Determining the extent of declining pasture productivity with nitrogen fertiliser

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Declining productivity of sown pastures due to a reduction in plant available soil nitrogen has typically reduced grass and beef production by 50% since initial land development within the Brigalow bioregion of southern and central Queensland. As this decline continues, it's estimated it will cost the northern beef industry more than $17 billion over the next 30 years. To assist landholders determine the extent of declining pasture productivity on their own properties, and assess the magnitude of response if more nitrogen is made available, nitrogen fertiliser was applied to approximately 70 replicated and non-replicated sites across southern and central Queensland between 2012 and 2014. Nitrogen (N) fertiliser as Green Urea NV® (Incitec Fertilisers) was broadcast onto existing grass-pastures in the lead up to a forecast rainfall event in summer. A range of rates were applied, from 25 – 200 kg N/ha, and dry matter yields and protein levels were measured. At all sites the grass pasture responded to the added nitrogen, with the magnitude of response dependant on the amount of nitrogen applied. As the production from sown pastures continues to decline, options that improve nitrogen supply and address this decline will be required to improve beef production across the northern region.

Key words
Northern region, sown pastures, nitrogen immobilisation, dry matter production, fertiliser.

Introduction

Sown pastures in the Brigalow belt of southern and central Queensland are highly productive and support approximately 32% of the beef herd in northern Australia (ABS 2012; Peck *et al.* 2014). However dry-matter production and quality of these pastures declines after sowing, typically due to a reduction in plant available nitrogen supply through immobilisation of nitrogen (N) in plant residues and soil organic matter. This productivity decline has reduced grass and beef production by around 50% and as the process continues it's estimated that the cost to the northern beef industry will be more than $17 billion over the next 30 years (Peck *et al.* 2011).

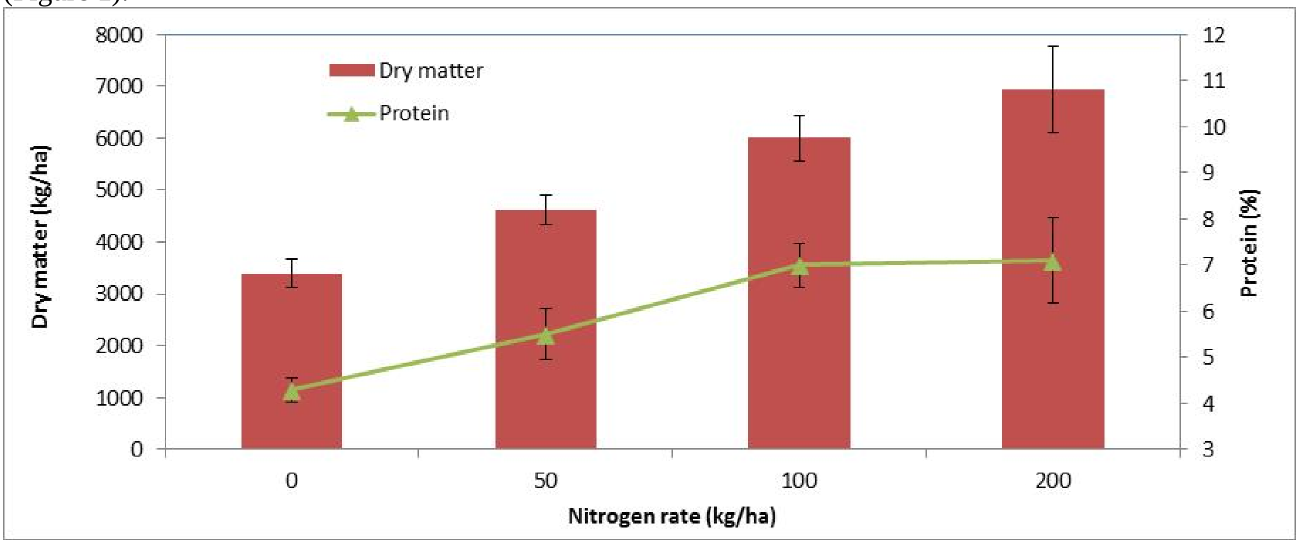
A range of options can be implemented to improve nitrogen supply to these pastures. Focus group discussions with beef producers indicate high awareness of the decline in grass production over time however many are uncertain of the cause of this decline with climatic (low rainfall or a run of dry years) or grazing management being stated as the drivers (Peck *et al.* 2011). To address this uncertainty, we engaged beef producers to assess the extent of pasture productivity decline on their own properties, using nitrogen fertiliser. The intention was to demonstrate that soil nitrogen supply to the sown pasture is the primary limiting factor, not that fertiliser *per se* is the solution. Once a producer recognises soil nitrogen supply as the cause, the next step of identifying appropriate solutions to address the issue can be assessed as other options, such as legumes could also play a role.

