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Diversifying Rural Economies: Identifying Factors That Discourage Primary Producers from Engaging in Emerging Carbon and Environmental Offsetting Markets in Queensland, Australia

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Abstract

Commitments to carbon neutrality at both international and national levels have spurred the development of market-based mechanisms that incentivize low-carbon technologies while penalizing emissions-intensive activities. These policies have wide ranging impacts for the Australian agricultural sector, and associated rural communities, where the majority of carbon credits and biodiversity credits are sourced in Australia. Undeniably, the introduction of carbon and environmental markets has created the opportunity for an expansion and diversification of local, rural economies beyond a traditional agricultural base. However, there is much complexity for the agricultural sector to navigate as environmental markets intersect and compete with food and fiber livelihoods, and entrenched ideologies of rural identity and purpose. As carbon and environmental markets focused on primary producers have expanded rapidly, there is little understanding of the associated situated and relational impacts for farming households and rural communities. Nor has there been much work to identify the barriers to engagement. This study explores these tensions through qualitative research in Stanthorpe and Roma, Queensland, offering insights into the barriers and benefits of market engagement. The findings inform policy development aimed at balancing climate goals with agricultural sustainability and rural community resilience.

Keywords: climate change; net zero; carbon farming; Australia; rural development

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1. Introduction

The drive towards carbon neutrality is generally accepted as a necessary step to reduce the impacts associated with anthropogenic climate change. Australia has committed to reducing greenhouse gas emission (GHG) by 43 percent by 2030, and to reaching "net zero" emissions by 2050, under the Paris Agreement (UNFCCC) [1]. In the past, Australia has been able to meet its two prior commitments to GHG emission targets under the Kyoto Protocols in 2008–2012 and again in 2013–2020 after a dismantling of the carbon

pricing in 2014 [2]. According to the Australian government's National Greenhouse Gas Inventory (NGGI), reported quarterly to the UNFCCC, Australia is on track to deliver on the Paris Agreement targets. More than half of Australia's emissions are still produced from electricity and stationary energy sources, with a further 17.5 per cent of emissions produced from agricultural emissions [1]. Long-term sectoral trends, which account for the largest reduction in emissions, are attributed to reductions in land clearing and native forest harvesting, increases in plantations and native vegetation, and due to soil carbon enhancement [1]. Whether these changes in land-use practice are a result of carbon farming incentives or based on natural farming processes and a growing awareness of the benefits of sustainable farming practices is not clear. By enabling large emitters to offset their emissions, some researchers have questioned whether carbon farming initiatives have provided effective disincentives for the industrial sector and large agricultural corporations to curb their carbon-intensive practices [3,4]. Others question the lack of planning regarding residual GHG emissions, which are not accounted for under existing net zero plans [5].

Carbon farming initiatives, described as land-based activities which aim to either avoid generating GHG emissions when producing food and fiber, or to change activities to increase sequestration and carbon storage in soil and native vegetation, are increasingly popular around the world [6–9]. Driving much of the carbon farming activity in Australia is the Safeguard Mechanism, a primary policy mechanism by which Australia plans to reach carbon neutrality by 2050. This is consistent with the scope and positioning of carbon farming in Europe, the United States and elsewhere, as the principal policy tool to meet carbon neutral commitments [10]. Initiated in 2016, and reformed in 2023 following review [11], the Safeguard Mechanism focusses on industrial facilities that produce greater than the initial baseline of 100,000 tons of CO_2-eq per year. Currently, this includes facilities in mining, oil and gas, manufacturing, transport and waste industries that produce about 28% of Australia's GHG emissions [12]. The electricity sector is also included under the Safeguard Mechanism but has a different baseline and reporting process [12]. The scheme is based on the regulation that if a facility operating under the Safeguard Mechanism has generated less emissions than the required baseline levels, the facility then automatically generates tradeable Safeguard Mechanism Credits (SMCs). Exceptions apply to landfills and facilities deemed to have surrender provisions, or with borrowing arrangements. SMCs can be either surrendered to meet their own Safeguard compliance operations, sold to other facilities that have exceeded their baseline emission levels or retained for future use. At this point in time, SMCs can be banked and used in any year up to 2030. Similarly, borrowing a maximum of 10% of the facility's baseline each year will be allowed until 2030, with interest applied [12].

