FutureBeef

Department of **Agriculture, Fisheries and Forestry**

CQ BEEF

Better Economic and Environmental Futures

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Nitrogen the key to fighting big losses from 'rundown' in sown pastures

Stuart Buck
Pasture Agronomist
DAFF Biloela

Pasture productivity decline or 'rundown' is widely recognised in sown pastures, especially in buffel. The grass doesn't grow as high as it used to; it gets thinner, paler and yellow; and may have even stopped flowering and producing seed. These are the classic signs of the 'rundown' that has reduced pasture production by up to 50% in many cases.

Over 180 graziers have now attended a series of 15 workshops across central and southern Queensland to understand how 'rundown' works and what we can do about it. A series of on-farm trials across Queensland this year have reminded us of how dramatic rundown can be and confirmed that nitrogen is the key to fighting back.

Many workshop participants have applied nitrogen to their pastures to see what will happen. The results from adding ~100 kg N/ha have been dramatic. All of the pastures have become much greener and many produced lots of seed (see photo below left for an example). Those that were measured had significantly higher protein levels. Not surprisingly, the fertilised strips were all heavily grazed by cattle (and roos) that sought out the better quality feed.

Most paddocks (30 out of 38) produced more grass, sometimes doubling biomass yield between January and May (Table 1).

All sown pastures will suffer rundown at some stage, and the only long-term solution is to get more nitrogen into the system. For most people this will mean getting legumes into grass-only pastures.

Establishing legumes into grass pastures is not easy, but with better agronomy over recent years we are seeing significantly more successes. Leucaena growers have led the way and shown better results are achieved by giving our legumes a chance with soil preparation and weed control.

Using some of the methods developed to improve leucaena establishment, like removing grass competition and storing soil moisture before planting will dramatically increase the reliability of establishment. The quicker legumes are established, the sooner nitrogen is added to pastures and animal weight gain increases.

fba FITZROY BASIN ASSOCIATION

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Queensland Government

Please use the feedback sheet provided to let us know of any topics you would like covered in the newsletter. Alternatively if you know of anybody who would like to receive the newsletter, ask them to fill out their details and return the feedback sheet.

Editorial

Two successful Breeding Edge workshops were run at Bowen (29-31 Oct) and Nebo (7-9 Nov). While we had him in the district, breeding and genetics specialist consultant John Bertram (previously DPI) was guest speaker at two field days. A day at 'Coovin' Clermont discussed bull selection on the 5th of November. How genetic gains can improve heifer management and breeder herd efficiency was discussed at 'Clarkwood' Clarke Creek on the 12th of November.

A field day to showcase the results of the Rolleston Market Compliance Producer Demonstration site was held on the 20th November.

There has also been activity at Moura, Bajool and Biloela. Ken Murphy and Paul Jones have discussed grazing systems, spelling strategies, pasture budgeting and calculating carrying capacity's with the old Moura CQ BEEF group. The old Bajool CQ BEEF group have met to discuss the balance between carbon and grazing with Dr Steven Bray and Biloela heard from Ian McConnell who holds the position of National Project Co-ordinator – Sustainable Beef with the World Wildlife Fund.

Articles on soil carbon and pasture rundown in this newsletter are a direct response to your feedback. Please keep sending in feedback sheets. We can only provide an industry relevant newsletter if you let us know where your information gaps are.

Due to budgetary constraints we will be moving from sending printed newsletters to email distribution in 2013. If we do not have your email we will be contacting you to add your email to our distribution list.

I hope you enjoy this edition; please send us your feedback.

On behalf of DAFF staff I would like to wish everyone a Merry Christmas and all the best for the New Year.

Byrony Daniels, CQ *BEEF editor*

From page 1

The rundown team has helped graziers assess the impact of rundown on 43 different paddocks this year. Each grazier was given a handheld fertiliser spinner and a bag of Green urea™ to spread on their pastures earlier this year. This product still needs rain to wash it into the ground and start working, but it is a special formulation that can last on the soil surface for up to 14 days before the nitrogen starts to break down and be lost. It's easy to do and gives a good indication of how much rundown may be affecting you.

If you are keen to try a few strips of Green urea this season to see the impacts of rundown on your own pastures, please contact Stuart Buck at DAFF Biloela on 4992 9187 or 0427 929 187.

Green urea fertiliser strips show the effect on different grass species on one property at Bell, SQ

Grass	Fertiliser kg N/ha	Dry matter		Colour 0-10[a]	Flowers/seed 0-10[a]	Protein %
		kg/ha	% increase			
Qld Blue	0	2090	---	3	2	3.1
	50	4936	136%	6	6	---
	100	6753	223%	7	7	8.2
Bambatsi	0	1682	---	4	2	6.5
	100	6535	289%	8	8	12.9
Green	0	9406	---	2	4	4.6
Panic	100	21932	133%	7	7	7.4
Rhodes	0	3016	---	1	3	4.2
	100	9429	213%	9	8	11.7
Creeping	0	2809	---	3	2	3.5
Bluegrass	100	6780	131%	9	4	8.3

[a] Scale of 0 being yellowest colour / no seeds to 10 being greenest / most seeds ever seen.

Climate update

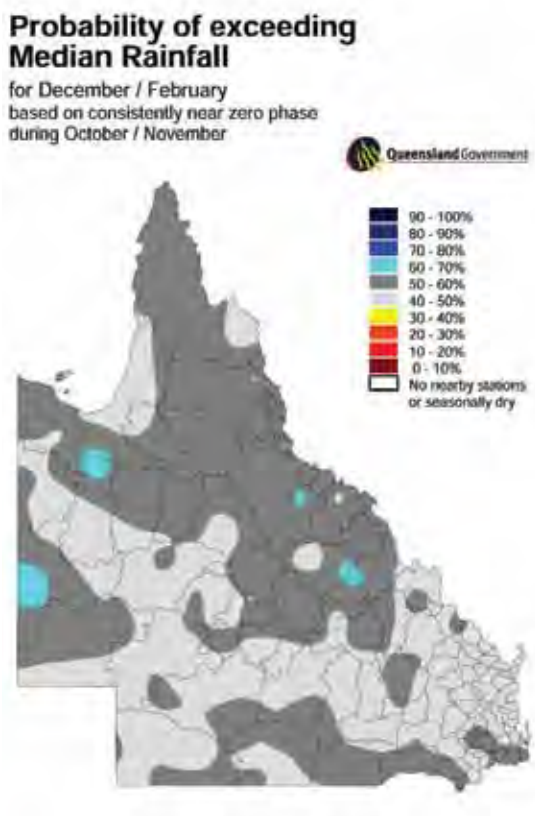
SOI in neutral phase

For the second month in a row the SOI has remained in a "Consistently Near Zero" phase. This phase is based on the shift in value of the SOI from the end of October (plus 2.3) to the end of November (plus 3.8).

