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Linking leucaena to carbon abatement opportunities in Australia
Leucaena: Una oportunidad para la reducción de carbono en Australia

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Abstract

The Australian Government has committed to reducing its greenhouse gas (GHG) emissions by 26–28% below 2005 levels by 2030. The Emissions Reduction Fund (ERF), a center-piece of Australia's climate change policies, provides incentives to reduce GHG emissions through economy-wide eligible activities, such as energy efficiency, waste management, revegetation, livestock management and savanna fire management. Emissions Reduction Fund methods define eligible activities, how to quantify abatement resulting from the activity and the required compliance measures.

The requirements for developing ERF methods that quantify GHG abatement estimates resulting from eligible activities are described. Leucaena planting is used as an example. For an ERF method to be made and maintained, the activity must meet all the legislative requirements. This includes meeting the offsets integrity standards and having regard to any adverse environmental, economic and social impacts.

Keywords: Climate change, emissions, Emissions Reduction Fund, greenhouse gas, national inventory, offsets integrity standards.

Resumen

El gobierno australiano se ha comprometido a reducir, para el año 2030, las emisiones de gases de efecto invernadero (GEI) de Australia en un 26–28% por debajo de los niveles de 2005. El Emissions Reduction Fund (ERF), una pieza central de las políticas de cambio climático de Australia, proporciona incentivos para reducir las emisiones de GEI, a través de actividades elegibles relacionadas a la eficiencia energética, el manejo de residuos, la revegetación, el manejo de ganado y el manejo de incendios de sabana. Los métodos ERF definen las actividades elegibles, cómo cuantificar la reducción resultante de la actividad, y las medidas de cumplimiento requeridas.

Los requisitos para desarrollar los métodos ERF que cuantifiquen las estimaciones de reducción de GEI resultantes de las actividades elegibles se describen en este trabajo. El cultivo de la leucaena para forraje se utilizó como ejemplo. Para que se pueda realizar y mantener un método ERF, la actividad debe cumplir con todos los requisitos legislativos. Esto incluye cumplir con las normas de integridad (*offsets integrity standards*) y tener en cuenta cualquier impacto ambiental, económico y social adverso.

Palabras clave: Cambio climático, emisiones, Fondo de Reducción de Carbono, gases de efecto invernadero, inventario nacional.

Introduction

In line with international frameworks, the Australian Government has committed to reducing its greenhouse gas (GHG) emissions by 26–28% below 2005 levels by 2030 (Department of Environment and Energy 2015). In 2016, agricultural emissions contributed 12.6% of Australia's total emissions. For the 2030 targets to be

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reached, agricultural industries must make a contribution and opportunities for the agricultural sector to reduce emissions must be identified.

One possibility in northern Australia is the planting of leucaena, which could both increase livestock productivity and reduce enteric methane emissions. The combination of reductions in enteric emissions and possible increases in soil carbon would contribute to reducing Australia's GHG emissions.

For an Emissions Reduction Fund (ERF) method to be designed that provides incentives for using leucaena as a livestock feed, the activity must meet all legislative requirements. Importantly, methods must meet the offsets integrity standards as stated in Section 133 of the *Carbon Credits* (*Carbon Farming Initiative*) *Act 2011* (Australian Government 2017) to maintain scheme integrity and deliver credible abatement. The offsets integrity standards require that endorsed methods must credit only abatement that: (a) is additional to that which would occur normally; (b) is measurable and verifiable; (c) contributes to reducing Australia's GHG emissions; (d) is supported by clear and convincing evidence; (e) accounts for project emissions; and (f) results in a conservative estimate of net abatement. In addition, before establishing a method the Minister for the Environment must consider whether activities under endorsed methods are likely to result in adverse economic, environmental or social outcomes [Subsection 106(4) *CFI Act*] (Australian Government 2017). All ERF methods are regularly reviewed to ensure they continue to meet the offsets integrity standards and other legislative requirements, and reflect new scientific knowledge.

Domestic climate change policy in an international setting

Australia's National Greenhouse Gas Inventory (NGGI) (Department of the Environment and Energy 2018a) is compiled using methodologies consistent with the international guidelines and reporting rules prepared by the Intergovernmental Panel on Climate Change (IPCC) and adopted by the United Nations Framework Convention on Climate Change (UNFCCC).