Methods

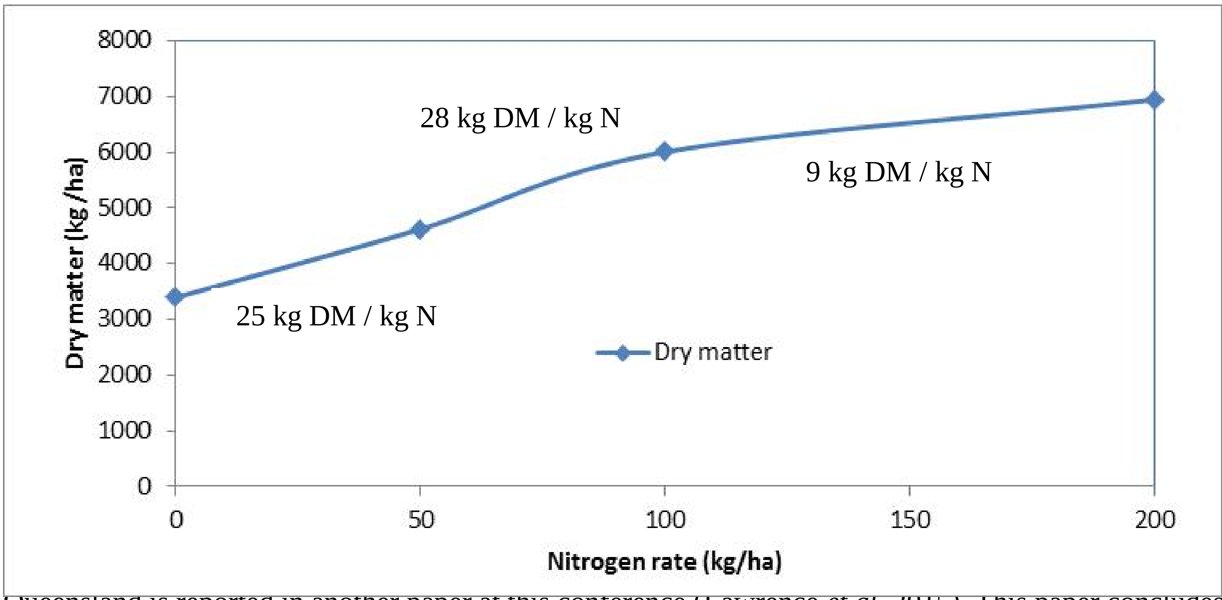
The aim was for beef producers to assess the extent of pasture decline on their own properties, and while pasture sites were selected on a random basis, each was assessed by the owner as having declining productivity. Fertiliser as Green Urea NV® (Incitec Fertilisers) was used due to its high concentration (N 46; P 0; K 0) and high availability of nitrogen, and simplicity of application. Nitrogen release from this product is inhibited for up to 14 days, which generally provides sufficient time for rain to fall and incorporate the nitrogen, making it ideal for broadcasting into pastures. Beef producers who attended a workshop to understand and learn how to recognise and manage pasture productivity decline were provided with a bag of fertiliser and a hand-held spinner to apply 100 kg N/ha in a strip 5 m X 20 m long. Most producers replicated this rate two or three times and also applied double and half rates, to broaden the investigation. The fertiliser was applied in summer and timed just prior to a forecast rainfall event to ensure incorporation. Cattle were excluded for 8 – 12 weeks following application to enable measurement of total pasture growth. All sites received sufficient rainfall (>50mm) during the summer growing season for the pasture to utilise the applied fertiliser. Just prior to the reintroduction of cattle to the paddock, or at the end of the growing season, quadrat cuts were taken within both the fertilised and adjacent unfertilised strips. This was done to assess pasture yield response and samples for whole-plant quality were also collected. Visual assessments of colour change, seed production along with height measurements were also taken, and these assessments were used to determine the extent of pasture decline at each site. Pasture samples were collected from each plot, dried at 80^{0}C and weighed to determine total standing grass dry-matter yield. Separate whole plant samples were collected and dried at 65^{0}C, ground to 2mm and analysed for total nitrogen. Results were then converted to protein by multiplying by 6.25.

