The feasibility of fertilising oats and forage sorghum with nitrogen and phosphorus in the Brigalow belt of Queensland: A modelling study.

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Abstract

Annual forage crops such as oats and forage sorghum are sources of high-quality feed for mixed grain and beef enterprises in the northern region. However forage productivity declines over time as organic matter and subsequent supply of nutrients decrease with continued cultivation. The use of fertilisers to maintain production from oats and forage sorghum is common practice in higher rainfall and irrigated situations, however fertiliser use in generally drier and more variable environments such as the Brigalow belt is minimal despite declining productivity. We undertook a desktop, modelling assessment of the feasibility of fertilising these forages with nitrogen and phosphorus in the Brigalow belt in southern and central Queensland to better understand the dry matter and feed quality responses necessary to generate positive economic impacts. Results indicated significantly higher dry matter production is possible with fertiliser use, which can lead to higher animal liveweight gain and stocking rates. However under current market conditions the additional costs associated with applying fertiliser outweighed the extra benefits that can be generated. A combination of high dry-matter and animal production responses, lower costs associated with fertiliser application and positive price margins for the livestock grazing the forage are required to make fertiliser application consistently profitable. This modelling study demonstrates land-managers in the northern region need to carefully consider and monitor both the production and economic responses from trial areas before paddock scale applications are implemented.

Key words

Northern region, modelling, oats, forage sorghum, gross margin.

Introduction

Annual forage crops such as oats and forage sorghum are sources of high-quality feed for mixed grain and beef enterprises in the northern region. Oats is the most commonly utilised annual winter forage, producing high quality feed at a time of the year when perennial sub-tropical pasture quality is low. This often enables graziers to finish stock six months earlier compared to if oats wasn't sown. Forage sorghum is popular during summer due high forage production that can support high numbers of stock. However forage sorghum grows at a time when sub-tropical perennial pastures are actively growing and are high quality, so one claimed benefit is to spell or rest large areas of grass pastures over the wet season. Other reasons for growing annual forages include: filling feed gaps; flexibility to match feed supply to seasonal conditions; opportunity to conserve excess fodder through hay or silage; consistent growth of stock throughout their lives to target premium markets (e.g. Meat Standards Australia grading).

Adequate soil nutrition is required to attain high amounts of quality forage for high animal performance (live-weight gain and stocking rate). In high fertility soils or recently cleared country, the inherent fertility and mineralisation from soil organic matter can generally supply enough of the main nutrients (nitrogen, phosphorus, sulphur and potassium) to sustain high forage yields and high feed quality. As cropping continues, without inputs and with cultivation soil organic matter declines and so does the supply of these nutrients to the point when fertilisers are needed to overcome nutrient deficiencies. Production and economic outcomes of fertilising these forage crops can be highly variable. Fertilisers add expense and generally high dry matter and live weight gain responses are required to overcome this extra cost. Despite declining productivity there is minimal fertiliser use in the generally drier and more variable environments such as the Brigalow belt. However limited studies have been carried out to determine the outcomes generated when these forages are fertilised with nitrogen and phosphorus.

Methods

A desktop, modelling study was undertaken to determine the feasibility of fertilising oats and forage sorghum in the Brigalow belt areas of southern and central Queensland. Modelled dry-matter (DM) production data from APSIM and information and data from past published research trials were analysed (Bell *et al.* 2012; Bowen *et al.* 2010; Chataway *et al.* 2011a; Chataway *et al.* 2011b), and regional experts consulted to ensure adequate coverage of readily available data. Expected biophysical production scenarios were then constructed in a spreadsheet to cover discrete soil fertility and rainfall scenarios possible from the geographic region.

Two separate forages (oats and forage sorghum) were modelled with three base levels of starting production with a range of levels of response to two different fertilisers. Forage sorghum had starting base production levels of either 5000, 10000 or 15000 kg DM per Ha per annum. These starting levels are taken to represent starting levels of inherent soil fertility not different starting levels of plant available water. Similarly, oats had starting base production levels of either 2000, 4000 or 6000 kg DM per Ha per annum.