Australia's National Inventory Report (NIR) is submitted to the UNFCCC as part of Australia's reporting obligations under the UNFCCC and the Kyoto Protocol. The NIR contains both national GHG emission estimates and estimation methods from 1990 onwards. The annual NIR (Department of the Environment and Energy 2018a) and the annual GHG projections (Department of the Environment and Energy 2017) enable the Government to track progress against Australia's emissions reduction commitments.

Under international reporting obligations, sources of agricultural emissions are: enteric fermentation; agricultural soils; manure management; liming and urea application; rice cultivation; and field burning of agricultural residues. In 2016, emissions from Australia's agricultural industries contributed an estimated 69.1 Mt CO_2-eq, which represents 12.6% of Australia's total emissions (Figure 1) (Department of the Environment and Energy 2018b). Enteric fermentation was the main source of agricultural emissions and was estimated to be 49.7 Mt CO_2-eq or 71.9% of all emissions from agriculture. The next largest source was agricultural soils (18.5%), followed by manure management (5.2%).

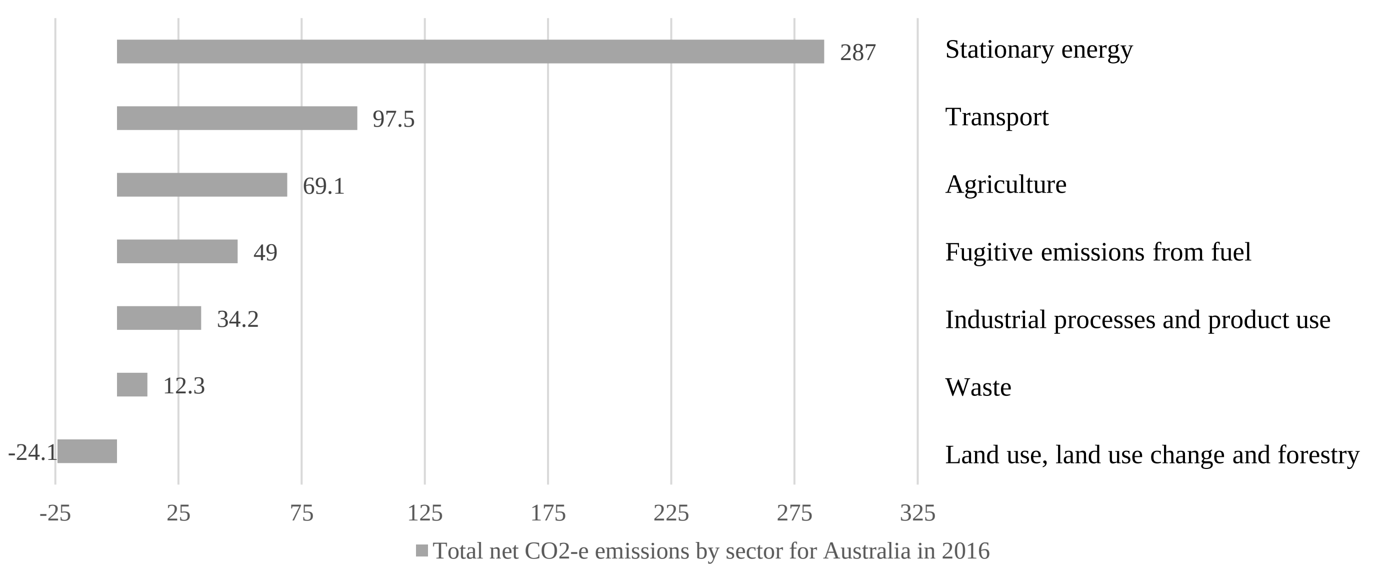

Figure 1. Total net CO_2-eq emissions by sector for Australia in 2016 (Department of the Environment and Energy 2018b).

In Australia, many in the agricultural sector are endeavoring to identify opportunities to reduce emissions. Large agricultural organizations such as Meat and Livestock Australia (MLA) are exploring opportunities to achieve net zero emissions, i.e. carbon neutrality (Meat & Livestock Australia 2017).

