Missed opportunity? Framing actions around co-benefits for carbon mitigation in Australian agriculture

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\section*{A R T I C L E  I N F O}
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\section*{A B S T R A C T}
Agriculture around the world is one of the industries most affected by, and faced with responsibility to mitigate, climate change. Through improvements in technology and efficiency as well as changes to land use management, agriculture can make an important contribution to meeting global commitments such as the Paris agreement or the Sustainable Development Goals. Yet international carbon markets have not resulted in sufficiently high financial returns to motivate the full potential of land sector changes in Australia and globally. Through analysis of 110 interviews with 55 farmers, 43 advisors and 12 stakeholders in the land sector we identify that the framing of ‘carbon-farming’ in agriculture as a financial opportunity creates a barrier to how farmers perceive participation in carbon markets. As a result of this finding, this paper argues that framing the opportunities with increased attention to co-benefits and broader economic incentives in addition to potential financial opportunities could re-invigorate how carbon farming is perceived and adopted.

\section*{1. Introduction}
Agriculture is the third highest greenhouse gas emitter in Australia and is responsible for approximately a quarter of greenhouse gas emissions globally (Smith, 2018; Bustamante et al., 2014). At the same time, agriculture has more potential for greenhouse gas mitigation than other sectors, primarily through landscape management (Smith, 2018), and improving on-farm practices, such as through innovations in technology and production strategies (Maraseni et al., 2018; Herrero et al., 2016). Australia is a signatory to the Sustainable Development Goals (SDGs) and to the Paris Agreement, which both require significant reductions of greenhouse gas emissions. The SDGs also require more general and wide-ranging improvements and broader interpretations of sustainability (Stafford-Smith et al., 2017) which will mean the agriculture sector cannot avoid making significant changes.

Financial arguments are often seen as compelling ways to motivate change and perceptions persist that ‘it is hard to be green when you are in the red’, or that financial stability comes first, rather than in tandem with, or driven by, environmental or social considerations (i.e. broader economic incentives). Natural disasters and drought are examples where environmental and social considerations become the priority issue, but these events are often regarded as temporary and so do not create permanent shifts in behaviour. In line with the financial approach, government led schemes in Australia and around the world have chosen to encourage carbon sequestration primarily through financial motivations. The Australian Carbon Farming Initiative (2011–2015) which became the Emissions Reduction Fund (2015-current) has seen some financial rewards returned to larger scale projects established predominantly in avoided deforestation, reforestation and savanna burning methodologies. Smaller scale projects are less likely to see worthwhile financial return from participating in emissions reduction, possibly due to the significant administrative (auditing) costs and project restrictions.

Expectations that market demand would be sufficient to drive an increasing price for carbon and catalyse further participation by the land sector in carbon programmes have so far not been realised, with the price currently fluctuating around $13 per Australian Carbon Credit Unit (http://www.cleanenergyregulator.gov.au/ERF/Auctions-results/june-2018). The high transaction costs of administration to participate in carbon farming programmes may be a significant barrier for mid-range and smaller land owners (Sanderson and Reeson, 2019). Similarly, revegetation schemes in Australia have to date had little impact, partly because the financial incentives are too low (Maraseni and Cockfield, 2015). Government extension and outreach programs designed to raise awareness about the potential and importance of carbon farming have largely resulted in farmers deciding it is not financially viable (McKenzie 2018). Due to generally weak (and lack of bipartisan) political support (Maraseni and Reardon-Smith, 2019), and the low...
price of carbon there has been a visible loss in momentum of carbon farming as a priority issue for industries, evidenced by the lack of carbon farming on industry conference agendas. With many of the projects with lower transaction costs already registered, the subsequent reductions in carbon emissions required to achieve Australia’s part of international agreements need a significant increase in the number of farmers participating in carbon sequestration (Lamb et al., 2016). It appears that conventional financial arguments are inadequate to motivate sufficient interest or participation. In this paper we understand financial arguments to include the dollar figure that may directly result from an activity whereas economic return includes more indirect financial returns, such as productivity benefits, or environmental benefits.