The starting levels of forage production were taken to represent the likely average production of paddocks that were: (i) restricted by soil nutrient supply; (ii) slightly restricted by soil nutrient supply; or (iii) no soil nutrient restriction. All are taken to have the same underlying level of soil water holding capacity. Paddocks in such condition are considered the most likely to show an economic response to the application nitrogen and phosphorus fertiliser.

The response to nitrogen fertiliser was tested by treating each starting level of each forage crop with 50 kg N or 100 kg N and predicting an average extra response of 0.05kg/hd/d liveweight gain at 50kg/ha fertiliser input, 0.1kg/hd/d liveweight gain at 100kg/ha fertiliser input for forage sorghum, and 0.1kg/hd/d liveweight gain at 50kg/ha fertiliser input and 0.2kg/hd/d liveweight gain at 100kg/ha fertiliser input for oats.

To test the response to phosphorus, the middle level of production (10000 kg DM /ha forage sorghum and 4000 kg DM /ha oats) was treated with either 5kg P or 10 kg P per hectare with a range of responses estimated.

The economic impact of applied fertiliser on beef production was assessed using paddock level enterprise budgets and discounted cash flow techniques from costs and prices relevant to the market conditions in southern and central Queensland in 2014. This method was assessed as the most appropriate way to filter the production responses and identify the level of response needed to improve the relative profitability of the different levels of forage systems. The impact of the predicted responses is largely limited to how they compare in a relative sense to the base treatment. The paddock level enterprise modelled was a steer turnover/bullock production enterprise that purchased store steers and sold finished bullocks direct to the meatworks. The boundaries of the enterprise were the physical paddock boundaries. The only expenses incurred by the paddock enterprise are those that vary with the number of cattle run in the paddock such as husbandry and selling costs. An allowance was made for the amount of additional effort and cost required to apply the fertiliser. The enterprise budgets were compiled in the form of paddock gross margins and were be used to identify the profitability of differing levels of fertiliser response within paddocks.