The Emissions Reduction Fund

The Emissions Reduction Fund (Department of the Environment and Energy 2018c) is a voluntary scheme that establishes methods which provide incentives for land managers, businesses, local councils and state governments to adopt new practices and technologies that will reduce Australia's GHG emissions. Methods have been developed for improved land management in forests and agriculture, savanna fire management, improved transport efficiency and energy efficiency, facilities, mining and waste to landfill and waste water management practices. Methods may be varied as new technologies become available, to add new eligible activities and to reduce unnecessary regulatory burden.

The Australian Government develops ERF methods that estimate GHG abatement resulting from implementing technologies and management practices (Department of the Environment and Energy 2018c). ERF methods describe: eligible activities that generate abatement by avoiding GHG emissions or sequestering carbon; how to quantify abatement resulting from the activity; and the required compliance measures. Registered projects allow proponents to use approved ERF methods to earn Australian carbon credit units (ACCUs). Once earned, ACCUs can be sold to the Australian Government or to other businesses seeking to offset their emissions.

Methods are legislative instruments and must be adhered to by scheme participants. To ensure ACCUs are credible and the abatement generated contributes toward Australia's emissions reduction targets, ERF methods must comply with the *Carbon Credits* (*Carbon Farming Initiative*) *Act 2011* (Australian Government 2017). Each project must comply with a number of individual project eligibility requirements in that Act along with the *Carbon Credits* (*Carbon Farming Initiative*) *Regulations 2011* (Australian Government 2015) and *Carbon Credits* (*Carbon Farming Initiative*) *Rule 2015* (Australian Government 2018).

An independent Emissions Reduction Assurance Committee (ERAC) provides advice to the Minister for the Environment on whether proposed new methods meet the offsets integrity standards, as specified in Section 133 of the *CFI Act*. The Minister must have regard to any adverse environmental, social or economic impacts, when deciding whether to make an ERF method [Subsection 106(4) *CFI Act*] (Australian Government 2017). Existing ERF methods are reviewed periodically by the ERAC to ensure they continue to meet the offsets integrity standards and other legislative requirements.

These reviews may indicate that an activity that was initially assessed as eligible may no longer be eligible. This may occur if there are changes in other legislation or unforeseen adverse economic, environmental or social impacts occur. Methods can be suspended by the ERAC if they have reasonable evidence that one or more of the offsets integrity standards is not being met. The Minister can also revoke and vary methods.

The Clean Energy Regulator administers ERF projects and contracts (Clean Energy Regulator 2018). Applications can be made for projects to be registered under an ERF method, and for a project to be registered under a method it must meet a number of individual project eligibility requirements. Projects must be new, and not required by law or already funded under a listed government program. There is also a list of 'excluded offsets projects', which could lead to particular adverse impacts, such as the planting of certain defined weed species.

Once projects are registered under an ERF method, proponents are required to undertake the eligible activity or activities and regularly report to the Clean Energy Regulator on the amount of abatement they have achieved. Projects are periodically audited to ensure they are undertaking the activity and estimating abatement as prescribed in the method.

Potential for planting leucaena as an eligible ERF project activity

Planting leucaena in agricultural systems is used here as an example to demonstrate the types of considerations when assessing whether activities would be eligible under an ERF method. This activity is assessed against the offsets integrity standards (s133 *CFI Act*) (Australian Government 2017). There are also other legislative requirements for consideration such as whether the activity is likely to have adverse impacts [Subsection 106(4) *CFI Act*] (Australian Government 2017) – also assessed here. These requirements maintain the integrity of the ERF and ensure that the value of ACCUs remains comparable across sectors. Requirements are:

1. Abatement must be additional to that which would occur in the absence of the project: Emissions Reduction Fund methods cannot permit activities that are likely to occur in the absence of the ERF, such as

being undertaken prior to project application. The combination of method eligibility and individual project eligibility requirements applies appropriate filters, so that only genuinely additional projects can be credited. For leucaena, this means that ERF projects should not be eligible if there is no additional planting of leucaena, or where non-carbon drivers would ensure that leucaena would be planted in the absence of the carbon market.