This paper aims to examine how action for climate mitigation on farms might be facilitated outside of financial arguments and promote ‘more resilient, economically viable and sustainable land use practices on a landscape level’ (Maraseni and Mitchell 2016 p.139). There is evidence of farms responding to the broader economic returns and reduced carbon footprints outside of the national programme (Torabi et al., 2016). Globally, changes to routine fertiliser application (Zhu et al., 2018), converting traditional cropping regimes (Cai et al., 2018), manure processing (Purdy et al., 2018), and including traditional crop varieties (Carranza-Gallego et al., 2018) are some of the changes being made in the absence of official project participation. In Australia, there have also been some positive responses to biodiverse carbon plantations driven by the value of co-benefits. These trends suggest that producers are capable of, and interested in, implementing the same sort of practices as methods advertised by the national programme and there is some motivation by broader economic incentives.

The co-benefits – defined as the positive benefits related to the reduction of greenhouse gases (IPCC, 2007) – of improving and maintaining carbon in farms are well documented in the agricultural literature, both in agronomic terms (Stokes and Howden, 2010) and from system-wide and policy perspectives (Bustamante et al., 2014; Griggs et al., 2015). Examples include improved soil health and productivity, improved water holding capacity and management of erosion and salinity as well as positive biodiversity (beneficial flora and fauna). Understanding the complete range of co-benefits is a new area of scholarship, of particular interest to emerging and often transdisciplinary fields of research, such as agroecology (e.g. Giessler, 2015). However, the lack of a significant co-benefit narrative around carbon farming is surprising, given the extent of possible co-benefits and the ‘no regrets’ scenarios on offer, which we examine below. Co-benefits further offer the potential to match the diversity in all farmers and farm systems by being more applicable to different contexts and individual goals and values.

The carbon farming story has been overwhelmingly framed in financial terms in recent decades, with the monetary gain as the primary narrative. This narrative has limited power to persuade in the land sector, where farmers’ decision making is framed by different values and objectives and is very diverse (Vanclay, 2004; Pannell et al., 2006). Frames are often unconscious but influential “interpretive overlays” that work to “guide communal interpretation and definition of particular issues” (Miller, 2000, pp. 211–212). Framing often involves automatic decisions about what aspects of an issue are considered important, who is involved, and what options for action are feasible or desirable. While framing can be understood as an individual-level mental process (Lakoff, 2010), its communal and social aspects are drawn upon in this paper (Cook et al., 2013; Miller, 2000). When framing is taken into account it is much more apparent how decisions need to fit with farmers’ objectives and farming styles, as well as their access to resources and financial returns may represent only one component of what farmers value and base decisions on (Vanclay, 2004; Pannell et al., 2006). Previous studies show how attention to framing can result in tailored pathways for change (Vanclay and Enticott, 2011; Fleming et al., 2014; Fleming et al. 2018), including in relation to carbon and farming (Ojha et al., 2019; Fleming and Vanclay, 2010). To better align with the framing used by farmers in their decision making, the carbon farming narrative needs to shift to a wider interpretation of responsible farming and the range of co-benefits available. Furthermore, this may be a useful way for policy to recognise and value farmers for the multiple services they offer (or could offer) through their management of the land.

Social learning is a particularly successful way to encourage uptake of change, by seeing what others are doing and what is working well (Gray et al., 2009). If farmer talk is that those farmers ‘at the top’ aren’t seeing the reward for carbon sequestration (financially), or that it requires a large scale operation, then others may be less motivated to participate. In addition, the gap in methodologies tailored to smaller scale farmers has created some groups, perceived as ‘fringe’ or ‘green’ farmers which potentially further reduces the salience and credibility of the message of carbon farming for the more mainstream. Against the background of competing legitimacy claims it may be difficult to engage farmers in the narrative of co-benefits first, financial return later. Nevertheless, to not engage farmers in discussion of co-benefits accrues an opportunity cost for individual farmers, as well as the agricultural sector combined and even the nation as a whole, which will only increase further the longer action is delayed (Garnaut, 2011). Carbon credits are generated over time - and over the course of many growing seasons - so efforts need to be planned and implemented in advance and require a longer term commitment than most other on-farm production methods. The long term commitment also reduces farmer flexibility and freedom but can motivate beneficial longer term whole of farm planning including succession planning.