By comparing the SOI phase at the end of November and historical rainfall records, the chance of getting above median rainfall for December through to the end of February across most of Queensland is predominately between 40 to 60% (or near normal).

For example Winton, Alpha, Rolleston, Dingo, Clermont, Nebo and Mackay all have around a 50% chance of getting above their long-term December to February median rainfall of 200mm, 235mm, 253mm, 296mm, 305mm, 335mm and 770 mm respectively.

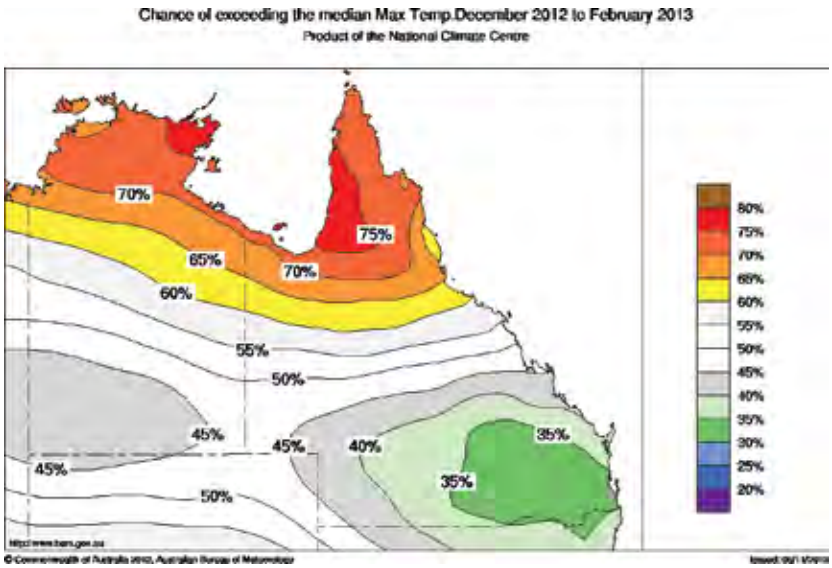
The last time there was a Consistently Near Zero SOI phase at the end of November was in 2004. Other years since 1960 that have had the same SOI phase at the end of November include: 1966, 1967, 1968, 1978, 1979, 1980, 1983, 1985, 1987, 1990, 1995, 1996, 2002, and 2003. It may be useful to find out what rainfall and seasonal conditions where like in your area for December to February in those years. More information can be found at www.longpaddock.qld.gov.au

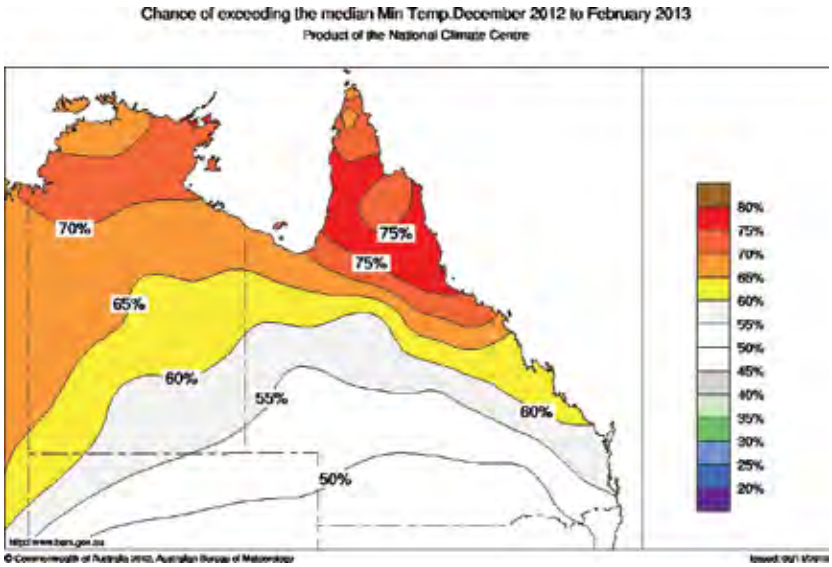


Temperature

Dave McRae and Mallory Terwijn
Department of Science, Information Technology, Innovation and the Arts

According to the Bureau of Meteorology www.bom.gov.au for the 3 months of December 2012 to February 2013 there is a 50% to 75% chance of exceeding the median maximum temperature for central and northern Queensland. The increased likelihood of warmer than average day time temperatures is also reflected with an increased likelihood of warmer than average minimum or night time temperatures throughout the northern half of the state.





Further Information

Climate indicators such as trade winds and tropical cloud patterns in the Pacific are currently at near neutral values. The international climate models surveyed by the Bureau to forecast the risk of El Niño and La Niña indicate the current neutral climate pattern is likely to remain for the remainder of summer. Of the 7 models reviewed, all indicate the continuation of a neutral climate pattern through to the end of May 2013 (with none indicating an El Niño). For more information try the ENSO Wrap-up produced by the Bureau of Meteorology available at www.bom.gov.au/climate/enso

When using a climate forecast you should remember that the probability or percent chance of something occurring is just that – a probability. For example if there is a 70% chance of recording more than 100 mm there is also a 30% chance of recording less than 100 mm i.e. 70-30; 30-70. It does not mean that you will get 70% more than 100 mm or 100 mm plus another 70%.