Under the Safeguard Mechanism, another form of offsetting credit is the Australian Carbon Credit Units (ACCUs) which are able to be purchased and surrendered by facilities that exceed the GHG baseline levels. One ACCU is equivalent to one ton of CO_2-eq emissions [1]. Similarly, the International Monetary Fund has recommended that Australia expand the Safeguard Mechanism into other sectors, which would lead to further expansion of domestically produced carbon credits [13].

Australian carbon credits are currently accepted in various international carbon offsetting schemes. As a consequence, the carbon stored in Australian soils that is sold as carbon credits (ACCUs) is then counted towards offsetting emissions produced in the country that purchases the credit, not in Australia [14]. To date, however, the Australian government, through its Emission Reduction Fund (ERF) has purchased approximately 90% of ACCU sales since 2014 [15]. Recently, both the EU, under the European Green Deal [16], and the USA have also committed to expanding their carbon policies, with Ernst

and Young reporting that increasing demand and rising quality standards around the world will increasingly make carbon credits both scarce and more expensive [17].

Carbon and environmental offsetting schemes also operate at the sub-national level; for instance, in the state of Queensland, the government's Land Restoration Fund (LRF) and other third-party schemes like Reef Credits are also contributing to an expansion of the carbon and environmental offsetting market beyond its initial government facilitated stage [18]. Queensland has committed to reducing GHG emissions by 30% by 2030 (from 2005 levels) and reaching net zero emissions by 2050 [18]. In addition, there is support from industry groups to reduce emissions and adopt sustainability-based practices at regional levels. The Low Emissions Queensland Agricultural Roadmap 2022–2032, which was updated in March 2023, identifies five pathways to achieve the reductions in emissions required. These include curbing emissions from livestock (noting the Methane Pledge), from cropping and horticulture, and supporting initiatives related to on-farm energy options, carbon farming and landscape management through improvements in supply chains [18]. In addition to these national and state government schemes, some private industries have introduced their own strategies to meet their climate goals. Meat and Livestock Australia has committed to a carbon neutral target by 2030 [19], whilst the Australian Pork Industry identify that piggeries have reduced their GHG emissions by 60% [20].

Due to these emerging policy frameworks at state, national and international scales, and actions taken by industries, carbon farming in terms of claiming and selling carbon credits through various land-based practices is a rapidly expanding and complex industry. In 2022, for instance, the Clean Energy Regulator (CER) reported that more than 200 million tons of carbon abatement had been purchased from Australian farms at a cost of between AUD 10.23 and 16.94/ton [21], which amounts to over AUD 2 billion. But, as carbon farming initiatives in Australia are still relatively young, the impacts of the scheme on primary production, on the natural environment, and on rural communities is not well understood.

Undeniably, Australia's climate policy has had and will continue to have large, complex implications for the agricultural sector in Australia and beyond. In considering all these initiatives, and an expansion of the Safeguard Mechanism, the National Farmers Federation (NFF) CEO Tony Mahar commented that through the current system, Australian farmlands are predominantly the "net" in Australia's net zero future, citing concerns about the implications for Australia's food security should the "balance between delivering carbon offsets and meeting our global food and fibre demands" not be realized [22]. A mapping exercise of land-use conflicts between agricultural development, carbon farming and biodiversity in northern Australia, for instance, further emphasized a need to consider the significant overlaps, trade-offs and conflicts occurring across the landscape [23].

So, in light of these dynamic and complex changes occurring within the agricultural sector, which has a significant impact on service industries and agriculture-based rural communities, the purpose of this study is to take stock of the impacts, both positive and negative, that are currently associated with carbon farming in Australia. In this article, we present the views of 20 primary producers, carbon consultants and community leaders from two large rural towns in southeast Queensland, Australia—Stanthorpe and Roma. Following thematic analysis, our findings were organized around observations, experiences and points of frustration or concern for participants. In this moment-in-time rapid analysis of these two case study communities, we highlight areas of concern that warrant further investigation and provide inception points for policy makers and local governments.

2. Background

To be eligible for ACCUs, projects need to be registered with the Clean Energy Regulator (CER) who assesses the method proposed to store carbon or remove emissions that will be undertaken in the Carbon Estimation Area (CEA), noting that a change in practice of the land area must take place; that is, ACCU cannot be collected for business-as-usual or non-activities. ACCUs can be sold back to the CER or sold on the voluntary market to other businesses seeking to offset their emissions. Provided that the ACCUs remain within Australia, these savings in emissions are then reported in the quarterly NGGI.