This paper argues that co-benefits promote desirable on-farm behaviours, and should be formally integrated into opportunities for carbon market participation. More consideration of co-benefits is useful for both sides of the market: supply (providing more motivation to produce carbon and participate in the market) and demand (requires higher quality or more highly valued credits). If carbon trading programmes included the broader economic narrative of co-benefits within carbon sequestration projects, it could revitalise the conversation around farm productivity and sustainability. Achieving greater recognition of this ‘transformation’ in agriculture towards achieving and being valued for a greater range of benefits – social, environmental and economic – is a key issue for agriculture and communities around the world to address in order to achieve more general sustainability, ‘social license’ and ongoing support. We identify the key policy and industry initiatives required to facilitate this reframing.

2. Methods

This is a synthesis perspective paper based on conceptually related research projects in 2017 and 2018, in which perceptions of sustainability and land management behaviours were investigated through interviews with 110 participants, including 55 farmers: 43 farm advisors (some participants identified as both, in which case we used their primary source of income), and 12 other types of agricultural stakeholders (others directly working in the sector, such as carbon aggregators, or industry representatives or policy advisors) From this dataset, overarching findings are drawn out about the role and importance of co-benefits as part of farming. The results of content analysis provide high level findings that 1) extend our understanding of co-benefits as part of how farmers currently frame their business, 2) identify ways to incorporate these values into the programmes where their participation is sorely needed; and 3) triangulate results across sectors.

Table 1 provides an overview of the case studies and information about the cohort interviewed. Interview questions were related to understanding processes of decision making, information sources and networks, actions taken on farm and perceptions of carbon farming and the carbon market (although questions were worded differently in each
The extensive effort involved in conducting such large scale qualitative research projects with similar themes justified synthesising the results in order to maximise research output and impact, namely reporting on the overarching findings (Binder et al., 2015).

During the data collection and analysis phases, critical review and comparisons of findings were enhanced through ongoing discussions (first and second authors). Thus, the motivation for combining data from the related projects is to:

- Allow for a more robust analysis of co-benefits relevant to carbon farming (triangulation)
- Include more perspectives related to agricultural decision making and land care values, so that these speak to a broader base
- Avoid duplication (different interviewees were targeted in each case study).

Combining data from the related projects also allows for an opportunity to reflect on the overarching barriers to carbon programme participation at multiple scales: policy / industry / individual, and where the similarities and synergies occur across sectors.

Drawing on the pragmatic benefits of agricultural innovation (Berthet et al., 2018; Pant and Odame, 2017) and systemic research methodologies (Thompson et al., 2017), the synthesis of qualitative research project findings allow for a more robust analysis of co-benefits relevant to carbon farming. For example, as utilised in previous work, the increased diversity of stakeholder opinions that could be captured within the agricultural sector leads to more systemically relevant findings (Nettle et al., 2013). Farmer respondents came from diverse agricultural sub-sectors including cropping, livestock, mixed enterprises and dairy, with some farm foresters, to maximise the inclusivity of subsequent recommendations (Cheyns and Riisgaard, 2014; Fielke and Bardsey, 2015). Similarly, farm advisors were included, predominantly extensionists, agronomists and consultants, with some carbon project developers and aggregators, to further increase the systemic validity of the findings (Timotijevic et al., 2011). Contacts were sourced from a combination of referrals from industry experts and industry networks, attendance at industry events and conferences, and internet searches. Interviews were generally 40–60 min in duration and were conducted either face to face or using telephone or videoconferencing, depending on the location of the researcher and participant. Ethics approval was received for both case studies.

