

Increasing trees on farms through natural capital accounting

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Abstract. Increasing tree planting on farms can provide a range of benefits. However, there are many barriers to increasing plantings on farms. To answer the research question of how natural capital accounting might be used to support farmers to increase trees on their farms, we spoke to 22 decision makers and stakeholders who are working to increase tree planting in different sectors. We also worked with farmers to plant over 200 ha of trees. The interview results show how tree planting programs can be supported to achieve longer-term, on-farm and social outcomes. The practical results highlight the importance of tailoring different strategies to different objectives. We find that natural capital accounting is a potential way to create partnerships across government and non-governmental organisations beyond the farm gate and to align individual and national scale objectives. Increasing trees on farms is not just about farmers, all of society has a role to play. We also note the need to raise public awareness of the different flow-on benefits of increasing natural capital on farms.

Keywords: natural capital accounting, tree plantings, restoration, farm productivity

Introduction

Global restoration of habitat is essential to address biodiversity loss and climate change. To achieve this, the Australian government have made a commitment to 30% vegetation cover by 2030 after the release of the State of the Environment report (Cresswell et al. 2021). This will require at least 4.9M hectares planted on private land (Mappin et al. 2021), but land access is a key constraint for large scale plantings. As managers of much of the available land, farmers are key to increasing national vegetation cover and also provide opportunities to deal with the environmental, economic and social pressures from climate change, biodiversity loss and global disruptions like Covid-19. Increasing natural capital on farms – particularly but not limited to, increasing the number of trees – has potential to convey a lot of benefits to both the farmer and broader society. Natural capital is defined here as:

those renewable and non-renewable natural resources (such as air, water, plants, soils, insects and animals and energy), stocks of which can benefit people both directly (for example, by delivering clean air) and indirectly (for example, by underpinning the economy) (adapted from Bateman and Mace 2020, p. 776).

Trees are not the only form of natural capital, but they are closely linked to many natural capital resources (air, soil, biodiversity) and increasing tree cover can help to increase a range of natural capital outcomes on farm. When trees and plants are established, they can provide a long list of positive outcomes for farmers and the general public (sometimes called co-benefits) like improved amenity, shade and shelter; in some cases increased property price, reduced soil erosion and salinity, improved soil health and water retention, habitat, food and corridors for native wildlife, environmental resilience, pollination services, economic diversification and cultural services (Chavasse 1982; Jose 2009; Smith 2009; Wratten et al. 2012; Polyakov et al. 2014; Schirmer & Bull 2014; Cunningham et al. 2015; Duru et al. 2015; Potts et al. 2016).

An emerging method to capture the status of natural capital on farms and better account for the benefits that natural capital provides, is natural capital accounting. There are a range of approaches to natural capital accounting, (e. g. Missemer, 2018; UNCEEA, 2021), however here we focus on natural capital at the farm scale, and the natural resources that hold value for farmers. Furthermore, we particularly focus on trees, as a window into understanding natural capital, although this is not exclusive.

Understanding farmers' objectives and their personal values are key considerations in (a) facilitating partnerships and land access for planting programs and (b) enabling natural capital to be maintained over the longer term (Fleming et al. 2019). Diverse planting designs (e.g., variation in stem density and species type) and variable landscape and farming contexts result in different co-benefits for farmers and different opportunity costs. Hence matching the planting design to what the farmer is looking to achieve on their farm is important. Once established, planted areas will need on-going management to provide their full longer-term benefits. However, longer-term planning and maintenance can be challenging for multiple reasons, including if (a) farmer objectives change over time, (b) a property changes hands, (c) market demands change and (d)

external factors like climate change, increasing drought, pest and disease pressure or financial considerations.

To understand how to increase the natural capital planted on farms, previous literature has largely focussed on individual farmer capacity and decision-making (e.g. Pannell et al. 2006; Reid 2008; Schirmer & Bull 2014; Torabi et al. 2016). In Australia, emergence of the 'Landcare' movement in the mid-1980s to encourage improved natural resource management, saw the planting of trees on farms become increasingly common (Powell 2009). The benefits of the Landcare movement were felt socially, as well as environmentally, as it established successful farmer networks, with multiple benefits to farmer well-being and learning (Pannell et al. 2006; Race and Curtis 2007; Schirmer and Bull 2014). However, the economic potential of large-scale tree planting programs has not been fully realised and environmental targets to increase biodiversity and land cover have fallen short (Bergstrom et al. 2021). The Landcare movement highlights how important it is to invest in community programs and extension workers (knowledge brokers) and work across governmental and non-governmental organisations, to enable a range of farmers to participate – the Landcare movement was not just for 'green' farmers, it was for everyone. The de-funding of extension advisors in Australia, was one contributing factor to the reduced impact of the Landcare movement in more recent years, along with a focus on economic factors overriding other (social/environmental) benefits (Hunt et al. 2012; Schirmer & Bull 2014).