For more climate related information, updates on the SOI or seasonal outlook go to www.longpaddock.qld.gov.au

What is F.NIRS?

Désirée Jackson
Scientist (Beef)
Longreach

Diet quality results does not take into account the amount of feed available to stock.

There is only one method of determining the diet quality of grazing cattle in northern Australia – that is through the use of F.NIRS (Faecal Near Infrared Reflectance Spectroscopy – hence the acronym!).

F.NIRS analyses are a reflection of the diet quality at the time of sampling, not a historical record on performance, such as weighing. The F.NIRS technology has been specially adapted for tropical pastures in northern Australia.

Unlike other tests, cattle can be on a urea-based dry lick or block when a F.NIRS test is done, and that test will provide a diet quality result for the pasture the cattle are eating – it is not affected by small intakes of lick. Once cattle are provided with an energy (eg. cottonseed or fortified molasses) or protein meal (eg. cottonseed meal, copra meal, etc.) then the F.NIRS results are affected because the cattle are usually consuming large amounts of supplement. Generally, once they're on an energy-based supplement, the diet quality of the pasture is probably quite ordinary so there is no real need to test anyhow.

The results include predictions of:

- Dietary crude protein (CP)
- Dietary dry matter digestibility
- Faecal nitrogen concentration
- Non-grass proportion of the diet

Whilst one NIRS analysis provides a good indication of the current dietary status of the cattle, it is important to get an indication of how quickly diet quality is falling to determine when cattle are likely to require supplements, how long a supplement will be appropriate before it needs to be upgraded, and when cattle are likely to begin losing weight.

Getting consecutive analyses done for a paddock or a group of cattle that are of most concern is important for developing both short- and long-term nutritional management strategies.

More information?

If you want more information on collecting and preparing samples for F.NIRS analysis or understanding the technology, please contact your local beef extension officer, or Désirée Jackson, DAFF Longreach, 46 501 223, or mobile 0428 107 885.

Staff on a breeder property in northern Australia collecting fresh dung samples from a watering point, for F.NIRS analysis.

NIRS information makes decisions easy

Byrony Daniels
Beef Extension Officer
DAFF Emerald
07 4983 7467

Six grazing businesses across central Queensland have been submitting monthly faecal samples to track diet quality through near infrared reflectance spectroscopy (NIRS) since June 2012. The work has been supported through the second round of the Climate Clever Beef project, which is focussing on demonstrating ways of improving beef business profitability and productivity while reducing greenhouse gas emissions. Results have been interesting given that 2012 started as a wet year in many parts of CQ with unseasonal winter rainfall drying up in July. Frosts have also impacted diet quality in many regions. The tests were taken in the first week of every month.

Growing out steers

Robert and Jane Sherry have been testing 380 kg steers grazing a paddock of buffel grass (with some Indian Couch) on brown cracking clay scrub soils on their property "Wahroonga" in the Clarke Creek region. The steers are rotated between three paddocks. Steers turned off into the feeder market so far have averaged 417 kg. Robert estimates the remainder will be turned off February next year.

Figure 1 below shows diet quality results from June to September. The increase in quality from August to September is associated with a rotation to a fresh paddock. August's NIRS results prompted Robert to shift the steers earlier than he usually would have.

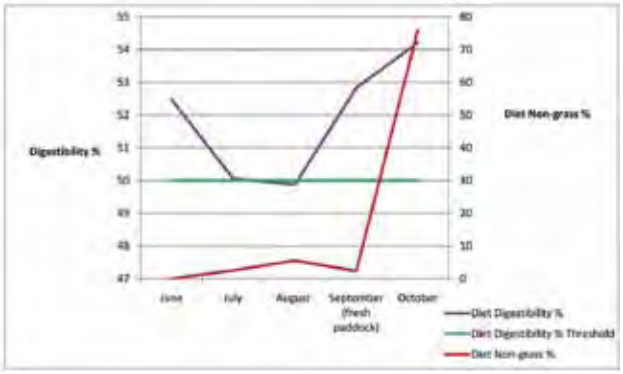


Figure 1. The predicted dietary digestibility of the Wahroonga steers' diet, June to September 2012 and its relationship to diet non-grass.

The steers were rotated into a buffel paddock with seca stylo. Digestibility is strongly correlated with energy, which means that as the digestibility of the diet increases, the energy level of the diet also increases. If we know the digestibility threshold for a steer to grow is at least 50% then rotating the steers into a new paddock with fresh feed would be expected to increase growth rates. The increase in the non-grass % of the diet in October would have contributed to the higher dietary crude protein. The non-grass component of the diet would have been principally a mixture of stylo and browse (currant bush).

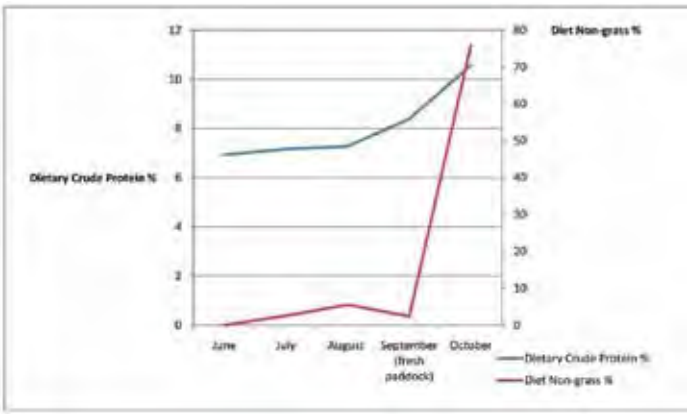


Figure 2. The relationship between crude protein and diet non-grass of the Wahroonga steers' diet, June to September.

Figure 3. Wahroonga steers in their fresh paddock. Photo taken 5/9/12.