To earn ACCUs, farmers need to use an approved method specified by the Emissions Reduction Fund (ERF), which include (i) agriculture methods (change in management of herd or cropping system to reduce NO_2 and NO, or a change in land management to increase carbon storage); (ii) vegetation methods such as direct planting of native vegetation in planting projects; and (iii) savannah burning methods that aim to reduce the extent of hot fires in the late dry season [12]. There are 16 methods in total which include practice or management changes like storing carbon in vegetation and soils, choosing not to clear woody vegetation, reducing methane emissions in livestock by providing better feed for grazing animals, reducing agricultural waste and changing the timing of savannah burning [12]. Other activities eligible to be registered as a soil carbon project include adding new irrigation, applying fertilizers, re-establishing or rejuvenating pastures and retaining stubble following harvesting, for example [14].

In Queensland, the state government have identified over 250 carbon farming projects in Queensland, operating under the Australian government's ACCU scheme [24]. Of these, over 200 carbon projects are located on Mulga Lands of Queensland across seven million acres [21]. Mulga Lands extend across Quilpie, Charleville and Cunnamulla townships and further south across the New South Wales/Queensland border.

Together these projects account for 36% of all ACCU projects with the vast majority (161 projects) employing human-induced regeneration (HIR) methods of carbon storage with a permanent even-aged native forest. This method avoided the suppression of native tree regrowth through the management of grazing activities and invasive weeds. At a national level, the HIR methodology accounted for 26% of registered projects and 30% of ACCUs issues between 2013 and 2023 [24]. As of 1 October 2023, HIR ceased to be a valid methodology under the ERF.

Although the carbon farming scheme developed with the CER was in its infancy, originally as the carbon farming initiative in 2012, some of the challenges that scientists have identified relate to the level of uncertainty in soil carbon measurements, mostly due to natural variability of carbon concentrations in the field and due to rainfall unreliability which in turn affects plant growth and carbon input availability [14]. Despite these current shortcomings, [14] proposes that the CER scheme can produce significant levels of abatement in agriculture which they warn may be overlooked if polluting industries prioritize the purchase of cheap carbon credits on the voluntary markets over investing in technological developments needed to reduce their emissions through production [14]. Note that this article was published just prior to the 2023 reforms of the Safeguard Mechanism being released, which announced the government's fixed ACCU price that effectively places a cap on the maximum price of ACCUs allowed to be purchased by facilities.

3. Methods

3.1. Case Study

To identify impacts, both positive and negative, that are currently associated with carbon farming in Australia which have influenced primary producer's uptake of carbon and environmental market opportunities, we have adopted a case study approach. Our case

studies are centered on two large agriculturally based neighboring regions within southeast Queensland—Stanthorpe and Roma (see Figure 1). These regions were primarily selected due to their historical and current economic links to agriculture, and because carbon farming projects are not common in these regions, unlike surrounding areas like the Mulga Lands. Both Stanthorpe and Roma are nodes of the Federal government funded Innovation Drought Hubs [25]. Due to the propensity of the region to periodically experience droughts, diversifying farm income through partial or full engagement in carbon projects would presumably be an option that most primary producers would consider. The fact that many producers have not taken up opportunities to engage in these alternative markets suggests that there are complexities preventing uptake that need to be highlighted. For these reasons, both case studies are well suited to the task of identifying the positive and negative impacts associated with engagement in carbon farming initiatives.