Results and discussion

Response of sown pastures to nitrogen fertiliser
Applying nitrogen increased grass yield at all sites, the magnitude of which was dependant on the amount of nitrogen applied. At the higher nitrogen rates (100 kg N/ha and 200 kg N/ha), dry matter grass yield was around double that of unfertilised grass. This demonstrates declining sown pastures in central and southern Queensland have a large capacity to utilise extra nitrogen supply and produce higher pasture yield. Grass protein levels also increased, but only up to the 100 kg N/ha rate, beyond which protein levels stabilised (Figure 1).



rate increment, 25 kg of extra dry matter per hectare was produced for every kg of nitrogen applied. The response was similar at the next increment (50 -100kgN/ha) with 28 kg of extra dry matter produced for every kg of nitrogen applied. The response rate decreased to 9 kg of extra dry matter at the 100 – 200kg N/ha fertiliser rate increment, indicating lower dry matter response efficiency at N rates above 100kg/ha. The response rates recorded in this study are similar to previous research in central Queensland on a buffel grass pasture, where a response of about 30kg extra dry matter of grass per kg nitrogen applied up to 120kg N/ha was measured (Graham *et al*. 1981). It's anticipated the response rate would increase as pastures decline further over time, based on other pasture growth factors remaining the same.



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Queensland is reported in another paper at this conference (Lawrence *et al.* 2015). This paper concludes that when 100 kg N/ha of fertiliser is applied, average gross margins in the year of application were calculated to increase by 121 - 217% when dry matter yield responses of 40 kg DM/kg N (i.e. an additional 4000kg/ha) and an additional liveweight gain of 0.2 kg/AE/Day (i.e. an extra 70 kg AE/year) can be achieved.

