Cultivated pastures improve animal production systems and contribute, amongst others to food security. Initially, annual pastures were established by conventional tillage methods, but from the 1990s permanent pastures were established on a minimum-tillage regime. Lime and fertiliser guidelines, which were developed for annual pastures established by conventional tillage methods, were followed on minimum tillage systems, despite changes in the soil physical properties and stratification of biological parameters. This study aimed to survey soil fertility of irrigated minimum-till kikuyu–ryegrass pastures in the southern Cape region and compare it to virgin soil. At least 20 soil subsamples taken at three depth increments of 100 mm from the surface were collected from every replicate. Standard procedures of the Non-Affiliated Soil Analysis Work Committee were followed to conduct a full range of soil chemical analyses. The soil fertility status of cultivated kikuyu–ryegrass pasture was affected, in many instances severely. Effects of lime application were visible through the higher concentration of calcium and magnesium. Organic carbon (34 to 56 ton.ha^{-1}), total nitrogen (2.1 to 4.9 ton.ha^{-1}) and cation exchange capacity (4.0 to 13.9 cmol.kg^{-1}) were related to each other and was improved in cultivated pasture soil. Potassium (0.11 to 0.45 ton.ha^{-1}), sodium (0.04 to 0.2 ton.ha^{-1}), copper (0.25 to 0.41 kg.ha^{-1}) and manganese (9.4 to 107 kg.ha^{-1}) registered higher concentrations in the cultivated pasture soil than in virgin soil. Boron (0.5 to 0.7 kg ha^{-1}) was not affected. Aforementioned nutrient concentrations were regarded as satisfactory from an agricultural and environmental viewpoint. However, phosphorus and zinc were drastically increased. The P concentration was 16 to 23 times higher in the 0 − 100 mm layer of the cultivated pasture than in virgin soil and Zn concentration between 26 and 53 times higher, depending on the district. Such high concentrations could cause deleterious effects on ecosystem health or sustainability of pasture production. This could be as a consequence of irresponsible sales-driven fertiliser advice to farmers, or the continued adherence to lime and fertiliser guidelines that were originally developed for conventionally tilled pasture systems. Prevention or mitigation of loading of soil with phosphorus and zinc in topsoil should be a priority. This study stresses the importance of adhering to fertiliser guidelines that fit the tillage system.

Keywords: kikuyu, nutrient cycling, phosphorus, ryegrass, soil fertility, zinc

Session 17: Pastures II

Chair: Sigrun Ammann

Effects of nitrogen fertilization and cutting interval on biomass yield and quality of banagrass (Hybrid *Pennisetum*) and guinea grass (*Panicum maximum*) grown as biomass crops

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High biomass yielding grasses are being evaluated globally as renewable energy sources. *Panicum* and *Pennisetum* species are some of the perennial grasses with potential for high lignocellulosic biomass. *Panicum maximum* (cv. Caprivi, Gatton and PUK8) and banagrass (Hybrid *Pennisetum)* were evaluated at the University of Pretoria Hatfield Experimental Farm for dry matter yield and chemical composition under varying levels of nitrogen fertilization (0, 75, 150, 225, 300 and 375 kg $N.ha^{-1}$) and two cutting regimes (2 cut vs. 1 cut system). A split-plot design with three reps was used for the experiment. Grass entries were assigned as main plots and nitrogen (N) x cutting regime as sub-plots. Each main plot measured 12 m x 12 m (144 m^2) and sub-plots 3 x 4 m. For the 2-cut regime herbage was harvested mid-season in February and the other at the end of the season in April. Herbage was only harvested in April for the 1-cut regime. The N was applied in two equal dressings, one at the beginning of the season in November and the other mid-season (February). Canopy height (CH), leaf area index (LAI) and light interception (LI) were monitored bi-weekly. Biomass was estimated from 2 quadrats of 2 x 1 m each. Herbage was sub-sampled, hand separated into composite, stem and leaf portions. The samples were dried at 70 °C to constant weight and analysed for acid detergent fibre (ADF), neutral detergent fibre (NDF), ash, N and gross energy (GE). Canopy height, LAI, LI, ADF, NDF, ash, N, DM and GE increased (p<0.001) with increasing levels of N fertilizer regardless of cutting frequency. Average CH of grass entries at mid-season ranged from 83.23-239.37 cm for banagrass, 73.38 – 229.87 cm Caprivi; 61.60 – 167.78 cm Gatton, and 58.80 – 154.23 cm PUK8. The respective values at the end of the growing season were 101.75 – 269.80, 88.95 – 230.85, 61.80 – 154.23 and 49.80 – 147.87 cm. The average biomass yields of Bana, Caprivi, Gatton and PUK8 ranged from 26 – 59, 19 – 45, 10 – 23 and 6 – 20 t $DM.ha^{-1}$, respectively. Ash, N, ADF, NDF and GE also increased significantly (p<.001) with N levels for both cut systems and ranged from 6.5 – 8.10, 6.1 – 9.8, 310.2 – 615.3, 390.1 – 799.1 and 14.25 – 16.79 $g.kg^{-1}$ DM, respectively. However, herbage from the 2-cut system was characterised by high N and ash but lower ADF, NDF, and GE than the 1-cut system. These results indicate the potential of these entries to produce high biomass which could be used for bioenergy and/or chemical production.