To recreate the momentum for increasing natural capital on farms, the Australian government has initiated programs to raise money and mobilise local community groups to rapidly plant trees. While these initiatives are often marketed around a target number of trees to plant, the metrics of longer-term outcomes like tree survival, carbon sequestration, productivity benefits or improved biodiversity are also important to promote to increase public awareness of the multiple benefits achieved. Supporting markets are also in development, with water credits, carbon offsets and biodiversity market instruments providing possible further ways to monitor and raise awareness of these broader benefits, although capturing the full range of cultural, aesthetic, health and provisioning services provided can be challenging (Bartelmus 2009; Bull et al. 2013).

National scale tree planting programs sometimes have the perverse outcome of simplifying trees to a blanket 'solution' rather than one part of an integrated approach to improving the social, economic and ecological function of landscapes. Assumptions are sometimes made about more trees being better and trees being good everywhere, when a more nuanced consideration needs to be made about longer-term objectives, species selection, ecological interactions and return on investment (Fleischman et al. 2020). Furthermore, the benefits to social and human capital associated with increasing natural capital are rarely the focus for investment (Fleischman et al. 2020), or for evaluation.

Digital technology to promote scaling up of natural capital and tree planting is another example of how investments in scaling natural capital have tended to focus on producing the technology itself, rather than building the underpinning capacity, learning, rules and expectations for data use (Sanderson et al. 2017). Satellite technology, remote sensing, virtual reality visualisations, dynamic modelling and machine learning all offer exciting potential for new approaches to understanding and improving natural capital, which are faster, and more inclusive of a range of stakeholders (AECOM 2020). These tools also have the potential to act as 'boundary objects' and bring together stakeholders across different organisations, worldviews and objectives (McGonigle et al. 2020). However, issues of transparency, trust and equity and the rules around data sharing and use still need to be resolved (Jakku et al. 2019).

One option to better shift the focus on tree planting to broader, more holistic and transparent considerations is natural capital accounting (NCA). NCA is rapidly gaining traction as a new method to holistically account for natural resources and environmental performance (Ogilvy et al. 2022). While primarily focussed on national scale environmental accounting, there is potential for NCA to provide a consistent, robust and comparable measurement framework at the farm scale (Ogilvy and Vail 2018; van Putten et al. 2021).

In this paper we explore how using natural capital accounting can support more tree planting on farms. The objective of this study was to better understand the underpinning institutional, social and governance arrangements (not just the individual farmer context) around natural capital understanding and natural capital accounting, to be able to better deploy natural capital accounting as a tool to encourage planting of trees on farms. To explore this social context, we conducted interviews with decision makers, advisors and stakeholders who are working to increase tree planting in different sectors and include our own reflections on a practical component aligned with this study that explored the objectives driving new plantings in Tasmania. Finally, we discuss the insights of the study into the opportunities and barriers for natural capital accounting to support tree planting on farms.

Methods

To understand the barriers and opportunities to support farmers to use natural capital accounting as a mechanism to scale up their tree plantings, 22 interviews were conducted with experts and practitioners working to increase the number of trees planted in Australia and beyond. The interviewees were sourced through formal and informal industry associations, referrals from partners in the project and via snowballing (participants suggest others) and according to ethics guidelines. Ethics approval was obtained from the CSIRO ethics committee (approval number 109/20). Twelve men and 10 women participated in a telephone or video conference interview (Covid-19 restrictions meant face-to-face interviews were not possible). The interviewees included those from backgrounds of conservation (6), farm advisors (4), finance (3), government (2), research (3), forestry (3) and agriculture (1). The interviews were conducted in a semi-structured manner, suitable for eliciting people's feelings and perceptions. Participants were asked about the opportunities and barriers to increasing tree planting by individuals, businesses, industries and government, as well the potential role of digital technology and communities, views about natural capital accounting, and any other opinions on scaling up tree planting and natural capital. The focus of this work was on *supporting farmers* to increase natural capital on their farms, therefore farmers were intentionally not the primary target for this research.

