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Effective incentives for reforestation: lessons from Australia's carbon farming policies

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Abstract

Large-scale reforestation will rely at least in part on private landholders who are motivated to increase forest cover on their properties. Well-designed incentives can encourage landholder adoption of reforestation within production landscapes, while delivering social, economic and biodiversity co-benefits. Here, I draw on lessons from extensive research on barriers and enablers to landholder adoption of tree planting, the growing literature highlighting the potential benefits of assisted natural regeneration (ANR) for large-scale reforestation, and experiences from a voluntary land-based carbon abatement ("carbon farming") program implemented in Australia since 2012, where tree planting and ANR comprise several approved reforestation methods. Carbon farming projects to date have primarily adopted the ANR methods, yet program outcomes have been undermined by increased deforestation elsewhere in Australia. Policy uncertainty, the provision of co-benefits and the availability of trusted information are key factors influencing landholder adoption. Incentives for reforestation must be underpinned by a coherent and complementary policy mix which facilitates long-term participation and genuine environmental outcomes.

Highlights

- Large-scale reforestation will rely on participation of private landholders
- Carbon farming has the potential to incentivise reforestation in production landscapes
- Assisted natural regeneration offers ecological and economic benefits over tree planting in landscapes which retain regenerative capacity

- Landholder adoption is influenced by co-benefits, policy certainty and coherence, and social networks
- Incentives for reforestation must be underpinned by effective controls on deforestation

Introduction

The international community has committed to end deforestation and restore 350 million hectares of degraded forest landscapes by 2030 [1–4], as part of agreements under the UN Framework for Climate Change [5], UN Convention on Biological Diversity [6], and UN Sustainable Development Goals [7] Translating such aspirations into on-ground outcomes will require governance interventions which can support and motivate communities to participate in forest protection and restoration [8,9]. The 2015 Paris climate agreement explicitly recognizes the importance of financial incentives to deliver carbon and non-carbon benefits from forests [5], and encouraged the 195 Parties to the Convention to implement and support such forest governance approaches. In 2015, $888 million was committed to forest carbon offset projects across voluntary and compliance markets worldwide [10].

Meeting ambitious targets for large-scale forest restoration will require a substantial increase in the current rate of reforestation [1,9,11], and the majority of reforestation opportunities lie in production and mosaic landscapes [12–16]. The carbon market provides an opportunity for landholders to receive financial benefits in return for sequestering carbon in vegetation and soils, otherwise known as 'carbon farming' [17–19]. However, adoption of afforestation and reforestation (A/R) activities under the UN Clean Development Mechanism to date has been lower than anticipated [20,21], and forest carbon credits from tree planting projects are costlier and traded at a third of the volume of credits from avoided deforestation and degradation (REDD+) projects in 2015 [10,22].

If widespread adoption of reforestation is to be achieved, there is a need to design and implement governance interventions which can align this goal with the attitudes, values and motivations of private landholders [2,9,20,23]. An extensive literature on landholder adoption of new methods [20,24] and experiences from programs which provide incentives for tree planting [25–30] highlights a range of barriers which can prevent the participation of landholders in such initiatives. A mostly separate, yet growing body of literature emphasizes the potential for farmer-managed and assisted natural regeneration (ANR) of secondary forests to deliver carbon abatement and multiple co-benefits at a large scale [14,31–34]. In landscapes where natural regeneration of forest is possible, ANR is often a far more cost-effective reforestation approach [8,18,32], yet tree planting remains the primary focus of carbon farming and other reforestation programs [13,35].

In this paper, I review the current state of knowledge about the use of incentives to encourage adoption of reforestation by landholders in production landscapes. I focus primarily on governance interventions where the main goal is to deliver carbon abatement, though I also consider how such programs can also provide economic, social and biodiversity co-benefits. I draw on a case study in Australia, where tree planting and ANR comprise several approved reforestation methods available through participation in a voluntary carbon farming program. I conclude by describing how the efficacy of incentives for reforestation are reliant on a mix of complementary instruments, including the provision of clear, accessible and trusted information, and institutional arrangements which discourage further deforestation.