2. Estimates of net abatement must be measurable and verifiable: Emissions Reduction Fund methods must describe a measured or modelled approach for calculating the net abatement resulting from the project activity. This approach must be supported by robust scientific evidence. Estimates of net abatement must be verifiable by an auditor and the Clean Energy Regulator. In the case of leucaena any approach would need to take into account variables affecting the extent to which methane emissions are reduced, such as preferential grazing (the proportional consumption of leucaena in the diet); and possible variability in enteric methane production between cattle breeds, leucaena species and geographic locations. Calculations must account for natural variability and credit only that abatement resulting directly from the project activity.
3. The net abatement resulting from projects using ERF methods must contribute to Australia's GHG targets: Abatement credited under ERF methods must contribute to Australia meeting its international GHG targets. To achieve this, the change in emissions resulting from the project activity must be evident in Australia's annual GHG accounts. Currently the national accounts do not estimate enteric emissions at a farm scale, and therefore do not detect differences in enteric emissions resulting from local changes to the composition of feed intake. The national inventory would require data on the scope and type of these changes for it to be sensitive to farm-scale differences in feed practices. This accounting approach must be consistent with the IPPC Guidelines for national inventories.
4. There must be clear and convincing evidence that supports the estimates of net abatement: Emissions Reduction Fund methods estimate methane emissions by direct measurement or using models that must provide robust estimates of the net abatement amount. Models must be calibrated with appropriate empirical data.

   Studies to quantify enteric methane emissions from livestock fed different diets have largely been conducted using intensive respiration chambers, where inputs and outputs can be accurately measured (e.g. Hulshof et al. 2012; Newbold et al. 2014; Charmley et al. 2015). In contrast, Tomkins et al. (2018) estimated herd-scale methane fluxes using open path laser technologies and Coates and Dixon (2007) applied faecal NIRS methodologies and $\delta^{13}C$ ratios. These and other studies (e.g. Charmley et al. 2008) have demonstrated there is a reduction in enteric methane and improved emissions intensity resulting from a change in diets for livestock, including livestock change to feeding leucaena.

   It is difficult however to extrapolate these laboratory results to grazing herds, as it is not easy to determine the preferential leucaena or grass grazing practices for herds and individual cattle. Implementing these approaches to estimate net abatement could be complex and costly, thereby reducing the potential for uptake of the activity for generating carbon credits.
5. Methods must account for all material emissions resulting from undertaking the project activity in estimating the net carbon abatement: Performing activities that reduce emissions or sequester carbon may generate additional emissions. Under the ERF, all material emissions that result from the project activity must be accounted for and must be deducted from the abatement resulting from the activity to determine the net abatement amount. For example, for leucaena, GHG emissions resulting from the use of machinery involved with planting and managing leucaena, and the use of irrigation and fertilizer must be calculated and deducted from the gross abatement. Carbon and nitrogen interactions during growth of both grass and leucaena (Conrad et al. 2017) that differ from those occurring before the project was implemented must also be accounted for.
6. Estimates of the net abatement amount must be conservative: It is important that the estimates, projections and assumptions in the calculations in ERF methods do not overestimate the credits that should be issued for a project. 'Conservative estimates' help ensure that estimates of net abatement do not credit more abatement than is evident in Australia's national accounts. That is, when 1 t CO_2-eq is estimated to have been abated due to an ERF project, the national inventory report should also account for at least 1 t CO_2-eq of emissions reduction. All assumptions and estimates for parameters used to calculate abatement must result in a conservative estimate of net abatement. Discounts are sometimes applied to net abatement estimates where there is uncertainty in the science. These discounts may be

reduced over time, with additional research outcomes contributing to more refined estimates of parameters.

7. Methods must address any likely adverse environmental, economic or social impacts from carrying out the project: The Government seeks to avoid activities under ERF methods that result in any adverse environmental, social or economic outcomes [Subsection 106(4) *CFI Act*] (Australian Government 2017). To address any potential unintended adverse outcomes resulting from undertaking ERF projects, methods are assessed at the time of their development and again during periodic reviews. Leucaena is currently classified as an environmental weed as it spreads rapidly and can form dense thickets. In some regions, regulations support appropriate management to prevent or minimize its spread. The potential risk of adverse environmental outcomes as a result of promoting the planting of leucaena under a carbon scheme will need to be periodically reviewed. In addition, the inclusion of leucaena in carbon schemes must consider minimizing the risk of leucaena toxicity to livestock. If the weed classification of leucaena was changed in the future, such that planting it as part of an ERF project activity becomes an excluded offset activity, then new projects would not be eligible under the ERF.