Fattening steers

Brendan Black and Anna Schafferius have been testing a paddock of steers with a starting weight of 500 kg in May at "Morpeth" near Nebo. The steers have been grazing a Brigalow blackbutt buffel grass pasture (with some Indian couch present). Dietary crude protein and energy (measured by digestibility) declined from May to August. By August, digestibility had dropped below 50%, where we would expect

steers to be at best maintaining live weight. In addition, the dietary crude protein (6.5%) was declining to a level where a response could be expected to urea supplements. However for earlier turnoff a supplement such as fortified molasses or grain would be needed to increase growth rate, rather than a urea-based lick.

The bullocks will be finished on a grain self-feeder in the paddock to enable them to be turned off before Christmas. This decision was influenced by concerns about the timing of this season's break and the F.NIRS results.

If the intention is to hold cattle until after the wet season, compensatory gain should be considered. Compensatory gain is the better than expected weight gain that can occur when animals are on good feed following a period of slow growth or weight loss due to poor nutrition. It reduces the benefit of dry season supplementation and affects the economics of supplementation.

Unfortunately the impact of compensatory gain is hard to predict as it depends on the length and severity of weight loss, animal age and the quality of the wet season feed.

Weaners less than 6 months of age and 150 kg may never compensate and heifer fertility can be compromised by poor post weaning growth rates.

When asked what she's learnt from the exercise Anna responds "Quite often the grass you see in the paddock has less nutritive value than you think and it goes off quicker than you think in the dry". Anna also comments that she's now learnt to consider the nutritional requirements of the class of cattle grazing the pasture when assessing the information. "We have used NIRS information gathered during the last two years to guide our supplementation program for our breeders. We have been feeding energy in the form of whole cotton seed to our first calf heifers to enable them to maintain body condition and get back in calf while lactating. Brendon and I both believe having a productive breeder herd is one of the main drivers of a profitable business."

Figure 4. Morpeth bullocks. The photo was taken in July 2012 when the lead went to the meatworks. Photograph courtesy of Brendon Black & Anna Schafferius.

Figure 5. The bullocks' paddock, taken in September 2012. Photograph courtesy of Brendon Black & Anna Schafferius.

Breeders and stylo

Rob and Ainsley McArthur of "Mystery Park" St Lawrence have been testing 450 kg breeders which are rotated through seven paddocks. The paddocks are Ironbark forest with black spear and native bluegrass pastures and some blue couch is evident. Each test taken was in a new paddock.

The breeders were all pregnant with the remaining 40% of No 2 calves taken off in June.

Seca and Verano stylos are evident in the pasture and so likely make up the majority of the non-grass component of the diet. Dietary crude protein in May was good (8.6%) went higher in July (10.3%) and back down to 6.2% in August. The change in crude protein measurements paralleled changes in the non- grass level in the diet (May 42.9%, June 70.6%, Aug 9.6%).

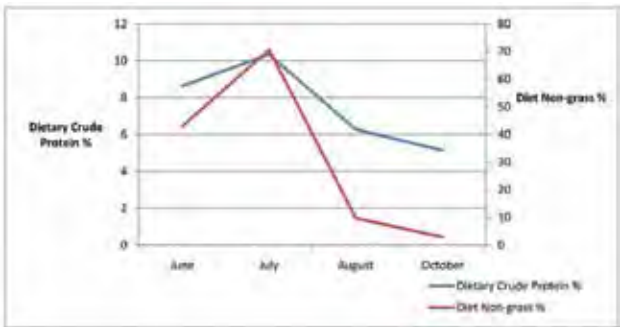


Figure 6. The relationship between crude protein, and diet non-grass of the Mystery Park breeders' diet, June to August 2012.

Ainsley McArthur confirmed that there was less legume in August and October pastures. The relationship between crude protein and diet non-grass has been a learning from the exercise for them. “Rotating and having fresh paddocks and fresh legume is really an advantage” Ainsley says. Another learning that Rob and Ainsley have discussed is that quite often urea won’t solve their problems. “It’s seems to be the nature of our country that digestibility and energy is the problem and our options are to spend a lot on energy supplement or look after cow condition through weaning management”.

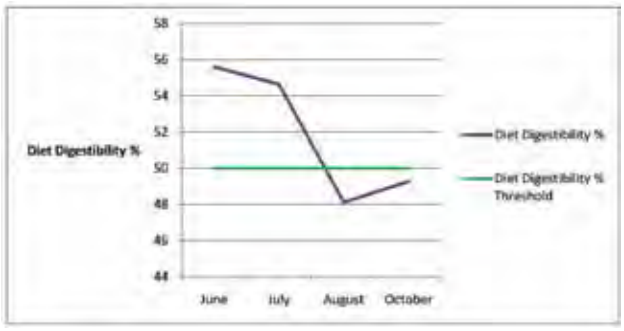


Figure 7. Forage digestibility of the Mystery Park breeders’ diet, June to August 2012 and the forage digestibility threshold for dry stock.

Figures 8 and 9. Mystery Park breeders. Photographs courtesy of Ainsley McArthur

Spelling strategies for recovery of pasture condition

Paul Jones
Senior Scientist
DAFF Emerald
07 4983 7415

Background

Wet season spelling of grazing land is a key recommendation for improving land condition. However, there is little reliable and relevant information on which to guide the design of cost-effective and practical regimes of wet season spelling. This project seeks to improve the evidence base and modelling capacity underpinning recommendations for use of wet season spelling to recover poor condition grazing land and design more reliable and cost-effective spelling options for producers. Funding is acknowledged from MLA and DAFF.

Project Details

Sites and treatments

Site 1 north of Clermont looks at the impacts of the timing, duration and frequency of spelling over a five year period (Figure 1a). The treatments are imposed on small plots within a paddock continuously grazed at the long term carrying capacity for the land type. Stock have free access to the plots when the spelling treatments are not being applied. Monitoring is also conducted in a rotationally grazed paddock adjoining the trial site.