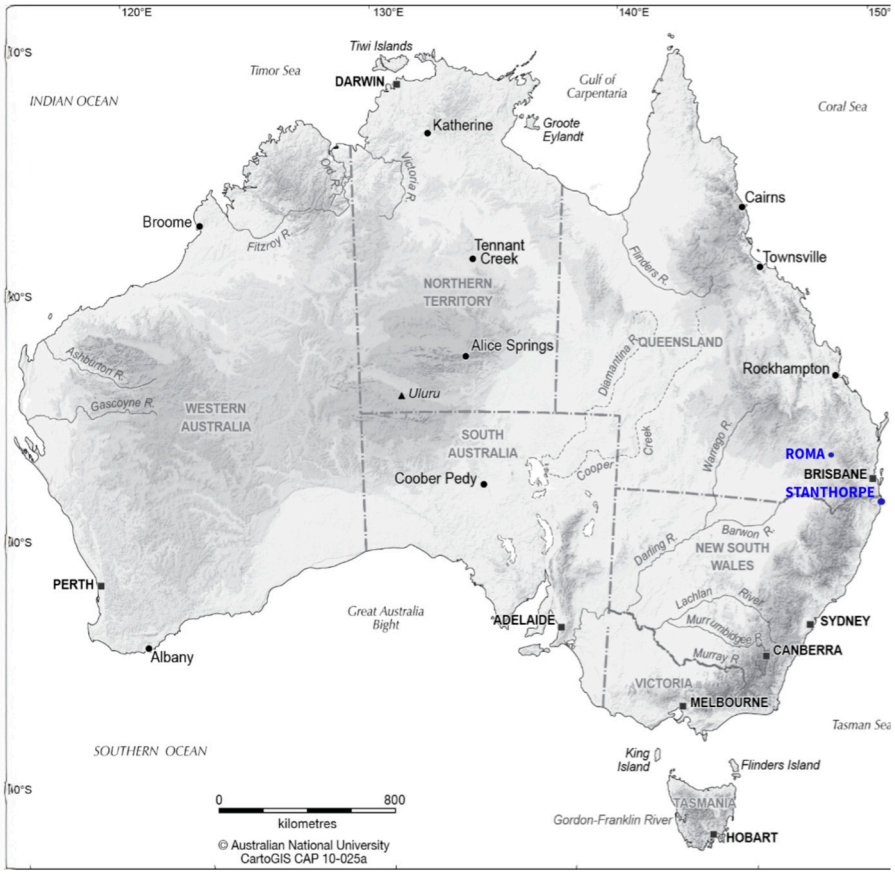

Figure 1. Stanthorpe and Roma, Queensland, Australia (source: map reproduced with the permission of CartoGIS Services, Scholarly Information Services, The Australian National University).

As depicted in Figure 1, Roma is situated in Queensland's Western Downs region, approximately 480 km northwest of Brisbane. As the administrative center of the Maranoa Regional Council, it serves as an administration and service hub for the surrounding rural areas. The second case study community of Stanthorpe is nestled in Queensland's Granite Belt region, roughly 220 km southwest of Brisbane. Positioned at an elevation of 811 m in the Southern Downs Regional Council area, it is one of Queensland's highest towns. The town is characterized by its distinctive granite outcrops and proximity to the New South Wales border, with a cooler climate than most Queensland towns.

According to the Australian Bureau of Statistics, Roma has a population of approximately 6000 residents. The demographic profile shows a relatively young population with a median age of 42, slightly below the Queensland average [26]. The gender distribution is

nearly balanced with 51% male and 49% female residents. Family households represent 72% of all households, higher than the state average. Socioeconomically, Roma has a median weekly household income of AUD 1450, below the Queensland average of AUD 1675 [26]. The unemployment rate hovers around 4.5%, which is lower than the state average. Home ownership rates are high at 63%, with 32% of properties owned outright [26].

Similarly, the Australian Bureau of Statistics also reports that the Stanthorpe region (Stanthorpe Surrounds) is home to approximately 6300 residents with a distinctly older demographic profile [27]. The median age is 49, significantly higher than the Queensland average with 25% of residents aged 65 and above. Gender distribution shows 51% male and 49% female residents. Socioeconomically, the Stanthorpe greater region reports a median weekly household income of AUD 1137, substantially lower than the state average of AUD 1675/week. The unemployment rate is approximately 3.9% with most of the regions' employment concentrated in industries like horticulture (vegetables), apple and pear growing, sheep and cattle grazing, followed by primary education, accommodation, wine and other alcoholic beverage making [27].

Roma's economy is anchored by three key sectors: agriculture, resources (particularly natural gas), and government services [28]. Stanthorpe's economy is also heavily reliant on agriculture, particularly horticulture and viticulture. The region's unique micro-climate enables the production of temperate fruits, vegetables, and wine grapes that are not viable elsewhere in Queensland. Both Stanthorpe and Roma are located within the Darling Downs Southwest region of Queensland, where the agricultural sector in 2025 employs approximately 22,600 people [29]. In 2020/20221, the total value of the Darling Downs and neighboring Southwest region's agricultural output was AUD 3941 million, which accounts for just over 27% of Queensland's agricultural commodities [28,30].