Carbon farming as a mechanism for reforestation

A large body of work has examined the potential economic returns and carbon abatement generated through establishment of tree plantings in production landscapes [36–41]. Much of this work has come out of Australia, where incentives for tree planting are available as part of a voluntary carbon farming program [42,43](see Box 1). Concerns about the potential negative environmental impacts of large scale monocultures [19,44] led to a renewed focus on how tree planting could profitably deliver social and biodiversity co-benefits alongside carbon abatement and complementary land uses [45–49]. Planting with a diversity of native trees and shrubs (‘environmental’ plantings) in place of fast-growing monocultures will typically require a higher carbon price, or the addition of a biodiversity ‘premium’ to encourage landholder adoption [45,46,50].

Notwithstanding these economic considerations, research on landholder adoption of tree planting highlight a range of other factors which influence their willingness to adopt [20,24], including: access to high quality information [20,51], financial costs and benefits, such as establishment and management costs, labour requirements, the likely impact on farm productivity and property value, the risk of seedling or tree death; and access to diverse income streams [23,25,26,29,52,53]; farm size and characteristics, including whether tree plantings can flexibly integrate amongst existing land uses [12,26,51]; the likely provision of social, cultural, and environmental co-benefits [26,27,30,54]; landholder socio-demographics, social norms and attitudes towards tree plantings on agricultural land or as a carbon abatement activity [23,25,26,55]; and uncertainty over future government policy settings and market prices for carbon and other commodities [25,52,56].

Although it has received comparatively limited attention as a reforestation approach to date, ANR offers several advantages over tree planting which may assist in overcoming some of the previously identified barriers to adoption. In the first instance, ANR can be highly cost-effective [13,18,57] since it uses low-cost techniques which accelerate the re-establishment of tree and shrub species naturally occurring at a site [8,58–60]. Regenerated secondary forests are often preferable for local biodiversity than tree plantings (especially monocultures) and are more likely to secure natural ecosystem functions which provide resilience to invasion by weeds and pests, and climatic risks such as fire and drought [18,44]. By exploiting the natural regeneration potential of degraded and deforested landscapes, ANR offers considerable economies of scale [2,15,61] and offers greater potential to facilitate large-scale reforestation than tree planting under current carbon prices [18,52]. However, tree planting will often be more suitable in landscapes which have been extensively modified, and lack the natural regenerative capacity (e.g soil seed bank and small trees) required for ANR to be viable [13,18].

Despite its potential for low-cost and biodiverse carbon abatement in across a range of forest ecosystems [2,8,9,14,58,62], there are few examples where ANR has been facilitated through a specific governance intervention [18,63]. Australia provides a useful case study to examine the efficacy of carbon farming as a mechanism for reforestation, since a range of tree planting and ANR approaches have been available to adopt as approved carbon abatement methods since 2012 (Box 1, Table S1).

<< insert Box 1 around here >>

Has carbon farming led to large-scale reforestation in Australia?

Research has identified large parts of Australia where reforestation may be economically viable under a range of future climate, land use, carbon price, discount rate, and method scenarios [18,41,45,46,50]. Here, I draw upon the latest publicly available data (see Supplementary

Material) to evaluate the extent to which reforestation has been adopted under Australia's carbon farming policies to date.

Vegetation methods (broadly classified into ANR, tree planting, and avoided deforestation, see Table S1) have been adopted for 427 (52%) of the 791 registered projects. As of March 2018, the registrations of 65 vegetation projects have been revoked, leaving 362 currently registered vegetation projects (Table S1). Of these, 237 have secured contracts with the Australian Government to deliver 124.3 MtCO2e of carbon abatement since 2015 (Table S2). In total, reforestation has been adopted across a project area exceeding 8 million hectares, of which 67% of this project area is under contract (Table S2). However, this cannot be considered as an accurate estimate of the actual extent of reforestation contracted under the ERF, since carbon abatement occurs on a subset of each project area [64] and these data are not publicly available.

Registered vegetation projects are largely concentrated in two regions of Australia (Figure 1). Tree planting methods have been adopted primarily Western Australia, within the highly modified Avon Wheatbelt bioregion and in the extensive semi-arid grazing lands (Figure 1a). ANR methods are the most frequently adopted (64% of registered vegetation projects) and cover the greatest project area, predominantly in the Mulga Lands and Cobar Peneplain bioregions in Queensland and New South Wales (Figure 1b). These bioregions are characterized by Mulga (*Acacia aneura*) dry forest ecosystems, which is used as livestock fodder and is typically re-cleared on a 15-year cycle to maintain pasture [65,66]. Avoided deforestation methods have been adopted by 17% of registered projects, and largely protect native forest (primary and previously cleared) in western New South Wales.

