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The identification of regions where severe fire regimes affect red-meat producers: project extension

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Abstract

This project found that for most bioregions in northern Australia, where cattle properties had had substantial areas of clay soils, the fire frequency on those areas was slightly below recommended practice for grazing land management. On coarser-textured soils, fire frequencies were generally well above recommendations. This indicates that fire frequency on those soil types could be reduced and achieve emissions abatement without deleteriously affecting grazing land management.

Executive Summary

Project background and aims: This project was conducted to extend the findings of a previous study (B CCH 2065) that defined areas of Australia where the Savanna Burning Methodology under the Australian Government's Carbon Farming Initiative (CFI) could benefit red-meat producers.

Specifically, the objective of this project extension was to support improved allocation of resources to improve fire management for red-meat producers by better understanding how fire regimes vary according to land productivity. This was to be achieved by:

1. For each bioregion within the Australian rangelands, determining the frequency and seasonality of fires on poor, medium and high productivity pasture lands as indicated by soil texture (sand, loam and clay respectively) and vegetation type (using the National Vegetation Information System). This analysis was to be done for each bioregion as a whole and for the aggregate of all properties with more than 1000 head of cattle.

2. Producing a manuscript describing fire regimes on Australian cattle properties for submission to a scientific journal.

3. Producing a report to MLA describing the conclusion of the research. The results would be interpreted in the context of property management planning required to improve fire management on cattle stations.

4. In the report to MLA, recommending future research and development needs to better manage fire on cattle properties to sustain production values, minimise environmental degradation and greenhouse gas emissions and minimise risk.

In accordance with contracting agreements, neither the report nor the manuscript will enable identification of individual properties.

Achievements: We used available mapping of soils and vegetation to investigate whether the fire frequency on cattle properties was greater on poorer pasture types than better pasture types. In many bioregions this was the case, with fire frequency on clay soils or on tussock grasslands being lower than on sandy soils or other, usually woodland, vegetation types. This indicates that there are opportunities for producers to employ fire management for emissions abatement on lower-productivity land without affecting management practices on more productive parts of their properties.

Our previous analysis found that there are 73 properties with more than a total of 537 000 head of stock that are subject to late dry season fires that affect on average 36 % of the area every year. About half of these stock are on 21 properties in the Gulf Plains, Sturt Plateau and Dampierland bioregions. In the current analysis, we showed that where there are substantial areas of clay soils on properties in these bioregions those soils have fire frequencies slightly below recommended practice for grazing lands. Coarser-textured soils have substantial much higher fire frequencies. Therefore, reducing fire frequencies on the coarser-textured soils should not deleteriously affect red-meat production.

Description of industry benefits: When, how and who?

The previous study identified regions where reductions in the frequency of fires overall and late dry season fires in particular could contribute to the management of pastoral properties in northern Australia through the gaining of carbon credits from savanna burning emissions abatement. Concerns have been expressed that the reductions in fire frequency under such management could adversely impact red-meat production through woody thickening and reduction in pastoral productivity. We found that, where there are substantial (>10%) proportions of properties with clay soils, the mean fire return period was often about one fire every six years. This is in slightly less than recommendations for northern Australian semi-arid grazing lands to maintain pasture quality and production and prevent woody thickening (one every four years). Exceptions included Ord Victoria Plain and Gulf Plains bioregions where mean fire return periods on clay soils were well below that recommended to manage woody cover. On other soil types, fire frequencies ranged from one in four to one in two years – much higher than recommended for grazing land management. Fire frequency on the coarser textured soils could be reduced and achieve emissions abatement without deleteriously impacting pastoral production. There may be a need to increase fire frequency on clay soils to manage pasture and woody vegetation.

Contents

1 Background

This report is provided in fulfilment of contract B. CCH. 2085 between CSIRO and Meat and Livestock Australia Limited (MLA): The identification of regions where severe fire regimes affect red-meat producers project extension. This report should be read in conjunction with the previous report to contract B.CCH.2065. The previous report made a number of recommendations about future research. One of these recommendations was to address the questions: "*Are the parts of the properties that burn frequently those that are least valuable as grazing assets? Could improved fire management focus on the least used parts of properties without affecting grazing practice on better value pastures?"* Accordingly, the previous project was extended to allow the collation of data from the first analyses to be complemented by further analyses in which soil and vegetation types could be used as an indices of pasture quality.

2 Project Objectives

This project was conducted to extend the findings of a previous study (B CCH 2065) that defined areas of Australia where the Savanna Burning Methodology under the Australian Government's Carbon Farming Initiative (CFI) could benefit red-meat producers.