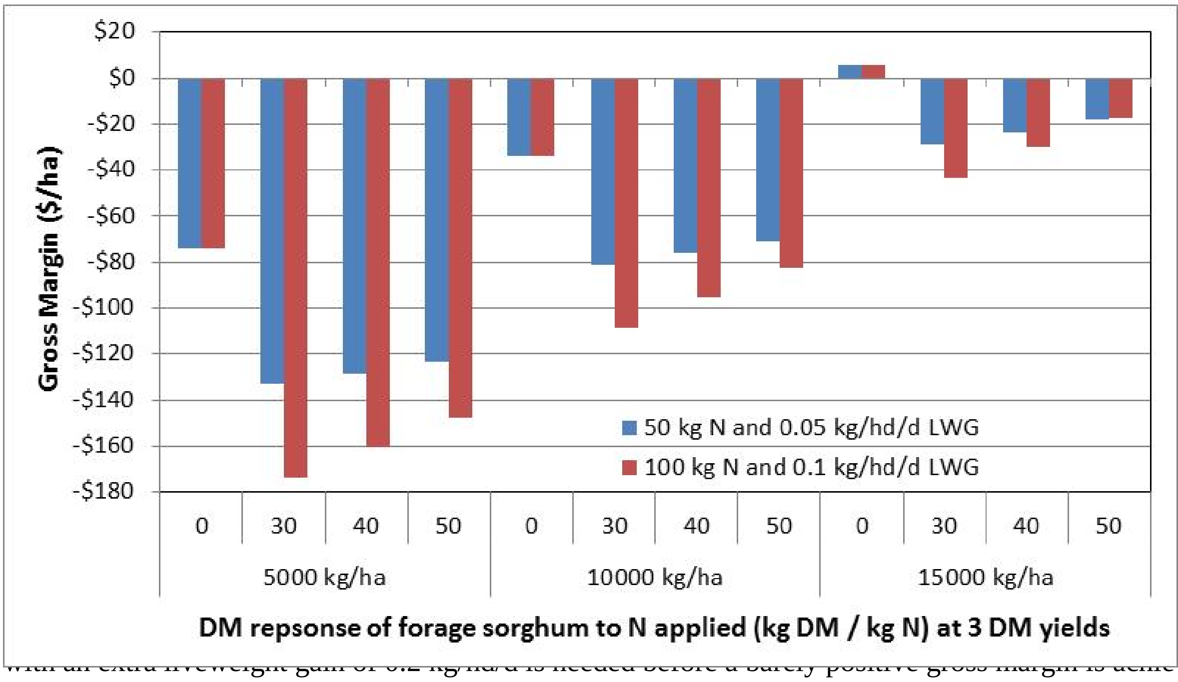
Results

Forage sorghum – Phosphorus fertiliser

The application of phosphorus fertiliser on forage sorghum makes the financial result worse in all cases ie negative gross margin for all scenarios (data not shown). At the levels of response, prices and costs chosen, there appears to be no realistic scenario for the application of phosphorus fertiliser to forage sorghum that appears capable of significantly improving the returns of the producer.

Forage sorghum – Nitrogen fertiliser

The application of nitrogen fertiliser on forage sorghum made the financial result worse in all cases. Except for the base scenario of 15000kg DM/ha without fertiliser, gross margins were negative (Figure 1). Increasing the production of beef through the addition of fertiliser simply increased the losses made. The relatively poor economic performance of the forage sorghum 'with' and 'without' fertiliser is largely a result of the high costs of producing the additional forage, the poor conversion rate of the additional forage to additional beef and the low price premium (on average) between the buying and selling price of the steers.



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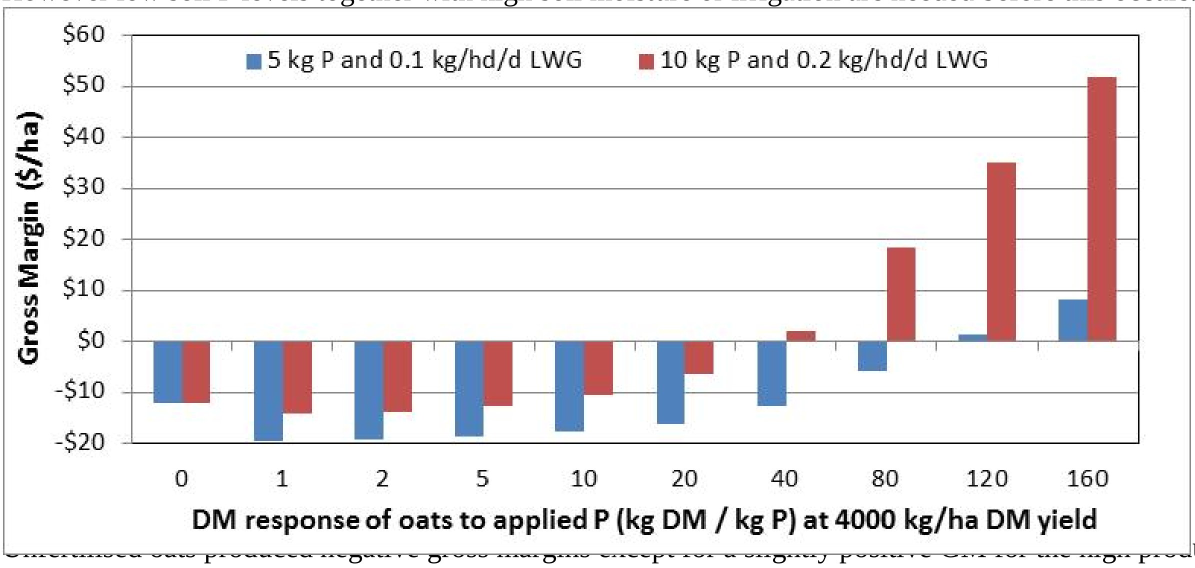
with an extra liveweight gain of 0.2 kg/hd/d is needed before a barely positive gross margin is achieved (Figure 2). The highest gross margin of around $50/ha was achieved when a plant response of 160 kg DM/kg P applied and 0.2 kg/hd/d extra liveweight gain. It appears that oats crops which have a moderate level of production may show a profitable response to applications of phosphorus if a very high stocking rate response per kilogram of fertiliser applied plus a high weight gain per head response can be achieved. However low soil P levels together with high soil moisture or irrigation are needed before this occurs.