<< insert Figure 1 around here >>

To date, 70% of registered ANR projects have been awarded contracts for carbon abatement, compared to only 23% of registered tree planting projects. This suggests the tree planting projects are not sufficiently competitive to be selected by the ERF's "lowest cost abatement" reverse auction mechanism [67]. Contracts have been awarded for 98% of registered avoided deforestation projects. The 100-year permanence period required by carbon sequestration projects has been highlighted as a major barrier to participation [25,30,68,69], and a 25-year option was introduced in response [70]. Nevertheless, the majority of contracted ANR (56%), avoided deforestation (95%) and tree planting (56%) projects are opted for the 100-year option.

The ERF operates under a sealed-bid process, so it is not possible to determine the average cost of implementing ANR, tree planting, or avoided deforestation methods using the data available. However, the data indicate that over three times as many registered projects have adopted ANR methods over tree planting, and contracted ANR projects outnumber successful tree planting projects at a rate of 10:1 (Table S2). While avoided deforestation projects still make up 21% of contracted abatement using vegetation methods, the available data suggests ANR is a cost-effective reforestation approach compared to tree planting, and its availability as carbon offset methods has led to its widespread adoption in Australia.

Concerns have been raised about the additionality and permanence of vegetation projects contracted under the ERF [67,71,72]. The operation of the ERF as a government-funded subsidy scheme subjects it to adverse selection, meaning that projects that may have been implemented 'anyway' (e.g not clearing forest, or allowing forest to regenerate when farming is not profitable) are cheap, and thus likely to be preferentially funded [67]. Further, deforestation in Australia has accelerated since 2011 (Box 2), and the carbon abatement secured by reforestation under the CFI and ERF has been offset by forest clearing from the past 3 years in Queensland alone [73].

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Enhancing the effectiveness of carbon farming for reforestation outcomes

Carbon farming policies primarily use financial incentives to encourage landholders to sequester carbon in vegetation and soils, but like all forest governance interventions [insert reference to introductory paper in special issue] will rely on appropriate institutional arrangements and information dissemination to be effective. The literature reviewed in this paper emphasise a number of factors which must be accounted for in the design and implementation of carbon farming and other reforestation programs, which can be broadly mapped onto the three axes of information, institutions and incentives (Figure 2).

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Landholders require clear and accessible information on the relative benefits and costs of adopting reforestation [20,29], including accurate information on the carbon abatement and co-benefits delivered by different reforestation methods [12,52,74], the financial return expected under different carbon prices, how carbon yields may vary according to soil type and rainfall zone, and how reforestation will impact on farm productivity and property value [23,25].

There is a need for cost-effective approaches which can assist landholders in identifying the most suitable reforestation method(s) for their property [13]. Carbon sequestration in regenerating forest can be slower, taper off more rapidly and offer lower abatement per unit area than tree plantings [18]. However, further research is needed to establish what are the costs and benefits of ANR relative to tree plantings in a range of landscapes [13,35,75].

Information sourced from trusted peers is often more highly valued by landholders than advice from external agencies, and adoption is strongly influenced by social networks [25,26,29,55,56,76]. Effective extension programs which draw on local "champions" and peer learning are crucial to increase awareness and adoption [9].

The literature indicates there is a preference for reforestation to be primarily landholder-driven, with "outsider" organisations providing a support and extension role rather than direct involvement [9,20,56]. Indeed, farmer-led reforestation may be the "only way" to achieve large scale forest and landscape restoration [8,9]. Intermediary organisations can play a key role in reducing transaction costs and absorbing performance risks [61,77,78]. In Australia, intermediaries can aggregate multiple sources of carbon abatement together within a single project and manage contracts on behalf of numerous landholders [71,77].

Flexibility in the scale, type and configuration of reforestation amongst other land uses is an important consideration, as is the length of time landholders are required to maintain the reforested land [20,24]. ANR may offer greater flexibility to landholders than tree plantings, but additionality and permanence are crucial to the integrity of carbon abatement schemes regardless of the method employed [42]. Given that contract length is a known barrier to adoption [20,25,30,68], arrangements which offer flexibility in duration in exchange for a risk premium [42,79] warrant further investigation.