Specifically the objective of this project extension was to support improved allocation of resources to improve fire management for red-meat producers by better understanding how fire regimes vary according to land productivity. This was to be achieved by:

1. For each bioregion within the Australian rangelands, determining the frequency and seasonality of fires on poor, medium and high productivity pasture lands as indicated by soil texture (sand, loam and clay respectively) and vegetation type (using the National Vegetation Information System). This analysis was to be done for each bioregion as a whole and for the aggregate of all properties with more than 1000 head of cattle.

2. Producing a manuscript describing fire regimes on Australian cattle properties for submission to a scientific journal.

3. Producing a report to MLA describing the conclusion of the research. The results would be interpreted in the context of property management planning required to improve fire management on cattle stations.

4. In the report to MLA, recommending future research and development needs to better manage fire on cattle properties to sustain production values, minimise environmental degradation and greenhouse gas emissions and minimise risk.

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3 Methodology

3.1 Methodology – Overview of the data and its analysis

In order to identify regions where there are both high numbers of cattle and severe fire regimes, a number of data sets were collated into a Geographic Information System. Fire data had been obtained previously from Landgate and rainfall data from SILO and the Bureau of Meteorology. Data on Property Identification Codes (PICs) and the numbers of active devices on each under the National Livestock Inventory System (NLIS) were obtained from respective state agencies and NLIS Ltd by mid-October 2012, and these were used to construct an index of relative cattle densities.

The project sought to identify regions where there were both high densities of cattle on each PIC and severe fire regimes in each of four fire regions based on the analyses of Russell-Smith et al. (2007) but modified so that the Interim Biogeographic Regionalisation for Australia (IBRA) provided the boundaries between fire regions. Property data was collated for each bioregion so that individual properties could not be identified.

3.2 Methodology – Assembling the data

The following data sets were collated for the analyses required:

1. The Australian rangeland boundary developed by the Australian Collaborative Rangeland Information System;
2. National Livestock Identification System (NLIS) data for Active Devices for each Property Identification Code on 1 Jan 2011 in Western Australia, South Australia, Northern Territory, Queensland and New South Wales;
3. Locations of each Property Identification Code provided by the relevant state agency as either shape files (WA, SA, Qld, NSW) or centroids (NT);

4. Rainfall history[1] ;
5. Interim Biogeographic Regionalisation for Australia (IBRA7);
6. Fire history from Landgate (http://www.landgate.wa.gov.au/corporate.nsf).
7. Soil surface texture data from the Australian Soil Resource Information System (www.ASRIS.CSIRO.au)
8. Vegetation types from the Australian National Vegetation Information System

The collation of data in dot points 1 to 6 was described in the previous report. These data layers in the GIS were overlain with the soils and vegetation data for the analyses conducted here.

4 Results and Discussion

4.1 Results: The draft manuscript

The previous project (B.CCH.2065) required a draft manuscript to be produced. This was because of the requirement of the Carbon Farming Initiative that methodologies be based on research published in the peer-reviewed scientific literature. Further, there is a major knowledge gap on the use of fire in northern Australian grazing lands with only 10 % of research papers on the subject of fires in northern Australia being pertinent to the effects and use of fire in pastoral areas (McIvor 2010). The resultant scientific uncertainty is likely to impede acceptance of the application of CFI Savanna Burning Methodologies to grazing lands. This is particularly so given the specific exclusions within the Savanna Burning Methodology (Anonymous 2012) for increasing stocking rate and a means or consequence of reduced fire frequency. For the present project, the results were incorporated in to the previous draft manuscript. The draft manuscript gives the results and conclusions of the analyses conducted for this and the previous projects and is included as Appendix 9.1. It represents a first step in addressing the uncertainties surrounding fire management for greenhouse gas abatement on grazing lands.

4.2 Results: Summary of new findings

As an index of potential pasture quality that could be used at national, bioregional and property scales, we found that soil texture was more usable than the vegetation types. Clay soils were defined as those with a surface texture of >35% clay. Such soils are typically cracking clays and

[1] http://www.longpaddock.qld.gov.au/silo/

support better quality pastures. Of the 18 bioregions in northern Australia where fire frequency was relatively high, clay textured soils represented more than 10% of property area in 10 of the bioregions. Of these 10 bioregions, fire frequency was substantially lower on clay soils than on loam and sand soils in seven bioregions (see Table 1 in draft manuscript). In the remaining three bioregions, fire frequencies were similar across soils types, but for two of these the average fire frequencies were low, at 7% or less burnt per year on average. Only on Cape York Peninsula did clay soils represent more than 10% of pastoral properties and have high fire frequencies (>30% per year).