There are eighteen carbon projects currently registered in Stanthorpe and Roma by the Australian government's CER [30]. These include three projects located in Stanthorpe, twelve projects in Roma, and a further three regional projects which include parts of the greater Roma area. Of these projects, ACCUs have been issued for only three projects to date [30].

3.2. Qualitative Interviews—Who and How and Thematic Analysis

In total, 20 semi-structured interviews were undertaken with a combination of primary producers (14), local government executives (2), and other local stakeholders (4) including carbon consultants. Participants were invited to participate in the study by local Drought Hub Node Managers residing in Roma and in Stanthorpe, based upon their direct or indirect experiences of engagement in local carbon projects. Interviews were conducted as face-to-face interviews in local coffee shops, or if preferred by the participants, as online interviews for a duration of up to 60 min. Human ethics approval was granted by the University of Southern Queensland (ETH2024-0581), and all research activities were carefully performed in alignment with the ethical standards defined by the 1964 Declaration of Helsinki. Informed consent was obtained from everyone participating in the study and processes put in place to maintain the anonymity of participants. Due to these ethical agreements, data is not available to be shared. Audio recordings of the interviews were compiled, with permission, and transcribed verbatim by the research team. Thematic analysis was undertaken following an iterative and reflexive process [31].

4. Key Findings and Discussion

This article focusses on the reasons why many primary producers in our study may be discouraged or unable to participate in the emerging carbon markets which are arguably based on observations of the impacts associated with neighboring carbon projects. Despite

lower levels of uptake, this is not consistent with the view that all of the participants were against the idea of carbon markets. Of the twenty interviewees, three identified reasons why primary producers might be drawn to carbon markets beyond just financial reasons. Participants referred to a sense of stewardship and caring for the country. Others were conscious of leaving a positive legacy by ensuring that the land was left in a better condition than when they took on the management of their land. For many, these were the traditional socio-cultural values of land holders in rural communities prior to the inception of carbon and environmental markets. Some, however, made the connection between these values and the emerging markets. For example, a primary producer from Roma commented that "there is a whole bunch of flow-on effects and ecosystem services that come out of running a well-designed project. And that's really the key to the whole shebang [meaning: process]".

Others considered that money was the driving reason behind producers becoming engaged in carbon projects. A carbon consultant from Stanthorpe reported that "no one mentions the good projects that are getting paid lots of money. You know, a lot of my clients have got existing carbon projects and they're getting nearly a million bucks [AUD 1 million] a year from, from tree carbon. So, no one actually highlights the projects that are going well. You only ever hear about the ones that aren't going well."

The literature on this topic also identifies several other benefits associated with carbon farming that our interviewees have touched on. Carbon farming streams that enriched soil carbon, and the health of vegetation and water supplies were also co-benefits from land management under carbon farming [32]. In agreement with this idea was a livestock producer from Roma who reported that "we're going to do what we need to do anyway, to optimize production. I'm going to build carbon so I'm going to put all the input in and build my soil up and build the pasture base up and grow better animals. But yeah, I won't get paid. Well, I'll get paid, I call that better animals, at the end of the day, I'll have better production". This producer was unable to raise the finance required to undertake preliminary testing in order to scope out a prospective soil carbon project, noting that there are minimal charges involved in scoping out vegetation-based projects. Similarly, another producer from Roma who found the initial costs to be a barrier to participating in a carbon project also stated that "we're still managing the place to sequester carbon to get all those other knock-on benefits".

Although not evident in the views of people participating in our study, others from neighboring areas in Queensland, where carbon projects are commonplace have referred to the benefit of an additional income stream for producers, particularly during different periods. For instance, a study located in the Queensland Mulga Lands identified that the largest incentives for adoption of carbon farming were economic drivers and the opportunity to diversify income streams. An interviewee from the Mulga Lands (carbon farmer) commented on their experience of being ostracized by their community when taking on a carbon farming project but considered that the economic benefits outweighed this experience [21]. He added that the income from the carbon project provided some relief from the strain of drought, commodity price fluctuations, and changes in vegetation management regulations. Others referred to certainty and stability of the carbon farming income stream as a "saving grace" for those struggling to sustain their agribusiness and commented on the influx of additional income that indirectly benefitted the wider community's economic activities. Many from the Mulga study did, however, comment that the income from carbon farming was a short-term solution [21].

