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Modeling veld production using MODIS LAI – Phase 3

10/31/2019

Modeling the net primary production of arid and semi-arid rangelands in southern Africa using MODIS LAI and FPAR products – Phase 3

Industry Sector: Cattle And Small Stock

Research Focus Area: Sustainable Natural Resource Utilisation

Research Institute: University Of Pretoria

Year Of Completion : 2019

Researcher: Anthony R. Palmer

The Research Team

Title	Initials	Surname	Highest Qualification	Research Institution
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Prof	E	van Marle-Koster	PhD	UP
Mrs	A.	Theunissen	MSc	Vaalharts Research Station

Aims Of The Project

1. To evaluate whether the Celtic mutation on the POLL locus is the causative mutation for polledness in Bonsmara and Drakensberger
2. To perform a genome wide association study of the Polled and Scur genes based on phenotypic data and genotypic data from the GGP Bovine 150K SNP bead chip
3. To apply sequence data available from the Bovine Genomics Program to finemap the suspected regions for the Polled and Scur genes

Executive Summary

The objective of this study was to compare four commonly used growth promotants in a commercial sheep feedlot. The steroidal growth promotants chosen for this trial were Ralgro (zeranol), Revalor G (Rev G; TBA/oestrogen- 17β), Revalor H (Rev H; TBA/oestrogen- 17β) and Zilmax® (zilpaterol hydrochloride). The growth promotants were compared with one another and within three sex groups, namely ewe, ram and wether (castrates), to determine which molecule or combination of molecules, if any, had the most

benefit and profitability when measured against a control group. Sheep were stratified based on initial weights and then randomly allocated to treatment groups in a completely randomised control study. All sheep originated from the same farm, and they were of similar age, breed, transport method, processing method, feed (the only difference being the groups receiving Zilmax® during the last 18 days of feeding, making provision for 3 days withdrawal), weather conditions, housing and time on feed. A time constant termination date was used in this study, in order to measure the performance of lambs in treatment groups over time.

This project has continued upon earlier, RMRD-SA funded projects that evaluate the using of earth observation (remote sensing) to model net primary production in South African grazing systems. The final results of this research are included in several research papers, students completions (PhD and BSc (Hons)), as well as a popular article. An Android application (Smartphone only) has been developed to determine the grazing capacity from the Google Earth Engine database of Landsat and MODIS imagery. This application is in the process of being tested in on-farm situations and is available to individual smartphones and tablets onto which the application can be installed. A further extension of the app development is an MSc project at Stellenbosch University that has prepared a new map of the fractional cover of grass, trees, shrubs and bare soil across South Africa. There has been one scientific paper published on the project since the last report, and two conference proceedings. A mini thesis (Geo-informatics Hons) describes how the application works. This application has also been made available in the public domain in the Google Earth Engine environment:
https://liezlvermeuln.users.earthengine.app/view/spacegrazer

The objective of this phase of the project was to further validate the production estimates being made using MODIS LAI and fPAR, and to develop an Android-enabled application that can convert these estimates into grazing capacity model that could be used by farmers.

Results

Aim 1 All MODIS LAI and fPAR data are now available via the Google Earth Engine (GEE) interface. It is no longer necessary to download and archive these data from the NASA Distributed Archive. A large number of Java scripts have been written to extract data for livestock farmers throughout the Eastern Cape from the GEE user interface. Ms T Zondani has been appointed on the project and has been trained to extract data from GEE. Through GEE, data acquisition has been extended to other MODIS products, including the enhanced vegetation index (EVI), net primary production (NPP), gross primary production (GPP) and evapotranspiration (MOD16). Water use efficiency maps (WUE) have been prepared for all the years 2000-2017.

Aim 2 During this phase of the project we held workshops with the farmers in several rural villages to determine their response to the climate change predictions for that region, particularly where it is predicted to become hotter and drier. The project has established a world-class scientific installation on a livestock farm in the Smaldeel. This part of the project has seen the establishment of two eddy covariance systems on a site that had experienced bush encroachment in the past 50 years (See attachment). Each eddy covariance system measures the direction and amount of carbon and water that moves between the earth and the atmosphere, and is a major contribution to South Africa's understanding of the dynamics of this exchange between the earth and the atmosphere. The installation provides the opportunity to explore the consequences of climate change on grassland and bush encroachment. The RMRD-SA contribution to this site has been the transport to and from the site.