On average, interviews went for 40 minutes. They were audio-recorded and professionally transcribed. The transcripts were entered in an NVIVO database (to facilitate analysis) and examined using a constructivist grounded theory approach to coding (Charmaz 2006). The analysis used theories of discourse analysis and included close attention to language use and meaning to construct codes, categories and themes (Fleming et al. 2022). In this paper we focus on the opportunities for different sectors of society to support farmers to increase natural capital and tree plantings through natural capital accounting.

In addition to the interview insights, our results are supplemented by reflections on supporting new plantings of 202 ha of trees across seven farms in Tasmania. These reflections are integrated into the discussion, from the perspective of the co-authors involved. Private Forests Tasmania (PFT) partnered with the CSIRO on the Perennial Prosperity Project, to support demonstration tree planting initiatives for farmers through \$600,000 in grant funding co-funded by Private Forests Tasmania, the federal government (Smart Farming Grant) and the in-kind contributions of farmers. The properties are distributed across the state in the Northwest, North and South of the state. Commercial tree species have been utilized for these plantings, so landowners have the option in the future to potentially harvest the trees to meet the growing demand for timber; *Pinus radiata*, *Eucalyptus nitens*, *Eucalyptus globulus* and *Acacia melanoxylon* were the species chosen, with some properties only planting one species and others choosing multiple species. Each landowner has their own objectives which they wish to achieve through the establishment of the commercial trees, however, some of the common denominators include shelter, aesthetics, carbon storage, diversifying their enterprises and the potential of income from the timber. Private Forests Tasmania shared their experiences in engaging with farmers on this project.

Results

The interview results revealed opportunities to support farmers to increase natural capital plantings at different scales through the application of natural capital accounting. The stakeholder groups (to highlight how thinking about natural capital accounting can go beyond the traditional focus on individual farmers) included: community; business/institution; industrial sector; and social/policy groups. A summary of the interview discussions, highlighting the benefits and constraints to increasing tree planting and the use of natural capital accounting is shown in Table 1. The discussions show that there are several ways that natural capital accounting can improve trust and transparency, act as a boundary object between parties and track progress over time, especially if investment is made in developing skills and networks. However, the key constraints relate to cost, complexity and achieving consistency in the use of natural capital accounting.

From the interviews, three themes cut across the stakeholder groups, relating to: 1) opportunities for natural capital accounting to connect parties along the supply chain in a shared objective to increase natural capital and farms; 2) opportunities for accounting to raise awareness of the public good benefits of natural capital; and 3) opportunities for natural capital accounting to be a boundary object to support scaling up tree planting on farms.

Table 1. Summary of interview discussions around benefits and constraints to scaling up tree planting and the use of natural capital accounting on farms

Stakeholder group	Benefits	Constraints
Community	<ul style="list-style-type: none"> • Matching planting to different local objectives can increase awareness of diverse benefits • Recognition of the flow-on benefits can increase public support • NCA can track progress on objectives and value ecosystem services • NCA can build trust and accountability along the supply chain • Capacity and technology needs are opportunities to build social and human capital (connections and knowledge). 	<ul style="list-style-type: none"> • Time, skill and money involved in plantings • Land availability • NCA not necessarily consistently and simply applied • NCA voluntary • NCA potentially costly and complex
Business/institution	<ul style="list-style-type: none"> • NCA supports accountability and trust • NCA aids reporting and shareholder investment • Ethical and sustainable branding 	<ul style="list-style-type: none"> • NCA not necessarily consistently and simply applied • NCA voluntary • NCA potentially costly and complex • Lack of trust along supply chain to share data
Industrial sector	<ul style="list-style-type: none"> • NCA provides a common mechanism to support investment, assess outcomes and link between local and national scales • Collaboration across sectors for training, learning and resource sharing (e.g. equipment) • Public communications that raise awareness and support for industry initiatives 	<ul style="list-style-type: none"> • NCA not necessarily consistently and simply applied • NCA voluntary • NCA potentially costly and complex • Lack of trust and shared alliance across sectors
Social/policy	<ul style="list-style-type: none"> • Investment in extension advisors and networks improves capability and social capital • Investment in initial markets to recognise and reward change • Longer term change includes system and holistic perspective • National scale NCA for reporting and strategy development. 	<ul style="list-style-type: none"> • Investment objectives misaligned with broader social and capability outcomes • Political cycles often short term • NCA at the local level not the same at the national scale