The likely provision of environmental, social and economic co-benefits from reforestation is a key factor influencing adoption. Landholders working in production landscapes value co-benefits such as improved soil, shade for livestock and biodiversity protection [17,25,30]. Reforestation can also offer opportunities to enable or re-establish traditional cultural practices [27] and tap into diversified income streams [54,80]. Importantly, co-benefits need to be incentivized, monitored and reported alongside carbon abatement. The inability to derive an accurate estimate of even the area of native forest to be restored under Australia's carbon farming policies is highly problematic.

Policy uncertainty and complexity are a major barriers to adoption [21,25,56], which is particularly apparent in Australia where climate policy has been characterized by frequent change and political upheaval [72,81,82]. A clear, long-term and systemic incentive is needed to encourage large-scale reforestation, which an economy-wide carbon price can deliver more effectively and efficiently than subsidies [67,83]. Secure land tenure arrangements are fundamental to provide landholders with assurance they will realise the future benefits of reforestation [1,28,56,84]. Finally, institutional controls or sanctions on further deforestation are required to effectively incentivize reforestation [72,85]. The absence of such controls reduces the additionality and integrity of reforestation efforts and create a perverse incentive for deforestation.

Conclusions

Restoration of degraded and deforested landscapes can provide multiple environmental, food security, social and economic benefits for communities. However, translating aspirations for large-scale reforestation into on-ground outcomes will require governance interventions which can effectively motivate landholders within production and multiple-use landscapes to adopt ANR, tree planting, or a combination thereof. Effective incentives for reforestation must be underpinned by a coherent and complementary policy mix [86], and incorporate experiences from carbon farming policies which encourage reforestation in production landscapes [18,25], lessons from extensive research on landholder adoption [20,24], and the growing literature highlighting the potential benefits of ANR for large-scale reforestation [8,9,14].

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Figures

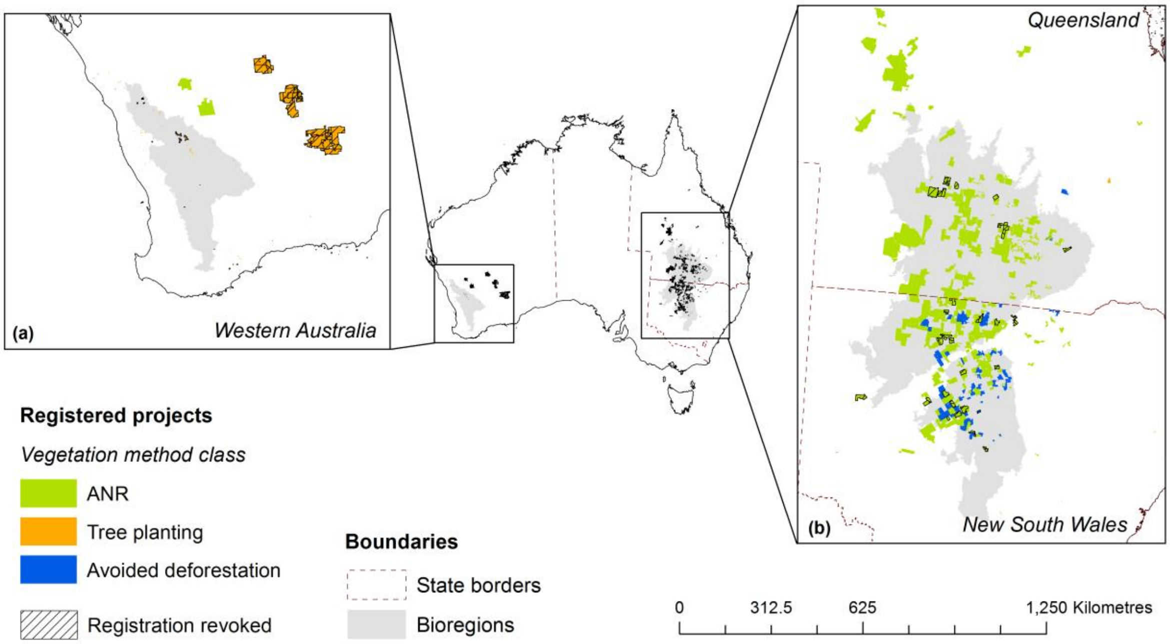


Figure 1. Distribution of vegetation projects (broken down by method class: ANR, tree planting, and avoided deforestation) registered under Australia's ERF. (a) Many tree planting projects are located within the highly modified Avon Wheatbelt bioregion in Western Australia. A single tree planting project covering over 1.5 million hectares is located in the semi-arid pastoral landscapes east of the bioregion, but is registration was revoked in February 2018. (b) The majority of ANR and avoided deforestation projects are located in the Mulga Lands bioregion crossing the Queensland state border, and the Cobar Peneplain bioregion south of the border in the state of New South Wales.