Keywords: lignocellulose, gross energy, tropical grasses, biomass, bioenergy

Illustration 9: Kynoch

The effect of bio-digester slurry on the mineral and chemical composition of napier fodder at different growth stages

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The effect of biogas slurry was determined on mineral and chemical compositions of Napier fodder harvested at different stages of maturity. The two treatments (bio-digester slurry and no slurry) were used to irrigate the Napier fodder for twenty weeks at two different sites (Maila and Ntabalala) in a complete randomised block design. There was no significant difference for K, B, Cu, Fe, Mn, Fe and Mo content in the fodder. However, P, Mg, Ca and Fe contents significantly differed between treatments at an early stage of growth ($p<.05$). The crude protein (CP) contents in the late stage of maturity at Maila were significantly different ($p<.05$). Ash content was not influenced by the stages of maturity. The moisture content at both sites decreased significantly with maturity ($p<.05$). At Nthabalala, dry matter, acid detergent fibre and neutral detergent fibre increased significantly ($p<.05$) with maturity. The application of slurry as nitrogen fertilizer has positive effect on CP of the Napier fodder harvested at late stages of maturity compared to the other chemical components of the grass.

Keywords: irrigation, biogas slurry, napier fodder, mineral content

Optical chlorophyll methods as tools for rapid and accurate nutritional assessment of pasture herbage: A review

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Traditional methods used to determine nutritional properties of pasture herbage require destructive sampling, are time-consuming, laborious and expensive to undertake. Consequently, the results of these procedures cannot provide real-time information necessary to synchronize nutrient requirements of the grazing animal with the feed supplied. This, therefore, highlights a need to develop alternative methods capable of providing instantaneous information on pasture nutritive value prior to grazing in order to facilitate judicious supplementation. One possible approach is the use of optical chlorophyll methods. The objective of this paper is to present a review of the current knowledge pertinent to optical chlorophyll measurements and their relationships to nutritional properties of pasture herbage. These methods are based on the strong relationship between chlorophyll and nitrogen concentration because chlorophyll contains the majority of nitrogen found in green tissues. Optical chlorophyll meters measure light absorption in the red (640 nm) and near infrared (940 nm) regions and calculate an index representing proximal chlorophyll concentrations that can be related to foliar nitrogen and other nutrient component through appropriate regression equations. Despite their limited applications in forage plants to date, optical chlorophyll methods have been used extensively in non-forage crops such as rice, wheat and corn to aid in managing fertilizer N nutrition. Optical chlorophyll measurements have shown potential to accurately predict nitrogen, crude protein (CP), *in vitro* organic matter digestibility (IVOMD), acid detergent fiber (ADF), neutral detergent fiber (NDF) concentrations, herbage yield and some minerals such as phosphorus and potassium in pasture herbage. However, the main limitation to optical chlorophyll measurements is probably the wide variety of pasture species, particularly those of interest in the tropics and their concomitant morphological and physiological diversities which can affect the accuracy of these measurements.