Treatments at Site 1 are:

- Annual early wet season spell
- Biennial early wet season spell
- Annual full wet season spell
- Biennial full wet season spell
- Full wet season spell in year 1
- Full wet season spell in year 2
- Full wet season spell in year 3
- Full wet season spell in year 4
- Full wet season spell in year 5
- Continuous grazing.

The Site 1 plots are located in an area in 'C' land condition. It was originally part of a very large paddock with poor water distribution which contributed to poor land condition. The current owners (since 2001) have improved infrastructure to enable better grazing management.

Site 2 (Figure 1b) is being established at the Wambiana grazing trial near Charters Towers. This site encompasses two trials, with a smaller combination of spelling strategies, being tested on land in 'C' condition. One trial is subject to a moderate stocking rate, and the other a high stocking rate. As with Site 1 stock have free access to the plots when the spelling treatments are not being applied.

Figure 1. Spelling strategies research at (a) Site 1, near Clermont, and (b) Site 2, near Charters Towers.

Treatments applied in both trials at Site 2 are:

- Annual early wet season spell
- Biennial early wet season spell
- Annual full wet season spell
- Biennial full wet season spell
- Continuous grazing.

On-ground assessments

Pasture yield, composition, ground cover and soil surface condition will be recorded to document treatment responses (or lack of). Pasture yield is the weight of standing dry matter per hectare. Composition is the proportion of the key pasture species. Key pasture species such as desert bluegrass and the wiregrasses will be mapped on permanent quadrats to measure their persistence, recruitment, mortality and crown cover. Crown cover is measured on the perennial grasses at ground level. It is the area of living crown

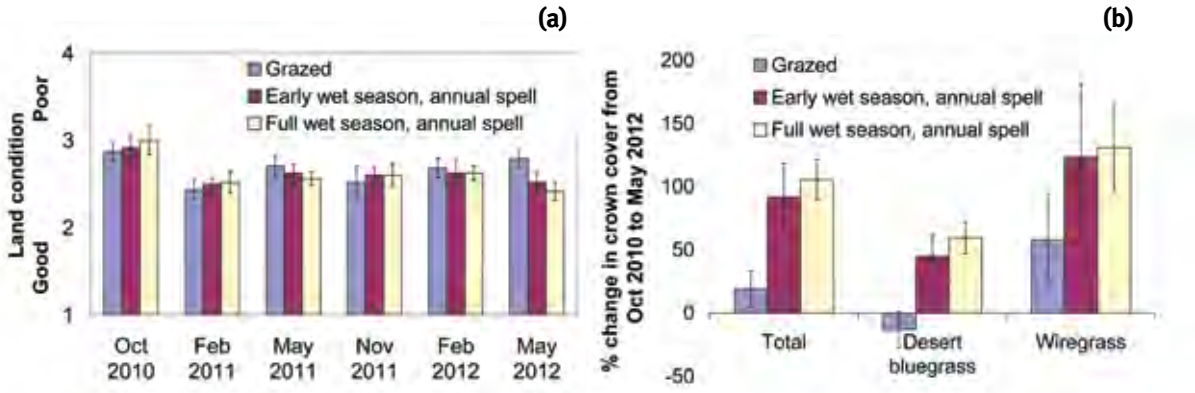


Figure 2. The effect of spelling strategies on (a) land condition, and (b) crown cover.

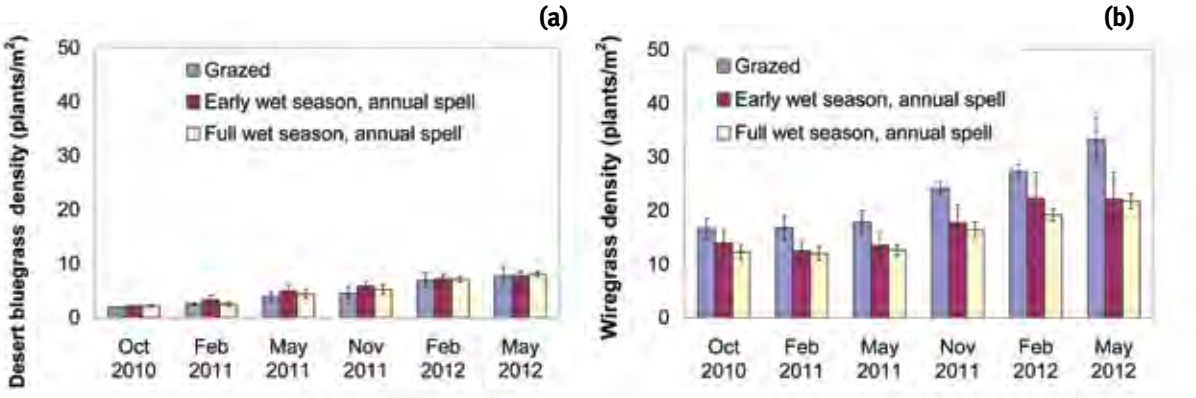


Figure 3. The effect of spelling strategies on (a) desert bluegrass, and (b) wiregrass density.

material at ground level and is a good indicator of the health and vigour of the pasture. Soil cores will be taken to determine seed reserves of pasture species. Plots are photographed at each recording. Land condition is calculated from the above pasture parameters to better understand changes in the ecosystem.

Results ... so far

Site 1 had predominantly dry or very dry conditions over the decade prior to the trial. Rainfall has been well above average for both years of the trial with 1052 and 953 mm received for 2010-11 and 2011-12 respectively. The good growing conditions have resulted in high pasture yields and crown cover.

Generally the spelling treatments have not impacted on the pasture dynamics compared to the continuously grazing area due to the above average growing conditions and the resultant low grazing pressure. Land condition has improved and has been driven by improvements in crown cover (Figure 2a & b). It would appear that crown cover in total, and of desert bluegrass is favoured by spelling.

Pasture yields and ground cover have increased across all treatments. Desert bluegrass and wiregrass recruitment has occurred with seedlings observed at all recording times. Most have survived, resulting in increased densities (Figure 3a & b). Hairy panic grass densities have also followed this trend.

The proportion of desert bluegrass in the pasture appears to be reduced by continuous grazing while the wiregrass appears to be increased (Figure 4).