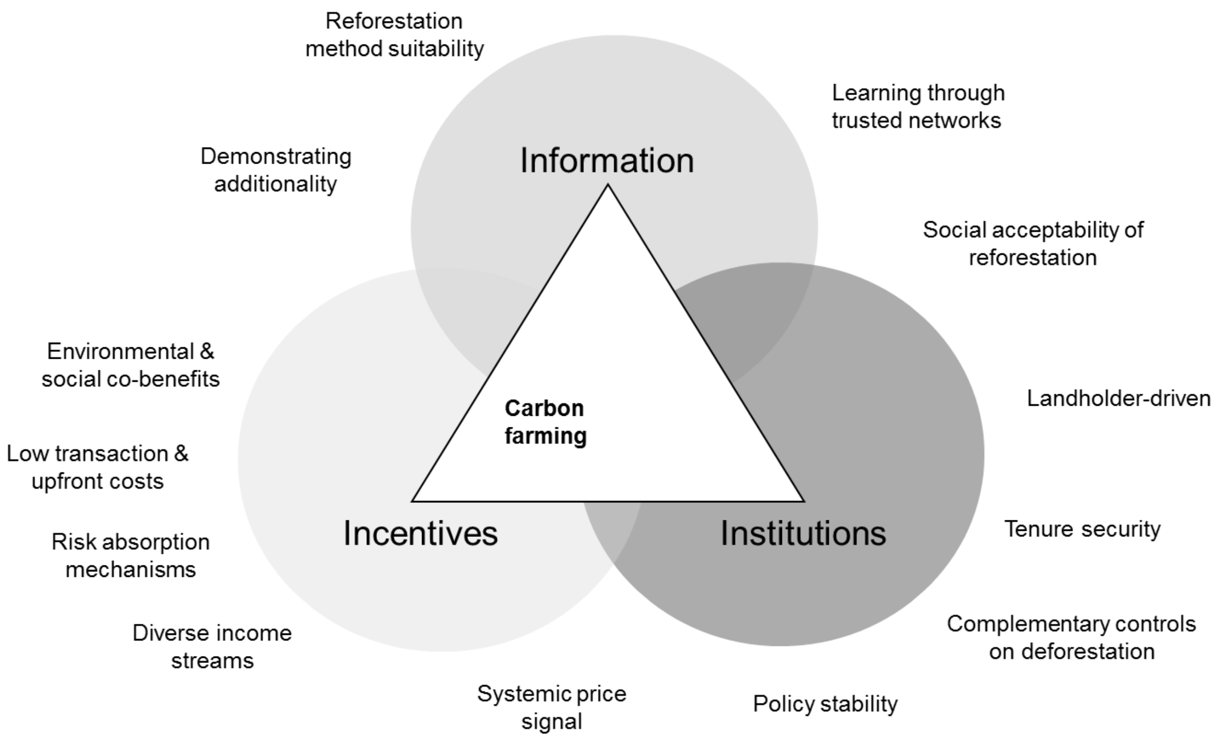


Figure 2. Summary of factors identified from the literature which underpin effective governance interventions for carbon abatement through reforestation