4.1. Costs as Barriers to Initiate and Implement Carbon Projects

All but one of the primary producers commented on the cost to initiate or implement carbon projects. A multigenerational primary producer shared that his "plan was always

to do something, whether it was an above ground project with trees, without clearing any trees or a soil project but the cost is just prohibitive. I've had three people quote for the initial baseline testing, and I've been quoted between $A20,000 and a $A100,000 to baseline the place". Others added that for soil carbon projects, establishing a baseline is initially required followed by soil testing and monitoring every five years, requiring a significant sum of money. Further, once a consultant does an initial assessment, costing a significant amount of money, there are no guarantees that the producer will be eligible to undertake a carbon project. In terms of generating ACCUs, the project needs to be capable of preventing the release of carbon emissions, or active in capturing and storing carbon emissions. In some cases, where the soil is already carbon rich, or land is well vegetated, a carbon project may not be economically viable. After an initial financial investment in conducting the testing by a consultant, there is a chance that the producer may find that a prospective carbon project is not feasible. Consequently, there is an element of financial risk involved in investing in the initial baseline tests in order to scope out a potential project to participate in the carbon market.

Some carbon consultants have partially countered this issue by providing free initial feasibility studies, with a view that they will re-coup a percentage of the ACCU value when sold. One consultant clarified that "sometimes that percentage is up around 40% of the ACCUs that are generated by the project. So, it's a significant amount." Several other producers also referred to the cost of implementing and then monitoring projects. When asked about why he was not involved in carbon projects, a producer from Stanthorpe commented that "a barrier to entry is the cost of project feasibility and then the cost of your first baselining, particularly in soil carbon". He added that the average cost to determine the feasibility of a carbon project was about AUD 15,000. Establishing a baseline, monitoring and then the cost of implementing the project which may involve fencing, planting or adding nutrients to soils are additional ongoing costs. We also note that following the compilation of our interviews in August–September 2024, the Australian government's CER introduced potential upfront payments of up to AUD 5000 for eligible, new projects [33].

As activities to enhance carbon sequestration benefit everyone, several studies from around the world have assessed the general public's willingness to pay and contribute to the costs incurred. Several studies have identified the general public's willingness to pay for these conservation benefits in Andalusia and in Scotland [34]. Similarly, a survey of over 920 Australians, of which only 2% were engaged in agriculture, found that the public were supportive of the government's carbon farming initiatives and were willing to pay up to AUD 19/year for each hectare's increase in native vegetation and AUD 1.13 per year for each additional metric ton of carbon sequestration [35]. These studies, located in diverse contexts, emphasize the public's support for biodiversity, and land regeneration co-benefits of carbon farming that the researchers considered the government could promote through carbon farming policies.

We also acknowledge that many producers in our study, and in others, have been actively engaged in these aligned activities long before the concept of carbon farming emerged. For instance, a study located in the northern wheatbelt of Western Australia surveyed 43 farmers (online) to ask about their farming enterprise, views on climate change and their willingness to adopt nine different carbon farming practices that included activities such as planting trees and establishing areas of native vegetation [34]. The study found that over 60% of the surveyed farmers responded that they were experiencing the impacts of climate change such as decreased rainfall, prolonged dry periods and droughts, more extreme rainfall periods, shorter growing seasons, etc. About 40% of cropping-only farmers and 60% of the mixed crop–livestock farmers claimed to have changed their farming practices in the last ten years to increase carbon sequestration, which included

minimum tillage, stubble retention, fewer fallow periods, fencing off remnant vegetation and trialing new species [34].

But many of these practices noted in [34] were likely undertaken prior to the initiation of the Carbon Farming Initiative in 2012–2014 which transitioned into the Emissions Reduction Fund in Dec 2014. In their study of Western Australian farmers, [34] found that there was a clear correlation between farmers undertaking these practices and their beliefs, experiences and observations of climate change, and for farmers with some knowledge of the carbon farming initiative. These studies imply that for many farmers, some of the carbon farming methods for acquiring ACCUs in many ways reflect good sustainable business practices, also evident in some of our interviewees' comments reported above.

Participating in some of the carbon projects can also take considerable time and work, which is reflected in the popularity of project types. Practices that require significant effort and finance like applying biochar, establishing areas of native forest or tree planting were the least popular carbon farming practices [34]. Perceived or realized competition for water between trees planted and crop production were also highlighted as disincentives to adopting tree planting practices. It can be argued that just the action of identifying that carbon locked in soil and trees has economic and environmental value can also have significant impacts on land-use decision-making by landowners. In this context, the inclusion of carbon farming as a land-use option incentivized a shift from traditional agricultural practices to one more aligned with biodiversity and conservation values [34].