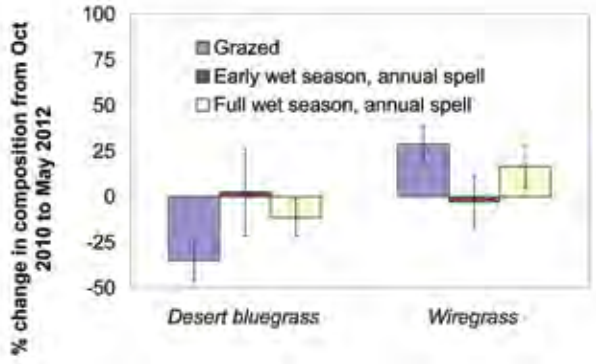


Figure 4. The effect of spelling strategies on the composition of desert bluegrass and wiregrass.

Discussion

A significant reduction in the contribution of wiregrass to the pasture composition and crown cover is a key desired outcome of this study. At Site 1, the lack of early change in pasture parameters with spelling treatments highlights the challenges land managers face when dealing with poor pasture condition. Good growing conditions for the two years of this study appear to have had an overriding effect on the pasture parameters recorded compared to treatment effects. Good seasonal conditions combined with a conservative stocking rate means that utilisation levels have been very low whether grazed or not. This demonstrates the importance of matching stocking rate to long term carrying capacity.

It is quite likely the pasture growth has been more limited by soil nutrition than by soil moisture under these wet conditions. The potential of the desert bluegrass to demonstrate enhanced growth compared to the wiregrass would have been limited.

Desert bluegrass has been observed as being slow to improve pasture composition under favourable management and good growing conditions. Its expansion appears to be restricted by a small, viable seedbank and is therefore slow to change density. The increase in density of desert bluegrass has been a very encouraging result. It will be interesting to see how spelling impacts the survival of these desert bluegrass seedlings.

The increased crown cover of desert bluegrass may indicate that it is primed to increase in density. The wiregrasses are known to decrease in density during dry periods. The longer-lived desert bluegrass may then be able to improve its level of composition in the pasture.

Grazing trials across northern Australia have had varied responses in land condition with wet season spelling. Many ecological studies have shown the sensitivity of perennial grasses to grazing during the early wet season growth period. There is still much to learn about the interactions of seasonal conditions, land condition improvement or maintenance and grazing management.

Key points

- **The first two years of the trial have received well above average rainfall**
- **Land condition has made a small improvement whether spelled or grazed**
- **Pasture yields and ground cover have improved whether spelled or grazed.**

Why soil organic matter matters

Fast facts

- Healthy soil is productive soil
- Soil organic matter plays a key role in soil health through biological, physical and chemical functions
- Undertaking particular management actions at specific sites will help maximise the benefits of soil organic matter

Soil health is important to optimise productivity in agricultural systems. Healthy, productive soil is a mixture of water, air, minerals and organic matter.

Soil organic matter contributes to a variety of biological, chemical and physical properties of soil and is essential for good soil health. It is composed of plant and animal matter in different stages of decay, making it a complex and varied mix of materials.

Functions of soil organic matter

Soil organic matter (SOM) is a key indicator of soil health because it plays a role in a number of key functions. These functions can be divided into three types:

- biological functions of SOM
  - o provides nutrients and habitat for organisms living in the soil
  - o provides energy for biological processes
  - o contributes to soil resilience (the ability of soil to return to its initial state after a disturbance, for example after tillage).
- chemical functions of SOM
  - o measure of nutrient retention capacity
  - o provides resilience against pH change
  - o main store of many key nutrients especially nitrogen and potassium.
- physical functions of SOM
  - o binds soil particles into aggregates improving soil structural stability
  - o enhances water holding capacity of soil
  - o moderates changes in soil temperature.

There are often strong interactions between these different functions. For example, the biological function of providing energy that drives microbial activity also results in improved structural stability and creates organic materials that can contribute to nutritional capacity and resilience to change.

Optimising the benefits of soil organic matter

Managing soil organic matter for a maximum contribution to soil health and resilience can present a conundrum.

Decomposition and mineralisation of organic matter are required for functions such as provision of energy and nutrients. However, the maintenance or increases in organic matter help to maintain its positive effects on soil chemical and physical properties.

So, when managing soil organic matter the never-ending turnover and the need to replace and rebuild is a constant demand of good agricultural practice.

When selecting management scenarios to optimise the benefits of soil organic matter the following needs to be considered for each particular site:

- what are the most important functions that organic matter provides?
- how big is the contribution of organic matter to soil health and resilience?
- Management actions that optimise the provision of these functions and maintain the contribution to soil health and resilience will ensure maximum benefit from soil organic matter.

Source http://www.csiro.au/Outcomes/Food-and-Agriculture/soil-organic-matter.aspx

Soil carbon: the basics

Source CSIRO
http://www.csiro.au/Outcomes/Environment/Australian-Landscapes/soil-carbon.aspx

Fast facts

- Soil carbon is part of the soil organic matter which is composed of decaying plant and animal matter
- There are four biologically significant types or fractions of soil organic carbon: crop and pasture residues and roots, particulate organic carbon, humus and recalcitrant organic carbon
- Each fraction has different functions due to the relative stability and biological availability of the carbon
- Factors such as water availability, soil type and management practices can influence the amount of carbon stored in the different fractions

What is soil carbon?

Soil carbon, or soil organic carbon (SOC) as it is more accurately known, is the carbon stored within soil.

It is part of the soil organic matter (SOM), which includes other important elements such as calcium, hydrogen, oxygen, and nitrogen.

Soil organic matter is made up of plant and animal materials in various stages of decay.

Un-decomposed materials on the surface of the soil, such as leaf litter, are not part of the organic matter until they start to decompose.

Different types of soil carbon

Soil organic matter is often reported in soil tests as the percentage of soil organic carbon present in the soil sample.

However, although determining the amount of soil organic carbon in soil is important for understanding soil health, knowing the type of organic carbon present is also important as this can greatly impact soil productivity.