Keywords: optical chlorophyll methods, pasture herbage, nutritional properties, nitrogen, chlorophyll

Yield, nutritional value and condensed tannin level changes in *Lespedeza cuneata* under different defoliation frequencies and intensities

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The rapid increase in the magnitude of anthelmintic resistance towards commercial chemical anthelmintics, calls for alternative methods to complement or replace anthelmintic treatment. Recent studies on bioactive forages highlight the potential of these to contribute towards parasite control. *Lespedeza cuneata*, a tannin containing legume, is, according to scientific literature, one of the promising bioactive forages. Besides anthelmintic properties, ruminant digestion can be complemented or compromised by condensed tannins, depending on the level of condensed tannins (CT) in the plant. The aim of this trial was to investigate *L. cuneata* in terms of dry matter production and forage quality, condensed tannin (CT) levels and changes in tannin levels over the growing season. Small plot trials, arranged in a randomized block design, were conducted to establish production criteria for *L. cuneata*, currently lacking in South Africa. The grand mean dry mass (DM) yield for the first growing season, (characterized by above normal rainfall), was 8.3 ton.ha^{-1}, compared to the 2.56 ton.ha^{-1} for the second growing season, (characterized by below normal rainfall). Highly significant differences ($p<.001$) were measured between the yields produced under different cutting frequencies (6, 8 and 12 weeks) and cutting heights (5 cm and 15 cm). Except for crude protein levels, the ADF (acid detergent fibre) and NDF (neutral detergent fibre) analysis of the complete plant indicated a less acceptable nutritional quality. Separated leaf samples of plants were analysed. Chemical feed analyses of leaves were more favourable, compared to feed analysis of the whole plant. The CT content of leaves increased significantly ($p<.05$) with increased moisture stress and varied between 24.5 and 122 g.kg^{-1} DM over the growing seasons. Therefore, although *L. cuneata* appears to have a good potential based on high yields and adaptability to low potential soils, its actual feeding value may be substantially lower than expected during certain times, such as drought, due to the high levels of CT.

Keywords*: Lespedeza cuneata,* dry matter production, forage quality, condensed tannins

Effect of types of legume intercrop on the mineral content of native *Panicum maximum* (Green Panic)

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The effect of type of legume intercrop on nutritional performance of native *Panicum maximum* was investigated during wet season for 16 weeks. The experiment was laid out in a randomized complete block design with each treatment replicated three times. *Panicum maximum* was intercropped with *Canavalia brasiliensis*, *Centrosema pascuorum*, *Centrosema plumeri*, *Clitoria ternatea*, *Psophocarpus palustris* and *Aeschynomene histris* at a spacing of 50 by 50 cm. At week 20, grasses were harvested for mineral analysis. The *Panicum maximum* inter planted with *Centrosema pascuorum* was higher ($p<.05$) in P (0.37ppm), K (0.55 cmol.kg^{-1}), Mg (0.46 cmol.kg^{-1}) and Fe (177.33 mg.kg^{-1}) while *Panicum maximum* interplanted with *Aeschynomene histris* was higher ($p<.05$) in Cu (7.70 mg.kg^{-1}). *Panicum maximum* interplanted with *Psophocarpus palustris* had the highest ($p<.05$) value (30.50 mg.kg^{-1}) of Zn. It could be concluded that *Panicum maximum* was better in terms of mineral compositions when inter planted with *Centrosema pascurium*.

Keywords: *Panicum maximum, Canavalia brasiliensis, Centrosema pascuorum, Centrosema plumeri, Clitoria ternatea, Psophocarpus palustris, Aeschynomene histris*

Evaluation of grazing Jersey and Angus/Jersey nurse cows in a multiple suckling calf rearing system