Box 1 Australia's carbon farming policies

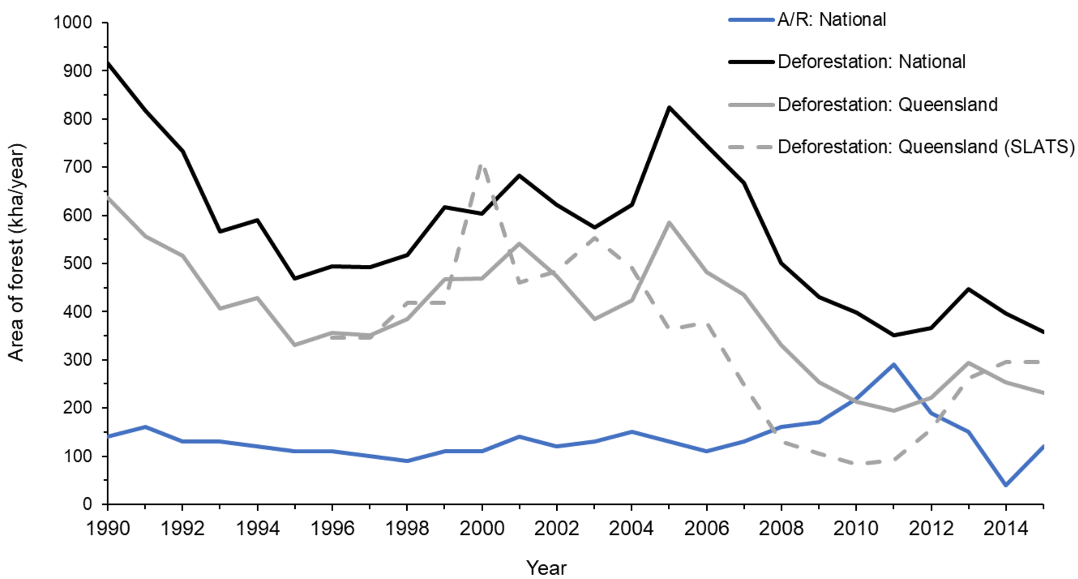
Carbon farming was initially established in Australia as a voluntary baseline-and-credit offset scheme, which was designed to work in conjunction with a legislated carbon price of AUD23/tCO2e (increasing by 5% per annum) from July 2012 [42,43,81]. The Carbon Farming Initiative (CFI) was considered to be the world's first national scheme to regulate the generation and trade of carbon credits from farming and forestry [43]. Through the CFI, landholders could generate Australian carbon credit units (ACCU) using an approved methodology determination ('method') and then trade these credits on domestic or international voluntary markets. All carbon sequestration projects were required to be maintained for 100 years to meet permanence requirements, and a 5% risk of reversal buffer is applied to account for the risk of carbon release due to fire or other catastrophic risks.

Following a change in government, the carbon price was repealed and replaced by an economy-wide abatement subsidy scheme in 2014 [67]. The Emissions Reduction Fund (ERF) was established with AUD2.55 billion of government funding over 4 years, and a reverse auction mechanism is used to purchase carbon abatement at the lowest per-unit cost. Existing CFI methods and projects transitioned into the new scheme, and a 25-year permanence option was introduced for sequestration projects (a 20% penalty on credits relative to the 100-year option) [70]. Six auctions have occurred as part of the ERF since April 2015 (http://www.cleanenergyregulator.gov.au/ERF/Auctions-results), with abatement primarily secured through vegetation methods (65% of total volume) and at an average price of AUD12.0/tCO2e. As of March 2018, AUD265 million remains in the ERF, and a seventh auction is due to be held in June 2018.

Box 2 One tree forward, two trees back: reforestation and deforestation in Australia

Deforestation in Australia is globally significant [73,85,87–89], with the latest statistics indicating 400,000 hectares of forest was cleared in the state of Queensland alone in 2015-16 [90]. Policies which govern the protection and management of native vegetation in Australia are primarily under the jurisdiction of its eight State and Territory Governments, which since 2010 have undergone a process of deregulation and relaxation [85].

The Australian Federal Government administers incentives for reforestation (see Box 1) as part of its policy commitment to reduce greenhouse gas emissions by 5% below 2000 levels by 2020 [91]. However, the latest data indicate that deforestation in Australia still far exceeds reforestation [92,93]. In absence of Federal Government controls on deforestation, the carbon abatement and reforestation outcomes delivered through public investment in carbon farming (Box 1) will continue to be undermined.



Annual extent of deforestation (primary and regrowth) and afforestation/reforestation at the National scale according to the latest National Inventory Report [92]. For comparison, deforestation in the state of Queensland is plotted using data from [92], and from the Queensland Government's Statewide Landcover and Trees Study (SLATS) program [93]. The substantial differences in the amount of deforestation identified by the National and Queensland data is largely explained by an inconsistent definition of 'forest' [94].