4.2. Challenges to Access Accurate Information

Challenges involved in obtaining accurate and trusted information were raised by four participants in our study. These interviewees identified this as a significant problem in their communities and highlighted the importance of being able to obtain trustworthy information from reputable sources. Carbon broker's operating without a social license to operate was a popular theme that arose in our interviews. Some interviewees spoke about the traveling salesmen approach of some brokers who were selling the carbon scheme. A producer from Roma commented that "I think farmers have pretty low levels of trust in brokers of any kind, whether it's a water broker, a carbon broker, or any kind". Another producer referred to a broking company that had completed their assessment without traveling to his property and was unable to do soil carbon projects. This, he considered, was not in his best interests, and in his view, it contradicted the purpose of the scheme, which was to find pathways to best retain and absorb more carbon.

Trust in the provision of accurate information was seen as only one of the business risks involved in engaging in carbon markets. Uncertainties regarding the future of carbon net zero policies also created some risks for producers. Some primary producers were also skeptical of the flow-on effects of changes in the policy environment. Referring specifically to the Safeguard Mechanism, a carbon consultant commented that "my take on it is, that there's certainly a reticence to sell carbon credits, based on the philosophy of selling them and then actually needing them [ACCUs], and having to pay a whole lot more per credit to get them back. Right? That to me is very common concern".

Other concerns relate to the impacts of climate and weather on carbon projects. In considering the impetus for the Safeguard Mechanism, another producer from Roma commented that "... it's got to work for large emitters at the end of the day and who's paying for it. But, farmers, I think they're the resource and they're the people that provide a large part of the solution. But I haven't heard what happens when things go backwards and that's nature. Are we going get left, hung out to dry?" It is also true that if a project does not generate and maintain the expected volume of carbon sequestration, it is subject to correction. In the worst case, this might require that ACCUs are either being adjusted or

revoked. The CER has introduced a risk of reversal buffer for all projects accounting for the possibilities of illegal thinning or clearing, animal grazing, climate-related disasters or poor management practices. This means that all projects in Australia, following their first reporting period are subject to a 5% reduction in ACCUs [36].

The misapplication or misinformation that produced perverse environmental impacts as a result of the carbon market initiatives was also a topic that three primary producers commented on. One producer simply commented that "personally, from a scientific view, it [the carbon project idea] just didn't make sense". Another sheep and cattle (livestock) producer clarified that the idea to "go and bulldoze your land every eight or 10 years and then we can capture carbon again. I do not understand that logic. To me, that is the worst thing. You destroy your microclimate, you destroy your ecosystems, um, every 10 years just to grow carbon. That's a skewed objective".

The sentiments and values pertaining to building up soils and leaving farmlands in a better condition as a legacy of producers are evident in these kinds of statements. This primary producer commented on a neighbor who had advised him to chop down his large trees for logging which would earn him about AUD 30,000. He reflected that this was a different view of farming and production to his own, commenting that "$30,000 is not going to make a difference in my life for my future. But having my big trees on the property and seeing them, seeing the bird life, seeing everything else, that's what I prefer, you know? So just a different way of looking at the same thing".

Several producers referred to the environmental impact of windmills which was a controversial topic in the Stanthorpe region at the time. Connections between the policy context responsible for the drive towards renewable energy and windmills, with carbon farming initiatives were referred to in several interviews. Specifically, the situation where environmental restrictions were applicable to primary producers, and then the dismissal of these same environmental restrictions by renewable energy projects had created some tensions in the region. A Stanthorpe producer identified that "where we have, you know, the red zones that we are not allowed to clear on, which is hills with certain native species and so on, they've cleared that, built roads and put towers on the middle of it, which is all the high hills and so on, where they catch the wind, of course." He added that because of the underground cables, infrastructure towers and windmills themselves, a lot of wildlife and pests have moved onto his property, indicating significant disturbance and environmental impacts to these ecosystems. Some primary producers were alarmed with the instability of these government-sanctioned environmental protections which compounded concerns regarding uncertainties around carbon policies and associated commitments.