### 3. Analysis

The interviews were audio recorded, reviewed and analysed through content analysis. High level themes were identified and used to provide insight into the cohort and inform recommendations for each project. This paper provides a synthesis across the entire dataset in a way that allows additional insights around co-benefits to emerge and as a means to extend our understanding of how a co-benefit frame can be operationalised and developed as an external motivator of behavioural change. Specific detail about the individual case studies, including the themes derived in each separate analysis are not reported here but will be documented in separate publications (e.g. Fleming et al., 2019). In describing and discussing our results we use the term ‘carbon programme’ to include activities that relate to carbon trading markets, greenhouse gas mitigation and/or carbon reduction programmes, recognising that these may also be combined.

### 4. Results

#### 4.1. Participants did not currently perceive any financial incentive to participate in the national carbon programmes

Across all of the interviews conducted, it was apparent that although there may have been interest to participate in trading carbon in the past, when the Carbon Farming Initiative was first introduced, the actual financial incentive was not seen to be worth pursuing and was perceived as risky. The perceived financial and operational costs (time and effort) to participate outweighed any (uncertain, potentially low) gain delivered by the market price. Individual farmers are required to input resources (time, money, energy) to learn about and initiate carbon farming projects, the financial returns of which are (as currently perceived) not worth the cost. Therefore, implementing projects for carbon sequestration in order to trade credits was not considered as a worthwhile or viable business opportunity.

“I don’t think that there are any methodologies that make economic sense for people in our farming system to look to adopt” (Int 1, Case study 2).

“The barrier is this – the scale and complexity required, and the long-term nature of the contracts and the low carbon price” (Int 2, Case study 2).

“I think the [farmers] have a lot of potential to grow carbon, but I think the rules and regulations around it, I haven’t seen too many of the promises of maybe 10 to five years ago come through” (Int 23, Case study 1).

### Table 1

| Case study 1                | Summary                                                                 | Participants                          | High level research interests                                                                 |
|-----------------------------|-------------------------------------------------------------------------|---------------------------------------|-----------------------------------------------------------------------------------------------|
| 'Trees on farms' (Led by first author) | This case study looks at how the number of trees on farms might be increased in agriculture. It aims to document the range of benefits of trees and establish methods to better estimate, plan for and recognise the value of trees on farms. | Phase 1: 2017 — face to face and over the phone interviews with 31 farmers and 13 farm advisors in Tasmania predominantly in cropping and livestock. | Perception and belief: Benefits and barriers to tree planting Decision making Values: World views and objectives Networks: Formal and informal information and knowledge pathways |
| Case study 2 'Carbon farming' (Phase 1 led by second author, Phase 2 led by first author) | This case study looks at the current state of carbon farming and perceptions of if and how digital tools may, or may not, be useful to support increased participation in carbon farming. | Phase 2: 2018 — face-to-face and phone interviews with 22 farmers and 4 farm advisors in Victoria, predominantly in dairy. | Phase 1: 2018 — phone interview with 2 farmers, 6 farm advisors and 12 stakeholders in the carbon sector. Phase 2: 2018 — phone interviews with 20 farm advisors around Australia, with interest or experience in carbon advice. |

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### Table 2
List of activities currently described in interviews across both case studies with thematic categorisation (environmental, social, institutional, economic, technology) of the motivations, possible barriers for implementing these changes and a relevant literature example.