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Some dairy farmers in the southern Cape recently implemented a breeding system where the bottom half of the herd, based on genetic merit and production, is inseminated with beef cattle semen. This reduces the number of dairy heifers on the farm, consequently lowering roughage demand. Emerging farmers in the southern Cape buy these crossbred calves and rear them on culled Jersey or Holstein nurse cows in an intensive system. The aim of the study was to determine the beef production potential of F_1 generation Angus/Jersey calves in a multiple calf rearing system using Jersey or Angus/Jersey nurse cows. The study was carried out at the Outeniqua Research Farm, George, Western Cape. The farmlet (24 ha) consisted of a mixture of non-irrigated kikuyu (*Pennisetum clandestinum*), taaipol (*Eragrostis plana*), white clover (*Trifolium repens*), cocksfoot (*Dactylis glomerata*), fescue grass (*Festuca arunidnaceae*) and perennial ryegrass (*Lolium perenne*) divided into 24 camps. Strategic fertilisation was implemented. Four F_1 generation Black Angus/Jersey first lactation cows and four pure-bred Jersey first lactation cows were compared. Each cow reared two calves (bull and heifer calf) by restricted suckling for three months, after which the calves were weaned on pasture with restricted access to a production supplement (15% crude protein) up to 12 months of age; subsequently calves were fattened on pasture-only up to 18 months of age and slaughtered. Cows reared two more batches of calves during their nine month lactation cycle, resulting in six calves reared per cow with a grand total of 48 calves reared during the study. Cows received 2 kg of concentrate split over two sucklings and suckling calves received calf growth pellets (18% CP) *ad libitum*. The different animal age groups grazed separately and were initially allocated four 1 ha camps each. A 56 day grazing cycle was implemented to ensure a forage availability of 2.5 − 3% of cow/calf body weight. Milk production of cows was estimated monthly by weighing calves before and after suckling. Weight and supplement intake of all animal groups were recorded on a monthly basis. Pre- and post-grazing sward height was recorded with a rising plate meter. Quadrat pasture samples were cut before each grazing for botanical composition and quality determination purposes. The weight of the Angus/Jersey and Jersey cows was 431 kg and 345 kg at the start and 450 kg and 327 kg after 5 months respectively. Average milk production of the Angus/Jersey and the Jersey cows did not differ significantly ($p>.05$) and was 9.9 $kg.day^{-1}$ and 8.4 $kg.day^{-1}$ respectively. The weight at weaning (3 months of age) did not differ between groups. Calves reared by the Angus/Jersey cows weighed 121.9 kg compared to the 119.7 kg of calves reared by Jersey cows. The weight of the Angus/Jersey cross calves at 5 months did not differ between the two groups and was 176 kg. The F_1 Angus/Jersey cow is a more sustainable option for intensive multiple calf rearing than the Jersey cow.

Keywords: pasture, beef cattle, cross bred

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Chair: Erika van Zyl

Salinity effects on germination potential of selected pasture grass species used for mine rehabilitation

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Coal mining destroys the environment and soil structure. A wide range of commercial grass/legume mixtures are used in rehabilitation of mined areas. The grasses are adaptable to the high levels of elemental contaminants and high salinity or electrical conductivity (EC). The aim of this study was to evaluate germination of three commonly used grasses, *viz. Cynodon dactylon, Digitaria eriantha* and *Panicum maximum* in solutions of varying EC. For each species 100 seeds were placed in 9 cm Petri dishes lined with Whatman #2 filter paper and allowed to germinate in distilled water or solutions of 100, 200, 400, 600, 800, 1000 mS/m (using NaCl) or Kleinkopje mine water with 405 mS/m. The design was a Completely Randomized Design comprising four replicates. Seeds were germinated in growth chambers at 25 ˚C and with 8 hours of light. The highest ($p<.05$) mean total germination was 71.3% for *C. dactylon* in distilled water. As EC increased, germination rate of *C. dactylon* declined linearly with a strong negative relationship ($p<.05$; $R^2=0.90$). The respective values for *P. maximum* and *D. eriantha* were 30.5% and 6.1% under distilled water. Germination of *P. maximum* decreased linearly with increasing EC ($p<.05$; $R^2=0.77$) whereas for *D. eriantha* germination decreased exponentially ($R^2=0.64$). When *C. dactylon, P. maximum* and *D. eriantha* seeds were germinated under Kleinkopje mine water, mean germination were 84.1%, 12.3% and 17.3% respectively. When seeds for *C. dactylon, P. maximum* and *D. eriantha* were germinated in varying EC, T_{50} was reached on day 3, 4 and 4.2 respectively. T_{50} of seeds in Kleinkopje water significantly ($p<.01$) decreased when compared to water for *P. maximum* and *D. eriantha*. Overall, the results demonstrated interspecific variations in grass species germination under saline conditions.