Supply chain

The interviewees discussed ways to support farmers to increase natural capital through changes to organisation and business structures. For example, by requiring businesses to report on their use of natural capital, all the way along supply chains. This approach was expected to result in a better valuation of natural capital, and greater support (investment) for farmers to improve on-farm natural capital, so that it can be reflected in the natural capital accounts of businesses they supply. To achieve this, new markets are required, as well as new regulation and new supply chain accounting and digital data capability. One participant described the importance of natural capital accounting in a supply chain to see the whole picture of natural resource use:

So that the companies can understand what they're buying in a supply chain and what their ultimate products - how energy intensive, how biodiversity intensive, how water intensive - are the products that they're generating (Int 17).

Other opportunities to support farmers to increase natural capital through tree planting included reinvigoration of training and (free) extension services, as well as partnering across sectors. Agriculture is not the only sector where tree planting can be supported, the financial sector, insurance, tourism, local communities, non-government and governmental sectors were all identified by participants as having a helpful role to play in investing in tree planting and using natural capital accounting as a basis for decision making and reporting. As one participant noted, natural capital accounting would be a useful mechanism to allow different sectors to better collaborate:

I think there's a great opportunity for Government, industry, the banks, all of that supply chain that kind of bring it to life to really collaborate (Int 12).

Awareness of public good benefits

Interviewees noted that public awareness of the need to increase natural capital was often superficial and lacked a wider understanding of the range of benefits that natural capital can provide. Therefore, campaigns could help to raise awareness of the longer-term outcomes and range of benefits of trees to encourage public support. Community engagement and ownership of tree planting designs and outcomes were seen as an important step to create community 'buy-in' and longer-term support for tree planting initiatives, including helping to care for the trees and being able to recognise the benefits trees provide into the future. Natural capital accounting was seen to be a useful way to improve scientific understanding about the links between natural capital and public benefits.

I mean, the benefit of natural capital from a public good perspective, not just from a private benefit perspective, is significant in terms of building connectivity, building healthy landscapes, heat retention, water retention in landscapes, all of those things that go to the public good, let alone protecting some of Australia's most critical natural assets, biodiversity assets as part of the public good (Int 20).

The interviews highlighted that trees are more than just planting and sustainable decision making must go beyond the individual farmer:

with trees on farms, it's not just about trees; we can't just put trees in the ground. It needs to be about biodiversity and species selection, location, and connectivity I feel like there's a bit of a simplification [...] I think it's having that holistic approach to what else is this enabling, and those sort of factors around wellbeing of people (Int 11).

Scaling up

When reflecting on the establishment of demonstration plantings, the project team noted that recognising and demonstrating the benefits of trees beyond the individual site scale was an important component of supporting farmers. A focus on communicating the program through sharing the stories and journey of the sites has allowed fellow farmers to gain insight into the challenges and opportunities for integrating trees into the agricultural landscape. Peer-to-peer mentoring was facilitated through neighbour field days and valued by participants. The partnership between PFT and growers was also considered important for achieving best outcomes as PFT are trusted knowledge brokers and facilitators who are key to identifying the best approaches and working with farmers to achieve the desired tree plantings in the ground. Natural capital accounting was a useful boundary object for PFT to account for, and track, different components of tree plantings and share results transparently and consistently across sites.

Discussion

The objective of this paper was to examine how natural capital accounting may be useful to support farmers to increase natural capital through tree planting, by identifying opportunities (and barriers) across a range of scales, not just for individual farmers. Our contribution is in highlighting how natural capital accounting brings in a range of opportunities for different sectors to be involved to support farmers. We advocate for a whole of society shift toward valuing natural capital and recognising farmers as key stewards of natural capital, through natural capital accounting, not just for the individual farmer to action, but also highlighting a role for community, business, industry and government. The key findings highlight two main opportunities: 1) recognising (and raising awareness of) the diverse benefits of trees and natural capital; and 2) the potential of NCA as a method to account for, and value, these benefits across sectors and scales.