Unfertilised oats produced negative gross margins except for a slightly positive GM for the high producing site (Figure 3). The economics of unfertilised oats, at all levels of baseline productivity, were only made worse by the application of N fertiliser, unless the scenario included response rates of 50 kg DM/kg N and 0.2 kg/hd/d LWG at the higher producing sites.

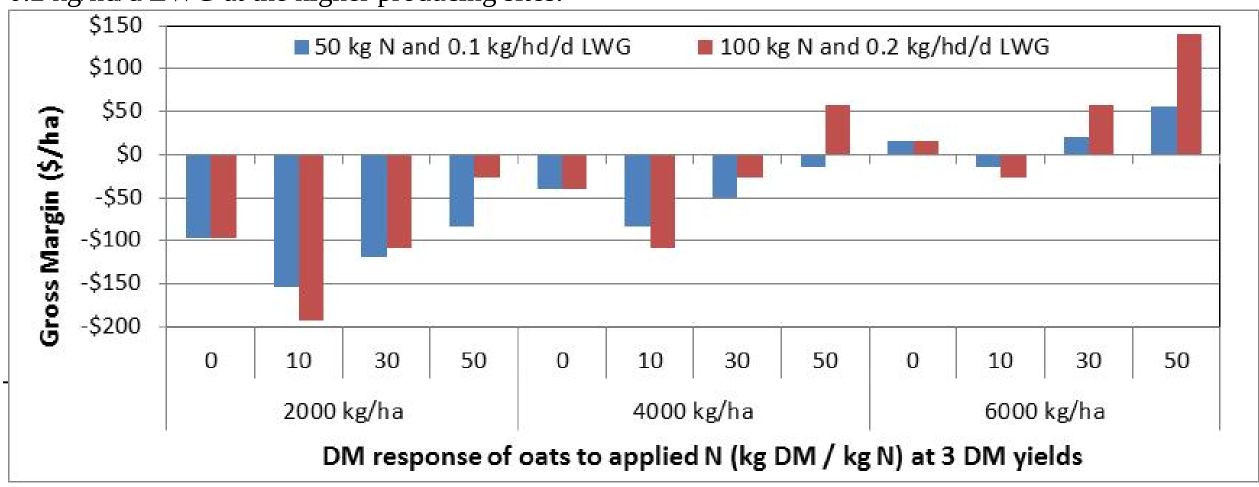


Figure 3. Gross margin for N fertiliser treatments and responses for oats

Discussion

This study indicates a lack of profitability of annual forages in the target region, and the inability of fertiliser to shift production to a profitable level. For oats there were some scenarios that provided a positive gross margin however these only occurred with a high plant response at a medium (4000kg/ha) or high (6000kg/ha) production site. However the only scenario that provides a positive gross margin with forage sorghum, albeit very small, is when 15000 kg/ha dry matter is grown without N fertiliser. Even the highest plant and animal responses didn't provide a profitable outcome. This indicates that fertilising forage sorghum is generally un-profitable under the animal response scenarios assumed in this study and that higher response or better price premiums are required to achieve a profitable outcome.

It is unlikely higher forage yield responses are biologically feasible for either crop. However, the magnitude of animal LWG responses to fertiliser is relatively unknown due to the paucity of past research into the impacts of fertiliser on diet quality. This analysis presumed applying fertiliser provides modest animal liveweight gain responses (0.05 kg/hd/d or 0.1 kg/hd/d) depending on the amount of fertiliser applied, whereas the main impact was to improve dry matter production and therefore stocking rates.

Conclusion

This desktop, modelling study demonstrates that the use of fertiliser is unlikely to generate extra profit from these forage crops. While some beef producers do use fertiliser, many have ceased growing annual forages. This analysis supports these actions and suggests that those producers fertilising annual forages may be better off considering alternative cropping or forage systems. Very high dry-matter and animal production responses in combination with lower costs associated with fertiliser application are required to make fertiliser application on annual forages in this region profitable. This study demonstrates land-managers in the northern region need to carefully consider and monitor both the production and economic responses from trial areas before paddock scale applications are implemented.

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