Aim 3 Using data from an eddy covariance (EC) system in the Albany Thicket, the project assessed the C sequestration options for farmers in the thicket. Carbon sequestration rates for the thicket biome are in line with those predicted by Aucamp and Cowling and Mills (2013) of 0,13-0,15 kg C m yr^{-1}. The EC system has been moved to the farm Endwell in the Adelaide District and the C sequestration benchmarks for this area, which is being invaded by *Vachellia karroo*, will be available during 2018-2019. The development of the grazing capacity of South Africa based on the NPP data from 2009 has been published in both the peer-reviewed (Meissner et al 2013) and popular media (Palmer 2013). Since 2014, we have tested the map against other estimates of carrying capacity. This beta testing of this map showed that the estimates for grazing capacity were too high (50%) and this was most likely due to the high fraction of woody plants (trees and shrubs) in the Eastern Cape. The new MSc project to prepare a tree/shrub/grass/bare soil fractional cover map was therefore initiated. The climate change predictions for the West Coast (hotter and drier conditions) have been incorporated into workshops and grazing management recommendations for two rural communities.

For the east coast, the predictions are more promising, with an increase in rainfall predicted. The effect is already being experienced in this region, with an increase in grassiness and a general improvement in the

net primary production being reported. In order to deal with this understanding and its implications for commercial livestock farmers, a new experimental site has been established at Endwell farm.

Aim 4.A BSc (Hons) project was completed using the relationship between Landsat NDVI and biomass production. The application accessed Landsat and MODIS databases via the Google Earth Engine portal (GEE). The student has registered for an MSc (Stellenbosch University). She developed an Android application called Land Suitability Index (LSI) using hybrid model technology. The application determines the geographic position of the farmer from the geo-location options on an Android smartphone. It uses GEE web-interface to collect data on the NDVI history of the specific site. This provides a long-term (19 year) summary of the photosynthetic performance of the site, and evaluates the current NDVI relative to the mean for the 18 years. This history is converted into the available biomass produced in the last 12 months. The farmer can then adjust his stocking rate based on the actual production. An improvement is the addition of proportion of vegetation that is grass, as this is the major one relevant to cattle and sheep. In order to achieve this, Ms Vermeulen, in her MSc, has developed and tested a new fractional cover map. The output is now available as a Google Earth Engine application called Spacegrazer.

https://liezlvermeuln.users.earthengine.app/view/spacegrazer

This application can be used by anyone to ascertain the grazing capacity of a site in southern Africa.

Ms Vermeulen conducted field surveys where she measured the fraction of grass, shrubs, trees and bare soil in pixel of a Sentinel scene. The results from this analysis will form part of her MSc thesis.

Conclusion

The project has made excellent progress since its inception in 2010. The has been exceptional growth in the understanding of the benefits and dis-advantages of using remote sensing to estimate net primary production. In commercial farmland, where farmers tend to leave standing biomass available for the dry season, the predictions of NPP provided by the MODIS products have been very useful, and can be used to predict the grazing available to the farmer. This certainty has been converted into two applications: 1) for an Android device and 2) on-line application in the Google Earth Engine environment. Both of these applications have been tested on several commercial livestock farms and on several game farms. Several farmers have been signed up to receive monthly predictions of the biomass available for their property. One of the big challenges when using remote sensing to predict production is the presence of woody species. This is being solved through a national map of fractional woody cover which has now been produced by the project through an MSc at Stellenbosch University. However, in communal rangelands, where most biomass is consumed as it is produced (the so-called continuously grazed systems), the MODIS products are not able to detect all of the net primary production. Fially, the project has also enabled us to establish, in collaboration with Rhodes University and the National Equipment Programme, two eddy covariance systems that measure the actual C sequestration and water use of rangelands. This collaboration has resulted in the establishment of a world-class experimental facility on a commercial livestock farm. At this site we are computing the impact of woody encroachment on grass production and water use. This will feed into policy on how the state will deal with woody encroachment and its impact on the catchment water balance.

Popular Article

Using Satellite Imagery For Climate Smart Adaptive Planning Of Grazing In Near Real Time By Weideman, CI And Palmer, AR 2019

Click on this link to download thea article which was published in the Wool Farmer Article LINK

Conclusions

Please contact the Primary Researcher if you need a copy of the comprehensive report of this project on : – mmakgahlela@arc.agric.za

📁 Cattle and Small Stock, Natural Resource Utilisation

🏷️ 2019, CSS, Online, Palmer, UP

‹ Innovative management for beef productivity

› Genetic markers for Haemonchus contortus in sheep

DEADLINES for RESEARCHERS 2021

Proposals for 2021: TBC
Progress reports: 28 Jan 21
Final reports: 29 Jan 21 Final includes comprehensive report and popular article

COMMITEE MEETINGS for 2021

RMRDSA CSS Planning - TBC
Project Committee - TBC
Pork Planning - TBC

Calendar

<			Apr 2021			>
Sun	Mon	Tue	Wed	Tur	Fri	Sat
				1	2	3
4	5	6	7	8	9	10

11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

PORK Priority Areas

Cattle & Small Stock Programmes

1 Sustainable natural resource utilisation

2 Improvement of Livestock production and forage

3 Management of agricultural risk to create a resilient Red Meat sector

4 Sustainable health and welfare for the Red Meat sector

5 Enhancement of production and processing of Animal Products

6 Consumer and market development of the Red Meat sector

7 Commercialisation of the emerging sector

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