| Type of on-farm activity | Thematic category | Motivation driving change (from interviews) | Additional benefits not driving change (noted in interviews and/or literature) | Possible barriers to implementation | Literature (examples) |
|--------------------------|-------------------|---------------------------------------------|--------------------------------------------------------------------------------|-----------------------------------|----------------------|
| Tree planting and regrowth (shelterbelts and windbreaks/riperian planting/amenity planting) | Environmental | Environmental improvement (e.g. soil, water, biodiversity) | Landscape level sustainability | Adoption far below potential (individually driven) | Schirmer and Bull (2014) |
| | Social | Animal welfare | Community wellbeing | | Baker et al. (2018) |
| | Social | Aesthetics and well-being | Potential income | | |
| | Social | Social acceptability/social license | Legacy | | |
| Renewable and alternate energy sources (solar and wind power/biofuel) | Environmental | Reduce emissions | | | Waheed et al. (2018) |
| | Social | Energy independence | Objective/world view | | Vanclay (2004) |
| Improve production efficiency (reduce inputs e.g. fertiliser, fuel/change feed regimes/utilise waste) | Economic | Product use (wood) | Premium branding | | |
| | Institutional | Energy independence | Premium branding | | |
| | Social | Lower long term energy costs | | | |
| Use traditional or historic knowledge (savannah burning, carbon ‘custodians’) | Environmental | Carbon sequestration | | | Agrawal (1995) |
| | Social | Preserving cultural practices | Benefit sharing | | Agrawal (1995) |
| | Social | Social/community vitality | | | Berkes et al. (2000) |
| | Social | Social acceptability/social license | | | McMurray et al. (2019) |
| | Social | Employment | | | |
| | Social | Training | | | |
| Technology | Environmental | Benefits sharing | Carbon sequestration | Access to knowledge | Agrawal (1995) |
| | Social | Social/community vitality | | Objectives/world views | Berkes et al. (2000) |
| | Social | Social acceptability/social license | | Capability/skill development | McMurray et al. (2019) |
| | Social | Employment | | | |
| | Social | Training | | | |
| | Social | Premium branding | | | |

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“The financial rewards for individuals to actually participate in carbon farming as a money making venture are really marginal” (Int 3, Case study 2).

“Given the politics of carbon farming in Australia and given the current price of carbon, given the uncertainty about the marketplace, it comes as no surprise to me whatsoever that farmers are just viewing this sceptical[ly]” (Int 6, Case study 2).

4.2. Co-benefits already motivate proactive on-farm changes but are not resulting in subsequent participation in national carbon programmes, yet

Examples of activities which create co-benefits alongside carbon mitigation that were actively being pursued by interviewees (no regrets scenarios motivated by a diverse range of farmer objectives) are shown in Table 2. These activities are occurring in a wide range of contexts, for a wide range of reasons, but are not primarily motivated by carbon sequestration. The most prominent of these are activities which improve on-farm productivity, efficiency and social license through renewable energy, tree planting, fertiliser reduction or other means. Interviews revealed that carbon is rarely part of the conversation between farm advisors and their clients, and other objectives are the central discussion, despite often achieving the same ends. This means that discussion of co-benefits being actively pursued could also raise awareness of the benefits of carbon sequestration and greenhouse gas emissions reduction.

“A lot of the practice issues relate back to carbon farming, but they’re not talked about in that context. They’re more talked about in the context of, like I said, climate forecasting and making better decisions on what forecasts and impacts of climate, change in climate and managing soil carbon of course” (Int 6, Case study 2).

“The thing that I find with planting out shelter belts is you win on safety, you win on productivity, and you win on sort of farm appeal, so this, even though you’re taking up some of the land you’re actually increasing your productivity so there’s kind of no downside (Int 9, Case study 1).

“I guess, if we look at the broader climate change, there are other things that affect us more directly and immediately. Things like dealing with extreme weather events and they’re the kinds of things that our industry is most worried about” (Int 15, Case study 2).

The interviews identified that although the co-benefits are desirable, there are nonetheless a range of barriers to farmers taking up activities to achieve co-benefits. These barriers span across social, institutional and economic factors (Table 2).

“Too much other stuff on my hands to be planting trees unfortunately” (Int 7, Case study 1).

“I don’t get involved in outside funding [programs]. Somewhere down the line they say, oh we paid so then they can determine what actually happens on our farm” (Int 4, Case study 1).