Potential carbon abatement using leucaena

Leucaena is a perennial legume that originates from Central America. It grows best in areas with deep, well-drained, alkaline soils high in phosphorus and receiving more than 600 mm of annual rainfall that occurs throughout the year. Leucaena is more drought-tolerant than most other pasture species, and is relatively frost-intolerant. In Australia, about 125,000 ha have been sown with leucaena (Beutel et al. 2018), the majority being in central Queensland.

Enteric methane emissions from livestock can be reduced by increasing the fermentable crude protein in the diet. Legumes like leucaena are high in crude protein and methane emissions per unit of feed consumed are lower on diets containing legumes (Kennedy and Charmley 2012; McSweeney and Tomkins 2015; Harrison et al. 2015; Vercoe 2015; Conrad et al. 2017). Kennedy and Charmley (2012) demonstrated a 30% reduction in enteric methane produced by livestock fed an optimal leucaena and grass diet relative to a pure grass diet, while Harrison et al. (2015) observed reductions of more than 23%, relative to baseline emissions, in animals fed leucaena.

Liveweight gains are greater when livestock are fed a leucaena-pasture grass combination, compared with many other mixed fodders or pasture grasses (Tomkins et al. 2018). Leucaena provides highly digestible protein and the grass provides a source of roughage and energy. The improved liveweight gains result in earlier turn-off ages or heavier turn-off weights. As a result, the enteric emissions generated per unit of meat production are lower. This is known as the *emissions intensity* for each unit of production.

A reduction in the emissions intensity can be credited under the ERF as is the case for more efficient energy use in the industrial sector (Department of the Environment and Energy 2018d). Eligible activities under the ERF beef cattle herd management method (Department of the Environment and Energy 2018d) include those that promote more efficient liveweight gain in pasture-fed beef cattle herds and increase the weight:age ratio of the herd. Under the ERF beef cattle herd management method the focus is on the outcomes resulting from the activity, rather than identifying specific eligible activities.

Pastures containing a mix of leucaena and grass contain higher crude protein concentration and more biomass than straight pasture grasses. This results in the potential to sustainably increase stocking rates (Harrison et al. 2016). Despite improvements in emissions intensity per animal, an increase in stocking rates has the potential to increase overall emissions from the herd. Emissions Reduction Fund methodologies credit the abatement resulting from improved emissions intensity per animal, but this can be offset by increased stocking rates and hence increased overall emissions by the herd or per unit area.

As a perennial legume, leucaena fixes nitrogen and increases the store of carbon in the soil. For example, Conrad et al. (2017) demonstrated an increase in soil carbon of 280 kg C/ha/yr in the top 30 cm of a vertisol soil in a leucaena-buffel grass grazing system over a 40-year period. Improvements in soil carbon concentrations are most evident when legumes are planted in nitrogen-depleted soils (Conrad et al 2018), and where there are minimal or no deficiencies of soil phosphorus and sulphur (Radrizzani et al. 2016). Where soils are low in P and S, nitrogen fixation and carbon storage can be improved by applying fertilizers. However, where improved management practices focus on carbon abatement, consideration must be given to the potential for additional emissions from this use of fertilizer.

An increase in soil carbon sequestration as a consequence of planting legumes is an eligible activity under the ERF measurement of soil carbon sequestration in agricultural systems (Department of the Environment and Energy 2018d). This method focuses on the outcomes resulting from the activity, rather than defining specific activities that are eligible. Only carbon that is sequestered as a result of undertaking the ERF project activity is considered to be genuine abatement.

Conclusion

Scientific evidence demonstrates that inclusion of leucaena in the diet of cattle in northern Australia can result in improved productivity, reduced enteric methane emissions and improvements in soil carbon levels. If promoting leucaena plantings were to be considered under the ERF, a method of crediting needs to be developed consistent with the offsets integrity standards. Each project would have to meet the individual project eligibility requirements. A key challenge for all potential methods is getting the balance right between accuracy, simplicity and practicality so that genuine projects can be rewarded for their contribution to lowering GHG emissions.

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(Note of the editors: All hyperlinks were verified 4 August 2019.)

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