UNIVERSITY OF NEW ENGLAND

Defining Sheep Grazing Environments Using Remotely Sensed Data at a Range of Scales

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Table of Contents

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

List of Figures

List of Figures (continued)

List of Figures (continued)

List of Tables

List of Tables (continued)

List of Tables (continued)

List of Equations

Glossary

ABRIEVIATION/TERM	MEANING
ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ArcMap	ArcMap is a geographic information system produced by the ESRI company
ASBV	Australian Sheep Breeding Values
ASReml	A REML package produced by Gilmore et al.
AVHRR	Advanced Very High Resolution Radiometer
AWI	Australian Wool Innovation Limited
CFW	Clean Fleece Weight
Crop Circle™	Active hand-held sensor produced by Holland Scientific
CSIRO	Commonwealth Science and Industry Research Organisation???
Design Matrix	A design matrix is a matrix of zeros and ones and it is used to allocate individual observations to groups. For example if we had a vector of observations [1, 2, 3, 4, 5, 6] and we wanted to allocated them to two groups [Group 1 – 1, 2, 3] and [Group 2 – 4, 5, 6] then we would create a design matrix as per below. [1] [1 0] [1 0] [2] [1 0] [2 0] [3] X [1 0] = [3 0] [4] [0 1] [0 4] [5] [0 1] [0 5] [6] [0 1] [0 6]
DM	Dry Matter
EBV	Estimated Breeding Value
EMR	Electromagnetic Radiation
ERDAS	Earth Resources Data Analysis System
ESRI	Environmental Systems Research Institute
FD	Fibre Diameter
FDP	Fibre Diameter Profile
FM+	Fibre Meat Plus
FOO	Feed on Offer (kg DM/ha)
GDM	Green Dry Matter
GFW	Greasy Fleece Weight
GIS	Geographic Information System
GPS	Global Positioning System
GrEI	Grazing Environment Index – an index developed as part of this thesis to combine data from the SGS experiment
GxE	Genotype by Environment Interaction
HRZ	High Rainfall Zone
IFOV	Instantaneous Field of View
IGF1	Insulin Growth Factor-1
ISODATA	Iterative self-organising data analysis technique (ISODATA) (Tou and Gonzalez, 1974) developed to classify multi-dimensional data.
LAI	Leaf Area Index
LANDSAT	Landsat is a series of Earth-observing satellite missions
LED	Light Emitting Diode
LUE	Light Use Efficiency
Majority Filter	A majority filter is used on thematic layers to reduce spatial variability. For each pixel the eight surrounding pixels (3x3 filter) is assessed. The central pixel's value is changed so that it is the same as the majority of the surrounding pixels. It is possible to use a filtering matrix of any size.
MapInfo	Map Info is a GIS produced by Pitney Bowes MapInfo Corporation
MLA	Meat and Livestock Australia
MODIS	Moderate Resolution Imaging Spectroradiometer
MSS	MultiSpectral Scanner
MT_{max}	Maximum Monthly Temperature
MVC	Maximum-Value Composite – The value of pixels of an area are compared in a

ABRIEVIATION/TERM	MEANING
	sequence of images and the maximum value is used in the composite. This technique is used to account for cloud cover when calculating NDVI.
NDVI	Normalised Difference Vegetation Index
NEDI	Nutritional Environment Difference Index – an index developed as part of this study to differentiate grazing environment classes.
NIR	Near Infrared
NOAA	National Oceanic and Atmospheric Administration
PfS™	Pastures from Space
PGR	Pasture Growth Rate (DM kg /ha/day)
PZ	Pastoral Zone
REML	Restricted Maximum Likelihood
RMSE	Root means square error
SAVI	Soil Adjusted Vegetation Index
SGEclass	Sheep Grazing Environment Class
SGS	Sustainable Grazing Systems
Shape files	Shape files are used to represent geographic features in a GIS
Sheep Genetics	*"national genetic information and evaluation service for the meat and wool sectors of the sheep industry delivered as LAMBPLAN and MERINOSELECT"*
Sheep grazing environment	For the purposes of the present study sheep grazing environments is defined as the quantity (green dry matter (kg/ha)) and quality (digestibility) of pasture available to sheep.
SLA	Statistical Local Area
SPOT	Satellite Pour l'Observation de la Terre
SS	Staple Strength
TM	Thematic Mapper
VI	Vegetation Index

Abstract

The grazing environment (i.e. the quantity and quality of pasture available) drives sheep production in Australia. The long-term viability of the sheep industry is dependent on the sustainable use of pasture, which requires monitoring. Remotely sensed data have the potential to monitor changes in pasture resources within and between seasons. Remotely sensed data have the potential to; map pasture resources within a paddock, differentiate paddocks within a farm, differentiate farms within a region and differentiate grazing environments across the country. This thesis examines the application of remotely sensed data in the sheep industry at three scales (within a paddock, at the paddock/farm scale and at a continental scale).

Data from a hand-held active sensor (Crop Circle™) were used to estimate green dry matter (GDM) within a paddock and produce a map that highlighted the variability within the paddock. The normalised difference vegetation index (NDVI) and soil adjusted vegetation index (SAVI) were used to estimate GDM in mixed annual and perennial swards over three years at two sites. Comparisons between NDVI, SAVI, pasture height and GDM indicated that producers should continue to use pasture height to estimate GDM but the Crop Circle™ could be used to map GDM variability within a paddock.

NDVI data provided by Pastures from Space collected at a paddock level were compared with liveweight changes at four properties. Weak correlations between NDVI and liveweight changes were observed. The weak correlations were possibly due to extended periods of supplementary feeding on all properties. At a property scale the relationship between NDVI and fibre diameter profiles and staple strength were explored. The relationship between NDVI and fibre diameter were strong in some environments and NDVI was positively related to staple strength.

At a continental scale NDVI data were divided by temperature data (as a factor related to pasture quality) to produce a meaningful and robust classification of grazing environments. Twenty-five sheep grazing environment classes (SGEclasses) were created and an index was generated to quantify differences between them. The robustness of SGEclasses was evaluated using Sheep Genetics data to determine if they could explain genotype by environment interactions (GxE). Analysis demonstrated that the Sire by SGEclass interaction explained a similar amount of variation to the Sire by Flock interaction. Therefore, clustering flocks into SGEclasses could improve estimates of breeding values. SGEclasses were also used as a factor in multivariate analysis separate relationships between NDVI and wool fibre parameters.

The present study showed that remotely sensed data have the potential to help define grazing environment and increase the efficient use of pastures in the sheep industry.