4.3. Technology could be utilised more effectively to promote carbon programme participation, or at least activities to reduce greenhouse gas emissions and/or sequester carbon

Technology (including innovations in digital services and decision support) was seen as an enabler for improving the application of carbon sequestration methods to farms of all sizes and types of production. Technology could open the door to new players entering the market, allowing greater participation from a wider number of participants and allow for more flexibility, especially from those currently restricted from participating due to scale limitations. In particular, soil carbon and ways to combine farmers in collaborative projects were seen as promising opportunities for technology to connect and inform. Virtual fencing, satellite data, blockchain and soil sensors were all given as examples of how technology could improve how farmers might be able to gain new entry points into carbon programmes, and reduce the cost of participation. Technology was also seen as an aid to decision making...
and as a tool to raise awareness about possibilities of reducing carbon footprints.

"We need to have remote sensors. We need the internet of things to connect all the sensors. We need machine language processing to maybe even interpret emails for farmers into plain language" (Int 11, Case study 2).

“We are on the cusp of enormous technological changes in terms of animal management” (Int 14, Case study 2).

“The only way the industry will move forward is through collaboration: if we don’t share information than we don’t learn” (Int 7, Case study 2).

4.4. Carbon programmes were viewed more favourably when they included additional project methods and offered additional ways of generating revenue associated with current production- farmers want to participate in markets if the return is there and they are eligible

The interviewees reported the potential for ‘carbon neutral’ or ‘carbon friendly’ labelling to provide a marketing edge. They were interested in how participation in carbon programmes might be useful to market their product or otherwise provide a source of public recognition or accreditation. Furthermore there was interest in branding opportunities that related to carbon sequestration more broadly, for example carbon credits that receive a higher price because they also contribute to positive social or environmental outcomes that customer’s value. Table 2 presents an account of which co-benefits can drive different types of changes summarised from the interviews and linked to relevant literature.

“There’s certainly a lot of keenness in farmers; there’s certainly an audience there and people are keen to participate” (Int 8, Case study 2).

“One of the owners of that’s gone carbon neutral totally and he’s quite keen to try and encourage other farmers to look at carbon neutrality, focusing more on the soil side of things, the trees are important aspects of them, and certainly in marketing our brand […] we would try to promote - it's like a green brand and trees are a very important part of the story and our land care ethic” (Int 6, Case study 1).

“I do think it’s starting to softly emerge, and starting to see a little bit of differentiation in market price if the project has particularly Indigenous community benefits, not to some extent biodiversity benefits as well, but projects with Indigenous flow on benefit through getting valued a bit different already than a standard project” (Int 20, Case study 2).

“If a farmer could be ‘carbon neutral’ approved - he could brand his product like that” (Int 5, Case study 2).

4.5. Co-benefits were described in different ways and therein lies part of the opportunity

Terminology around carbon farming and co-benefits was diverse. Carbon footprint, carbon efficiency, carbon intensity, promoting vibrant communities, social benefits, environmental stewards were all terms used, but in essence are about the wider value of farming, and being recognised for these contributions in multiple ways (not only financial). Directly recognising and valuing co-benefits was acknowledged by interviewees as a potential opportunity to innovate the concept of carbon farming. When considering co-benefits, carbon farming is not just about carbon sequestration, but also about other issues as well (social, environmental, economic).

“Shelterbelts are part of animal welfare. I hadn’t thought of that, but that’s probably something in the future that we will be ticking on and off the boxes for audits and stuff […]” (Int 17, Case study 1).

“It’s not only by encouraging farmers to do that sort of thing [planting], not only are you addressing the carbon emission issue, you’re also addressing the bio-diversity issue. You’re providing habitats for bees, et cetera, for honey production. You’re providing shade and shelter for animals, and in this day and age of pretty serious animal welfare accusations in the farming community, you would say that you are creating a better environment for your animals and it’s really a positive thing that you are looking after your animals” (Int 7, Case study 2).