4.3 Discussion: Impacts on red-meat producers

The savanna burning emissions abatement methodology has arisen from a desire to reduce the frequency of fires overall and late dry season fires in particular. For much of the grazing industry, concerns have been expressed that if fire frequency is too low it leads to woody thickening. Thus, there has been a perceived conflict between the goal of the emissions abatement methodology and the goals of the grazing industry. Our previous analyses demonstrated that there are substantial number of cattle and properties where fire frequencies are very high, with more than one fire every three years. Our latest analyses have shown that apart from Cape York Peninsula, the frequency of fires on clay soils, and hence on the better quality pasture land is well below that on other soil types.

We found that, where there are substantial (>10%) proportions of properties with clay soils, the mean fire affected area on those soils was often about 14% to 18% equivalent to one fire every six years. This is slightly less than recommendations for northern Australian semi-arid grazing lands to maintain pasture quality and production and prevent woody thickening (one in four years) (Cowley et al. 2014; Dyer 2001). On other soil types, fire frequencies ranged from one in four to one in two years – much higher than recommended for grazing land management. Thus fire frequency on most clay soil areas is consistent with recommendations for grazing lands, and fire frequency on the coarser textured soils could be reduced and achieve emissions abatement without deleteriously impacting pastoral production. Exceptions included Ord Victoria Plain and Gulf Plains bioregions where mean fire affected area was just 4-7%, which is much lower than that recommended to manage woody cover.

We conclude that there is potential for red-meat producers to modify property management plans so that the frequency of late fires and fires overall on coarser textured soils could be reduced. This could generate accountable emissions abatement on lower productivity soils, without the risk of

increasing woodiness and decreasing pasture productivity on more productive soils. On the higher productivity clay soils, fire management would be better targeted to current recommendations for pasture and woody vegetation management rather than for fire emissions abatement (Cowley et al. 2014).

5 Success in Achieving Objectives

In fulfilment of the objectives, the analysis of interactions of cattle density, fire regime and pasture quality has been included in the draft scientific paper to be submitted to the Rangelands Journal. The annual extent of fire and its seasonality is described across the rangelands at the scale of four broad rainfall classes and at bioregional scales within those rainfall classes. The variation in fire frequency across soil textures and vegetation types is described. Data from the National Livestock Inventory Scheme is used as an index of cattle density on properties and presented at the scale of bioregions to avoid breaching privacy obligations.

In the draft scientific paper, the following seven bioregions contained properties with medium to high cattle densities and a high frequency of late dry season fires: Daly Basin, Dampierland, Central Kimberley, Sturt Plateau, Gull Falls and Uplands, Ord Victoria Plains and Gulf Plains. These frequencies are well above those recommended for grazing land management. Fire frequency generally appears to be lower, and in keeping with recommended practice, on better grazing lands as indicated by clay textured soils or tussock grasslands. Except for Daly Basin, the mean annual rainfall of all of these bioregions is less than 1000 mm so they are excluded from the current Savanna Burning Methodology. However, they could be included in the lower-rainfall methodology currently under development.

6 Impact on Meat and Livestock Industry

6.1 Now

As required, this project has identified regions where improved fire management is likely to lead to reduced greenhouse gas emissions and benefit red-meat producers. Seven bioregions identified in the draft manuscript where research into fire management for emissions abatement on cattle properties could improve participation in the Carbon Farming Initiative. In most of these, the fire frequency is lower on the more productive soils indicating that reductions in the frequency of late

dry season fires can focus on areas of lower pastoral productivity. Specific knowledge gaps have been identified in section 7.

6.2 In five years time

In five years, the cattle properties in northern Australia that suffer from relatively frequent late dry season fires could be accessing the carbon economy to support improved fire management and to reduce greenhouse gas emissions. Research supported by Meat and Livestock Australia could have led to improved management of frequent fire for those properties and regions subject to frequent late dry season fires and led to reductions in greenhouse gas emissions. Such research would aim to reduce uncertainties that may restrict access to the CFI and would support business models for involvement in carbon trading through reductions in emissions from fires.

7 Conclusions and Recommendations

1. In addition to the conclusions and recommendations of our previous report, we have found that in northern Australia fire frequency on clay soils where they occupy more than 10% of properties is often slightly less and in some cases much less than recommended practice for semi-arid savannas. The exception to this is Cape York Peninsula where fire frequency is high across all soil types. In most of northern Australia, on coarser textured soils, fire frequency is substantially greater than recommended practice for grazing lands and thus fire management for emissions abatement could reduce that frequency without deleteriously affecting production.