Keywords: germination rate, salinity stress, disturbed mine lands

The value of coated Rhodes grass seed in rehabilitation

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The increase in degraded areas by mining and poor agricultural practices, the quest for sustainable farming and rehabilitation challenges initiated a research project conducted by the University of Pretoria and North West University. One of the aims of the research is to identify if Rhodes grass (*Chloris gayana*) physiology is suitable to survive environments where rehabilitation is required. In addition, the research aimed to determine whether seed coating can benefit the establishment of Rhodes grass, and under which environmental conditions coating will improve the success of the rehabilitation effort. The objectives were met by conducting germination, emergence, establishment, production and survival and sustainability trials under controlled laboratory and phytotron conditions in addition to field conditions. We hypothesised that the use of coated Rhodes grass seed will improve establishment and subsequent stand success. The methodology focused on comparative analysis for the use of coated and uncoated seeds and included parameters often encountered by rehabilitation practitioners, such as water availability, growth medium amelioration, nurse crop inclusions and seeding rate variations. Results from the emergence trials showed that coated Rhodes grass seeds had higher emergence (up to 15% more) in a sandy loam soil. Amelioration of the growth medium influenced the emergence of seedlings from both coated and uncoated seeds. Coating can act as a water reservoir under dry conditions to improve the germination under these conditions. The subsequent success of establishment was evident in a field trial where the plant density was consistently higher when coated seeds were used, regardless of the sowing density. The higher plant density also influenced the number of weeds established in the stand, and the dry matter production of the stand. The coating ratio and the subsequent seeds per kg influenced the establishment when sowing at a fixed seeding rate (e.g. 7 kg.ha^{1}). A coating ratio of 1:5, that is five times less coated seeds than uncoated seeds, exerted more effective competition to exclude weeds when compared to a 1:7 coating ratio. This suggests that an adjustment in seeding rate must be considered under such conditions. The data from this research project show that Rhodes grass is able to adapt to several severe environmental conditions, such as drought, acidic or saline conditions and is able to utilize resources very efficiently. The benefits of using coated Rhodes grass seed are evident from these comparative studies.

Keywords: *Chloris gayana*, seed coating, establishment, production

Inter- and intra-species competition as influenced by variable seeding rates and nurse crop association

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The secret of successful planted pastures lies in the execution of good pre-establishment techniques such as optimal seeding rates and nurse crop function. The current debate on the value of higher or lower seeding rates of pasture species, and the inclusion of a nurse crop in production systems, raises the concern of whether significant competitive effects exist amongst plants in the sward. *Eragrostis curvula*, *Digitaria eriantha* and *Chloris gayana* are commonly cultivated subtropical grass species in South Africa and are used as test species in this field study. Replicated field experiments in a Randomized Block Design were conducted, evaluating the pasture growth response to variable seeding rate treatments (80% of selected seeding rate, selected seeding rate and 120% selected seeding rate) of uncoated and conventionally coated seed; in the case of *D. eriantha* and *C. gayana* Mycortex coated seed was also used. The experiments included the measurement of the effects of an annual nurse crop, *Eragrostis tef*, on the establishment of associated perennial grass species. A primary function of the nurse crop planted with a perennial grass species is to minimize fierce weed competition. It was concluded that a higher seeding rate gave a better first season plant density, however, the following season this treatment had an equal plant density as the original lower seeding rate treatments for *E. curvula* and *C. gayana*. This was due to intraspecies competition (competition between plants of the same species) in season one resulting in plants out competing one another. The establishment success of perennial species was lower, where nurse crops were included as a result of interspecies competition (competition between plants of different species). Season two data indicated that *D. eriantha* and *C. gayana* did not have lower plant densities where a nurse crop was planted, whereas *E. curvula* still had significantly lower plant densities. The results highlight the interactive effects between seed coatings, seeding rates and nurse crop treatments as a function of selected species.

Keywords: nurse crop, seeding rate, *Eragrostis curvula, Digitaria eriantha, Chloris gayana*

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