Natural capital accounts can incorporate the multiple and longer-term benefits of trees while at the same time serving as a potential 'boundary object' to link to larger scale structures in business and institutions (such as reporting and insurance) with on-ground action by farmers and communities. Boundary objects provide a 'solid nexus for communication and collaboration among disparate world-views' (Franco-Torres et al. 2020, p. 35). A farm 'account' would also lend itself to improved transparency across conservation and production (agricultural or forestry) sectors and enable new forms of policy and research to improve conservation outcomes for the wider community. Significant work remains to synthesise and standardise these approaches at the farm scale (Ogilvy et al. 2022).

If a simple, transparent and standardised approach can be achieved, farm scale NCA has the potential to align different farmer objectives and help link between local and national scales. NCA can be a bridge between government and non-government, for profit and not for profit, cross industry and community initiatives for increasing investment in natural capital planting. NCA offers a potential benchmark to monitor and report on natural capital. This in turn gives an evidence base for public (consumer) trust and social licence and can be tracked and attributed to financial returns (van Putten et al. 2021; Ogilvy et al. 2022).

There is still substantial opportunity to recognise farmers' efforts at environmental stewardship, carbon sequestration, land improvement and wildlife protection both financially and socially. Involving farmers more directly in planning policy, developing markets and designing funding programs that focus on achievement of long-term outcomes would go a long way toward achieving integration between policy makers and policy implementers, which is called for in the literature (Zinggbebe et al. 2020). Rather than funding planting schemes for fencing and labour, incentives could be tailored toward achievement of other longer-term outcomes or metrics (e.g. tree survival, or realisation of public benefits).

Developing infrastructure sharing arrangements (e.g. processing and transport) as well as training and mentoring programs (Reid 2008) are other areas where intervention from government and other sectors are needed to support farmers. This requires collaboration and a 'big picture view' of how regions can operate holistically to achieve multiple outcomes and so planning and incentives to work collaboratively across sectors should be developed (Holt et al. 2019). Barriers to achieving collaboration across sectors are a lack of trust, a lack of autonomy and a lack of flexibility to share responsibilities. This can be overcome by establishing new alliances which actively focus on establishing trust and are able to change arrangements to suit different contexts (Karlsson-Vinkhuyzen et al. 2018).

There is a key role for extension officers, adoption officers, knowledge brokers and researchers to share knowledge about tree planting and work together for more collective action and to form the fundamental basis for trusted relationships. Knowledge brokers, like PFT, can be useful to link and share knowledge and views on success across scales (McGonigle 2020). Achieving system change requires connecting people, building momentum, involving the public, sharing knowledge and resources, building capacity and motivation and coordinating strategies. Extension has a huge role to play, especially across sectors and scales, and helping to drive forward more integrated, longer term and people-centred strategies.

We recommend that natural capital accounting be further explored in relation to linking individual farm scale objectives with community or business (even national) outcomes. For example, through monitoring local threatened species or water quality. The link between farmers and broader scales can also be enhanced and explored through digital technology, such as through citizen science programs and remote or virtual technology (Chandler et al. 2017). This requires investment in capacity building and attention to benefit sharing and equity (Jakku et al. 2019).

Other recommendations out of this work are that natural capital accounting allows the broader benefits to farmers and the wider community to be assessed and acknowledged, and the benefits are not limited to economic and individual returns on investment but can demonstrate how the broader community can benefit as well as farmers. Improving natural capital on farms benefits the whole ecosystem and so accounting for the services and dependencies of natural capital is an important step towards valuing their role and monitoring their status (Costanza 2020). A broader conceptualisation of values and beneficiaries of natural capital is important to recognise and integrate in decision making (Raymond et al. 2009).

Conclusion

Natural capital is vital for many direct and indirect benefits and underpins the systems on which we rely. Attempting to increase plantings on farms by focusing on individual and economic objectives has limited the positive outcomes and scale of changes that have been achieved. A holistic approach is needed. This paper described the result of 22 interviews with stakeholders aiming to support farmers to increase natural capital on farms, through natural capital accounting and highlighting opportunities beyond the farm scale. Raising awareness about the diverse benefits of trees to encourage beneficiaries to invest in natural capital improvements, and wider use of NCA are highlighted as two potential pathways to achieving more investment in increasing natural capital. NCA is an opportunity to develop partnerships across government and non-governmental organisations and align individual and national scale objectives and take the onus off farmers as the sole drivers of increasing natural capital on farms. Finally, investment in developing capacity, networks and knowledge brokers is just as important as investing in new technology or paying for plants to achieve greater motivation and longer momentum for tree planting.

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