“If we get the feed efficiency right- say a steer is on the earth for half as long but reaches the same potential, our GHG emissions are cut in half” (Int 6, Case study 2).

5. Discussion and recommendations

The case studies demonstrate that broader economic incentives (e.g. co-benefits) are motivating changes in some farmers’ land management behaviours. These incentives send a powerful signal: that if incorporated into carbon programmes could lead to increased participation. Re-framing the opportunity of receiving broader economic benefits through carbon programme participation could support the framing used by land managers to decide how to integrate the project and associated risks into their existing enterprise.

Achieving co-benefits as a direct consequence of carbon farming activities could help farmers recognise that carbon programme participation can align with (rather than take away from) their personal values and the objectives of their farm. There is widespread academic recognition of the multiple dimensions of agricultural land use, and the importance of valuing such diversity in different ways and different contexts highlight different values (Argent et al., 2007; Bjorkhaug and Richards, 2008; Cocklin et al., 2006; Klerks and Proctor, 2013; Pant, 2014; Westley et al., 2013). For example, multifunctional agricultural development provides a conceptual framework that allows for approaches to evaluate and include monetary and non-monetary values in decision making (Fielke and Wilson, 2017; Wilson, 2007). As such, the co-benefits of more considerate agricultural decision-making have broadened farmers’ and agricultural stakeholders’ worldviews to more intangible socio-environmental benefits (Fielke et al., 2018). In New Zealand, work revegetating riparian margins resulted in farmers perceiving a variety of social, environment and practical farm management benefits, along with the obvious resourcing costs involved with such activities, however, farmers who did not participate were only able to imagine the costs involved with such an exercise and none of the co-benefits (Maseyk et al., 2017). These findings suggest that perhaps it is only through this broader recognition and wider framing regarding multiple routes to, and values based views of, carbon farming activities that resulting co-benefits will emerge in the outlook of the farmers involved, creating the momentum to increase positive socio-environmental outcomes.

Recognition of co-benefits in carbon programmes could have immediate and long term positive consequences. These include:

• Socially - improved farmer livelihoods; innovative community initiatives and networks; new markets for products which tap into particular consumer values
• Financially - more monetary return to farmers and communities and more opportunities for climate traders and aggregators; and
• Environmentally - improved landscape conditions; improved biodiversity and restoration; reduced emissions.

Carbon trading could be revitalised immediately by the recognition that co-benefits have economic value to both the farming enterprise and the general public: this could drive a premium price for carbon credits that demonstrate environmental and social benefits.

In the longer term, a number of recommendations need to be actioned by areas of policy, industry and research to further improve carbon programme participation, with overarching lessons relevant to all countries. Current policy mechanisms need to evolve from rigid one size fits all scenarios (as currently presented by the ERF in Australia) to more flexible and layered approaches. Approaches must also be integrated to avoid conflicts, such as between policies for adaptation and
for mitigation (Mushitaq et al., 2013), which a co-benefits perspective can help to achieve. This work points to the need to more explicitly include a wide range of co-benefits in mechanisms that encourage and support farmers to participate in national carbon programmes. New initiatives and levers also need to be employed by policymakers to reward farmers that pursue carbon sequestration through the co-benefit route. Certification schemes are an example where broader consideration of sustainability (including socially and ecologically through co-benefits) could have immediate impact (Dargusch et al., 2010). New policy levers could counter the administrative burden imposed by governance scales which limit the progress of climate policy (Jakob and Steckel, 2016). Current barriers to participation could be addressed through a combination of changes at the institutional level, primarily through policy to increase and incentivise co-benefits. Institutions could also support capability development of staff within industry to provide support and advice on achieving co-benefits, especially in ways that are tailored to individual contexts and take into account individual objectives. Furthermore, government initiatives can help farmers by improving information about their options, helping farmers to measure and verify their carbon and setting up transparent ways for carbon buyers to engage with carbon sellers, as was demonstrated in New Zealand (Maraseni et al., 2018).