There are four biologically significant types or fractions of soil organic carbon:

- crop residues – shoot and root residues greater than 2 mm found in the soil and on the soil surface
- particulate organic carbon – individual pieces of plant debris that are smaller than 2 mm but larger than 0.053 mm
- humus – decomposed materials less than 0.053 mm that are dominated by molecules stuck to soil minerals
- recalcitrant organic carbon – this is biologically stable; typically in the form of charcoal.

The different types of soil organic carbon not only differ in size but are also composed of different materials with different chemical and physical properties and different decomposition times.

Key functions of the different types of soil carbon

Each fraction of soil carbon has different functions, most of these are due to the relative stability and biological availability of each fraction:

- crop residues
  - readily broken down and provide energy to soil biological processes
- particulate organic carbon
  - broken down relatively quickly but more slowly than crop residues
  - important for soil structure, energy for biological processes and provision of nutrients
- humus
  - plays a role in all key soil functions
  - particularly important in the provision of nutrients - for example the majority of available soil nitrogen derived from soil organic matter comes from the humus fraction
- recalcitrant organic carbon
  - usually charcoal - a product of burning carbon-rich materials.
  - decomposes very slowly and is therefore unavailable for use by micro-organisms
  - many Australian soils have high levels of charcoal from millennia of burning.

The amount of each type of organic carbon in Australian agricultural soils varies significantly.

In rainforests or good soils organic carbon can be >10%, while in many poorer soils or soils which are heavily exploited, levels are typically <1%

The proportion of some fractions can also vary due to management practices. This is important as different fractions decompose at different rates and contain different quantities of nutrients, which will have an impact on the health and productivity of the soil.

Factors which influence soil carbon levels

Fast facts

- Soil characteristics, climate and management practices can alter the amount of carbon in soil
- Soil carbon is a balance between inputs (such as plant shoots, roots and leaves) and outputs (such as decomposition and conversion into carbon dioxide)
- Regardless of its potential, the amount of carbon a soil can actually hold is limited by factors such as rainfall, temperature and sunlight, and can be reduced further due to factors such as low nutrient availability, weed growth and disease

How much carbon can a soil hold – how big is your bucket?

Many factors, such as rainfall, temperature, vegetation and soil type determine the amount of carbon in soil.

Some of these factors are fixed characteristics of the soil, some are determined by the climate and some can be influenced by management practices.

The amount of carbon in a soil can be thought of as a leaking bucket that constantly needs topping up.

The size of the bucket represents the total amount of carbon the soil could potentially hold.

Factors such as clay content, soil depth and soil density will affect the size of the bucket, for example, the bucket will be smaller for sand than clay soil. Management practices cannot influence the size of the bucket.

Factors which affect soil carbon losses – how leaky is your bucket?

Losses of carbon from soil result from decomposition and conversion of carbon in plant residues and soil organic materials into carbon dioxide. Processes that accelerate decomposition open the losses tap further.

The rate of loss is determined by:

- type of plant and animal matter entering the soil
- climate conditions (rainfall, temperature, sunlight)
- soil clay content.

Some management practices which reduce carbon inputs and/or increase the decomposition of soil organic matter can also influence carbon losses. These include:

- fallowing
- cultivation
- stubble burning or removal
- overgrazing.

Factors which affect soil carbon inputs – how much are you re-filling your bucket?

Soil organic carbon inputs are controlled by the type and amount of plant and animal matter being added to the soil. Any practice that enhances productivity and the return of plant residues (shoots and roots) to the soil opens the input tap, re-filling the bucket and the amount of carbon in the soil.

The majority of carbon enters the soil as plant residues.

Fire can also contribute by converting plant dry matter into charcoal which enters the recalcitrant fraction. However, fire itself can lead to carbon losses through release of carbon dioxide.

Plant residue, and thus soil carbon inputs are mainly affected by the:

- type of plants being grown
- amount of dry matter the plants accumulate over the growing season
- environmental factors which govern plant production.

As a rule of thumb, only 5-15% of carbon inputs to soil become soil organic carbon (SOC). For example, if 10% of carbon inputs become SOC, and 1 tonne of dry plant material contains 450 kg of carbon, then this will add about 45 kg of SOC to the soil.

Soils under pasture tend to have higher SOC than soils under crops because:

- pastures have a higher root to shoot ratio
- soil under pastures is less disturbed
- soil under pasture has lower rates of organic matter decomposition.

In the grazing situation carbon input is maximised by maintaining vigorous pastures. These pastures have strong root systems

Source http://www.csiro.au/en/Outcomes/Climate/Adapting/Soil-Carbon-Levels.aspx

returning carbon, high levels of standing dry matter and good ground cover.

Overgrazing can seriously damage the pasture sward and soil health, leading to decreases in SOC. Heavy grazing reduces pasture growth rates (lower biomass production) and standing dry matter, and increases bare ground (allowing erosion and loss of topsoil and associated organic matter). It is important to reduce carbon losses from soil by improving and maintaining ground cover.

Actual soil carbon levels

Even though a soil may have the potential to store a certain amount of carbon, it is unlikely that this will be the actual amount that is ever found in the soil.

Limiting factors (such as the availability of water) will affect the attainable amount of soil carbon. While decreased productivity due to reducing factors (such as low nutrient availability, weed growth, disease, or subsoil constraints) will further lower soil carbon levels.

Managing for land condition

Paul Jones
Senior Scientist
DAFF Emerald
07 4983 7415

Producer profile:

John and Jan Burnett
Bendemeer
Clermont

Background

The Burnetts own and manage several properties in the Fitzroy and Burdekin catchments. The properties are mainly scrub, forest and downs land types with significant areas cleared with buffel grass established. The herds are mainly self replacing and turnoff is EU and Jap steers, domestic and EU females and cull cows. Most of the properties are developed so that cattle are not walking more than three kilometres to water and paddocks sized to carry less than 600 head for ease of management.