2. In addition to the key research and development questions regarding potential adoption of CFI Savanna Burning Methodologies on grazing lands that were identified in the previous report, research could also target the following knowledge gaps

    a. **Overall lack of knowledge:** We have demonstrated that for many red-meat producers, fire frequency is very high on their properties, yet as was identified in a previous MLA study (McIvor 2010) relatively little research has been conducted on the interactions of grazing land management and fire. There is a wide range of issues that need to be addressed to enhance sustainable grazing land management in the context of frequent fires in northern Australia that have been raised by McIvor (2010).

b. **Finer resolution support to red-meat producers wishing to engage in savanna burning for emissions abatement:** The previous project and this project extension focused on understanding patterns at national and regional scales. Having identified cattle producing regions with high potential to participate in the current emissions abatement methodology and the potential future low rainfall methodology, finer scale studies could contribute to multi-property fire management plans. Such plans would require involvement of property managers/owners and could take account of current plans and historic spatial patterns of fire occurrence, grazing intensity and soil types.

c. **Other aspects of fire management:** The Einasleigh Uplands, Desert Uplands and Brigalow Belt North bioregions, have high cattle densities on properties, strongly summer dominant rainfall but relatively low fire frequencies. In these bioregions there may be advantages for some red-meat producers in using more fire to manage pastures and the tree/grass balance. As well, clay soils on properties in most bioregions across northern Australia have fire frequencies less than recommended for woody vegetation and pasture management. What social and biophysical issues affecting fire management in these regions and the potential benefits from changing fire management? There are now available tools to predict spatial patterns of fire behaviour across landscapes under various fuel, weather and landscape conditions and to predict the outcomes for tree populations. With appropriate field calibration, and consultation with all stakeholders, such tools could be used to improve advice to producers on the goals and practice of using fire.

8 Bibliography

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9 Appendices

9.1 Appendix 1: Draft Manuscript for *Rangelands Ecology and Management*

Interactions between fire regimes, grazing and soil types in Australian rangelands: a continental scale analysis

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Abstract

The strategic use of early dry season fires has been advocated to reduce the greenhouse gas emissions from burning of savannas in Australia, but most of the research supporting this has come from outside of commercial grazing lands and in areas with more than 1000 mm rainfall. In this paper, we aimed to identify regions where commercial pastoral properties could alter fire regimes to reduce greenhouse gas emissions. We examined the interactions of fire regimes and cattle density across the 51 bioregions within the Australian rangelands. We showed that fire frequency increases greatly with increasing summer dominance of rainfall. Within the humid north of the rangelands where fire frequency is greatest, increasing cattle density is associated with declining fire frequency. Seven bioregions were indentified where at least some properties had both a high frequency of late dry season fires and relatively moderate to high densities of cattle. Often the fire frequency was least on the clay soils which usually support better pasture than on sand soils. This provides opportunity to manage fire on poorer quality grazing lands for emissions abatement without influencing management actions on more productive lands. Adoption of approaches to reduce emissions from fires in these bioregions is contingent on further research into quantifying the impact of fire management on emissions at rainfall levels less than 1000 mm and understanding the interactions with cattle production and management.

Introduction

Fires burn across more than 300 000 km^2 of northern Australia's tropical savannas annually (Russell-Smith et al. 2007). Emissions of the greenhouse gases nitrous oxide and methane from Australian savanna fires comprise 2 to 4 % of annual accountable emissions (Cook and Meyer 2009). This is a uniquely high proportion for an OECD country. Much research has focussed on improving the accuracy of emissions estimates and on developing land management practices to reduce the pyrogenic emissions. These emissions were first quantified as part of the Kapalga Fire Experiment in Kakadu National Park Northern Territory (Hurst et al. 1994), which was established in response to frequent, widespread and intense late dry season fires in the Kakadu lowlands (Andersen et al. 1998). It was suggested that increased use of patchy early dry season fires could reduce overall fire frequency and fuel combustion and consequently reduce greenhouse gas emissions (Cook 2003; Cook et al. 1995). Following further research (Cook and Meyer 2009; Meyer et al. 2012; Russell-Smith et al. 2003a; Russell-Smith et al. 2009b), this approach was formalised as a methodology under the Australian Government's Carbon Farming Initiative (Dreyfus 2012) and will be referred to herein as the Savanna Burning Emissions Abatement Methodology. Successful application of this methodology allows carbon credits to be issued which can be sold on a carbon trading market. Specifically the methodology requires that reductions in emissions from fires must be achieved by planned and purposeful deployment of prescribed early dry season burns in combination with other natural and constructed barriers and active extinguishment to stop the spread of fire. The

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