Mechanisms for sharing the costs of programme participation are essential as current programmes do not offer an equitable way of balancing implementation costs, market risks, and financial returns. For example, the resources required to obtain financial benefits can differ significantly if comparing payments for choosing not to clear land for the duration of an agreement (even if it was never going to be cleared) compared to actively investing in altered capital infrastructure and changes in practice (such as planting and accounting for trees on farms, or bio-energy altering livestock enterprises). The barriers reported in this paper support arguments that carbon farming is not as simple as individual farm-based transactions when the multiple levels of stakeholders in carbon sequestration are considered (Kongsgager, 2017).

One area not explored in the paper which may be relevant to ongoing discussion of carbon farming opportunities are co-costs or unintended costs arising from co-benefits, such as the need for specific skills (and thus training) or specific management techniques (thus a time and labour cost). Another gap in the interview reports was very little mention of land and sea connections despite some potential breakthroughs coming from seaweed and/or algae in cattle feed mitigating methane emissions (CSIRO, 2018; Herrero et al., 2016), and developments in Reef Credits as potential offset opportunities (Green Collar, 2017). The connection between land and sea is often overlooked (by both agriculture and marine industries) but collaboration across this divide could be of potential significance in the future (Cottrell et al., 2017). Another limitation is a full understanding of co-benefits across scales and who pays or who benefits (Lee, 2017).

The social acceptability of production on farms may become increasingly important in economic terms. As methods for capturing ‘whole of life’ costs and services are increasingly demanded by consumers, for example natural capital accounting – calculating the total stocks and flows of natural resources and services (Monfreda et al., 2004), or true cost accounting – capturing the full cost and benefit of food production to more accurately inform price (Bebbington, 2007), or life-cycle assessment – accounting for the environmental impact of all stages of production (Roy et al., 2009). Forecasting that carbon neutrality is likely to become a ‘gate-keeper’ for access to certain markets, for example selling meat to China and charging a premium price, some industries, such as Meat and Livestock Australia have already committed to carbon neutrality by 2030 (Meat and Livestock Australia (MLA, 2017). Another example is Qantas ‘Future planet’ (https://www.qantasfutureplanet.com.au), which could set a benchmark for others to follow in terms of emissions offset targets.

Finally, research into carbon farming co-benefits is lacking, especially in terms of evaluation (methods for valuing) and ways to combine, ‘stack’ or ‘bundle’ benefits. Research is required to produce methods to better evaluate, compare and combine co-benefits, not in terms of reducing everything to a dollar value, but in terms of accounting for diversity and complexity in policy and decision making. Whether or not particular combinations of co-benefits result in increased carbon sequestration or other particularly beneficial outcomes, or alternatively negative trade-offs – needs to be examined. As an example, the IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) is attempting to make decisions using this broader definition of ‘value’. Another example is looking to traditional indigenous methods to inform (and create new) certification pathways (McMurray et al., 2019). Understanding how to fully maximise the value co-benefits is needed as the scale of desired change is large (and growing) and so ways to optimise carbon abatement will be required.

6. Conclusion

Framing matters in how decisions are made on farm. The carbon farming story has been overwhelmingly framed in financial terms both in Australia and around the world. Shifting this framing to include wider interpretations of responsible farming and the co-benefits available in addition to financial returns may be a useful way to encourage and value farmers for the multiple services they offer (or could offer) through their management of the land. It also means that farmers would be better positioned to be rewarded financially when/if the price of carbon became favourable, and through new market opportunities based on different product offerings related to carbon credits, such as those that explicitly target co-benefits to the environment or to society. Around the world, citizens (farmers included) are currently missing out on the benefits that could arise from a carbon market. Putting co-benefits at the heart of driving change to policy and research focussed on maximising and accounting for co-benefits could transform how carbon is considered and how behaviours occur on farm and in the market place in relation to carbon. Australia has a particular opportunity, with such a large area of land, to lead the world in making the change towards recognition and application of agriculture to harness multiple co-benefits and global impact.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2019.03.050.

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