Managing for good land condition and animal performance is a key business priority for the properties to ensure future viability. This is achieved through conservative stocking, adjusting stock numbers to seasonal conditions, wet season spelling and burning.

Managing for land condition

John is quite passionate about land condition and the benefits it brings economically, ecologically, and to the management of the business. Good land condition enables the maintenance of carrying capacity and gives a good body of feed as a buffer for dry times. John believes that subtle changes to pasture management can have a major impact on productivity. "A two month wet season spell is not hard to manage and gives a big improvement. With good land condition and ground cover we can get a pasture growth response to almost any fall of rain, and at any time of the year (except on the very heavy clay soils)." It also gives the ecological resilience needed in pastures, when adjusting stocking rates for spelling and burning. Some paddocks may end up with a higher than desirable stocking rate for short periods and this is quite acceptable when you have good land condition.

> *"Subtle changes to pasture management can have a major positive impact on productivity"*

John uses a number of strategies to maintain and improve land condition. Firstly the property stocking rates are aimed to be lower than long term carrying capacity by 25%. This conservative strategy ensures not only good ground cover and a good bulk of feed, but also that 25% of the property can be spelled. Spelling may be for generating a fuel load for burning, or to regenerate the vigour of a pasture to improve land condition. Burning is conducted to rejuvenate pastures and control tree and shrub thickening. Burning is managed in conjunction with spelling. Regrowth is controlled through a multi-faceted approach using burning, chaining, chemicals and blade ploughing.

Stocking rate management

The overall stocking rate is constantly monitored via a comprehensive system where all paddocks are assessed annually. Pasture information and levels of woody regrowth are considered when estimating the long and short term carrying capacities of each paddock. The aim is to stock at 75% of long term carrying capacity for each property. This allows a large buffer of feed on hand for dry conditions. During dry conditions the stock numbers can be reduced through more stringent culling of the breeder herd, or earlier sales of the dry cattle. The numbers of cattle which are normally purchased onto the

properties will also be reduced. Cattle numbers are then built up gradually after a drought, as pasture resilience allows. Good distribution of water points assist with an even grazing distribution and effective infrastructure allows regular spelling.

"We could run more stock, but prefer to ensure our future viability by conservatively managing our cash flow and equity."

Integrated management

John believes the benefits of a planned stocking rate and rotational grazing have synergy with the practicalities of property management and stock husbandry. For example, where a paddock is to be burnt, adjoining paddocks will be run at a higher stocking rate for fire hazard reduction. Breeder herds can be rotated to another paddock following processing at branding or weaning, for ease of management. Turnoff cattle will be moved closer to trucking yards as they approach weights for their target markets.

"We always have 25% of our property area available for spelling, burning, or as a feed reserve."

John has cell systems in place which are used on some of the properties. Although originally installed in the early 90's to manage pasture degradation while retaining carrying capacity, these systems are now mainly used to educate young cattle. These small paddocks receive short grazes and long spells. Spelling regimes for most of the properties are dependant on paddock and herd size. Smaller paddocks are rotated more regularly, while the more extensive paddocks carrying 300-600 head are given a wet season spell at least every five years.

Looking back, looking forward

A critical time in John's career was when his father fed survival rations to their cattle in 1969 and he experienced the worst aspects of a drought. He has never repeated this practice, but supplements with a mineral/protein mix as required. Following on to the wet years of the early 70s and further property development, John believes that we all had high (and false) expectations of carrying capacity and pasture resilience due to the abundant growing conditions and recovery of the country.

"The result was we were very vulnerable to parthenium weed invasion into large areas of clay soils, and consequently the drought years in the early 1990s. We soon understood the competition characteristics between Parthenium and perennial grasses. However, we also realised that there was a whole host of management complexities to achieve viability while still managing for the health and vigour of perennial grasses to outcompete Parthenium. It is important that the beef industry (and related sectors) do not make the same mistakes following this run of exceptional seasons. Global Warming may have changed our climate forever, but my bet is there are more dry years just ahead somewhere!! We will continue to manage our pastures for the season we see at the time."

John is very positive about the landscape management of the grazing industry and believes a large portion of beef businesses are now managing stocking rates according to the seasonal conditions being received. "The satellite ground cover data that government departments have from the Grazing Systems Project has shown that a number of properties across Queensland have improved over the last 20 years. This is particularly noticeable through the droughts of the early 1990s and 2000s. There has been a dramatic improvement that shows as an industry we have demonstrated our improved management. This deserves public recognition."

John believes that financial systems still can be improved to better work in synergy with the grazing industry to achieve profitability and sustainability. "Mortgagees should not be encouraged to run high stocking rates to maximize short term cash flow. Conservative stocking rates should be encouraged to ensure future viability."

Summary

Well established infrastructure, together with a conservative stocking rate policy, reducing numbers during dry periods, wet season spelling, burning and a flexible rotational grazing system that works in synergy with the practicalities of management contributes to good land condition. This management system has enabled John to be in the position he wants, and expand the enterprise.

Key points

- **Managing for good land condition and animal performance is a key business priority**
- **Monitoring pastures and stocking rates at a paddock level every year**
- **25% of the property area is available for spelling, burning, or as a feed reserve.**

Staff Profile

Carly Harris

Technical Officer (Grazing Systems)
Emerald
07 4983 7420

Childhood: I was born and grew up on the outskirts of Gympie. I was heavily involved in showing cattle during high school for many local stud cattle producers. This encouraged me to enrol at university and study Animal Production Science.

Career: I graduated from the University of Queensland, Gatton Campus in December 2011 and began my position with DAFF in April this year. I am involved in the Spelling Strategies project which seeks to improve the evidence base and modeling capacity of wet season spelling to recover poor land condition in northern Australia.

Interests: I have a keen interest in agriculture and in particular the beef industry.

Producers gather 'round...

Ian McCamley talks to field day attendees about his cattle business and the decisions they make when sending cattle to the abattoir. At the Rolleston Market Compliance Field day.

The crowd at the Heifer Field day at Clarke Creek on the 12th of November.