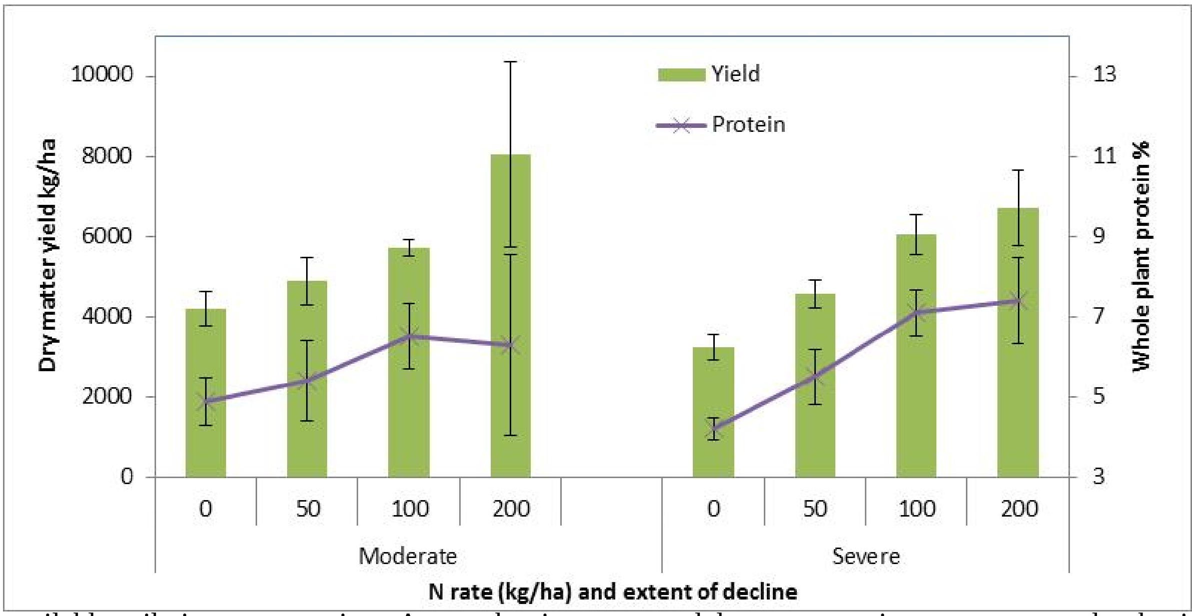
Extent and impact of pasture decline

An aim of this study was to demonstrate that soil nitrogen supply to the sown pasture is predominately the cause of declining pasture production, and not other factors such as rainfall. Before measurements at each site were undertaken, an assessment of pasture decline was conducted and sites were grouped into either ‘moderate’ or ‘severe’ pasture decline. A larger proportion of sites were assessed as having ‘severe’ pasture decline, and these pastures had lower dry matter yields (Table 1). This indicates productivity of most pastures across these districts has significantly declined, implying impacts to regional communities and the beef industry are high. The average pasture production from the unfertilised sites with ‘moderate’ pasture decline was almost 30% higher than the production from sites with ‘severe’ pasture decline. Combined with higher whole plant protein levels, sites with moderate pasture decline provide significantly higher beef productivity potential. This demonstrates the importance of determining the extent of decline and assessing options to reverse this trend before pastures reach a severe state.

Table 1. Dry matter yield and protein of pastures with either moderate or severe decline

Extent of pasture decline	Dry matter yield (kg/ha)	Whole plant protein (%)	Total number of sites measured
Moderate	4191	4.9	6
Severe	3229	4.2	35

The same nitrogen fertiliser rates produced comparable grass yields regardless of the extent of pasture decline, with higher variability occurring at the 200kg N/ha fertiliser rate for both dry matter and whole plant protein (Figure 3). This high variability maybe due to the low number of sites where this rate was applied, the lack of rainfall to enable the pasture to fully utilise this amount, or another limiting nutrient or environmental factors at one or more sites. Practically, this highlights the riskiness of applying such rates of nitrogen fertiliser in these districts, and that land managers need to assess small areas before such rates are applied across whole paddocks or properties.



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r dry- plant available soil nitrogen over time. Across the sites measured, larger proportions were assessed as having ‘severe’ pasture decline. This indicates the productivity of most pastures across these districts has significantly declined, implying impacts to regional communities and the beef industry are high.

Applying nitrogen fertiliser increased grass dry matter at all sites, the magnitude of which was dependant on the amount of nitrogen applied. At the higher nitrogen rates of 100 and 200 kg N/ha, dry matter yield was around double of unfertilised grass, demonstrating sown pastures with declining productivity have a large capacity to utilise extra nitrogen supply and produce more dry matter yield. Grass quality (protein) also increased, but this response was not as consistent as grass dry matter yield.

As the production from sown pastures continues to decline, beef producers need to assess the range of options and choose the one(s) that best suit their enterprise. The only long term solution to address declining pasture productivity would appear to lie in improving nitrogen supply through fertiliser use or integration of perennial legume species adapted to the landscape.

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