These diverse types of uncertainties raised by the participants in our study have also been reported in other areas of Australia. Negative aspects of carbon farming included factors like policy uncertainty (including reviews of AD and HIR methods, and ACCU pricing uncertainty, which was partially resolved in the 2023 reforms), complex rules and the "perceived" inflexibility regarding future land use [32]. In comparing 25 yr to 100 yr permanence periods with total exclusions of stock, they point out that this longer permanence period could lead to loss of future land-use flexibility. Similarly, the lack of farm business flexibility under the requirement for a permanence period of at least 25 years was also another area of complexity [14]. Other disincentives included a potential increase in invasive native scrubs and woody weeds [37], increased risk of wildfires and pest occurrences due to absenteeism farming aligned with corporate carbon farms, and potential decreased land values [38].

Other barriers for farmers to engage in carbon farming schemes related to a lack of understanding of low-cost abatement choices available, and understandings of the transitional costs involved in undertaking a changed farm practice [34]. Since this paper

was published in 2016, it seems that there are several locally based carbon farming agents and much greater amounts of information available to assist farmers to appraise the carbon farming options, like CSIRO's tool named looc-c.farm, which estimates the amount of carbon credits that a potential project might generate. In a similar study situated in western NSW that focused on carbon farming's "social license to operate" (akin to social acceptance), researchers found that there was generally a lack of confidence in the governance (monitoring and evaluation) of carbon farming due in part to the policy complexity, uncertainty and accessibility of accurate information [38].

4.3. Disincentives Relating to Policy Uncertainties and Their Implications for Primary Producers

Other risks to farming businesses that interviewees spoke about related to arrangements for payments for credits, with some referring to situations where producers had already received payments for locking up land for the next 30 years. Two interviewees explained that this meant that essentially the specific parcel of land under the carbon project could not be productive for the duration of the project, which had implications for succession planning and potential land values.

Relatedly, a farming consultant from Stanthorpe noted that "the industry average of onboarding from the time you do a first inquiry to when you register a project, is something like 10 months. So, there's a lot of time taken with me and my clients, and it's apparently an industry average, is that you do a lot of work around convincing, not convincing, but justifying why these projects work. There's also a fair bit of succession in that as well. Gotta muck around [meaning: work through] because they're long contracts. It's a whole generation. So, if you're dealing with young kids now you've got to go, by the time this contract's completed, these kids will be running these farms. So, what happens is, you end up triggering a lot of succession stuff when you go into these projects as well."

Others were skeptical that those with soil carbon projects would actually benefit directly from their carbon project. A producer from Roma states that "a lot of people that I talk to about carbon farming, they think that it's never going to come off. You've got to make these large investments now and then you've got to do your testing along the way as well. And then, you might get payback, but you don't know what it is". These environmental uncertainties in combination with policy uncertainties can produce significant disincentives for primary producers. Consequently, some producers have opted to wait and see what develops.

Associated with the power imbalance that many small-scale farmers experience when dealing with Australia's large supermarket chains [39], some producers are skeptical that farmers will actually benefit from the carbon farming schemes. A producer from Roma commented that "the problem that we see as farmers now is the downward pressure, so Coles will not buy the meat if you don't provide them with a carbon zero product." He added "so I need to be carbon zero and I sell you a lamb so that lamb is now produced carbon zero. But you also want some of my credits to buy my lamb instead of buying my neighbor's lamb, that are not carbon zero. So, what we see now is the processors, the middleman, and the retailer all have to either buy offsets, which they have to do for their shops, their electricity, all the other stuff, but for their product as well. So those products, they try to push back onto the farmers. So now suddenly I'm thinking, okay, say I have 400 tons [of carbon offsets]. Do I sell it on the market or do I keep it. So that will become another issue." Another producer commented "it's the people in the middle that were going to make the money out of it". We note that the implications of large supermarket's carbon zero brands have not been raised in the literature to date. This is a significant factor for Australian producers that supply the two large supermarkets operating in Australia as

described by [39]. Just as our interviewees have described, other Australian studies have also reported producers' concerns regarding policy uncertainties [38].

4.4. Societal Impacts and Implications for Social Resilience

In neighboring communities, the effect of carbon farming projects at scale, and the rising number of corporate carbon farms, has led to some profound societal effects. An elderly farmer from Stanthorpe reflected that "I used to be based in Western Queensland as in Cunnamulla and Charleville. I'm aware of a number of properties that I was involved with have changed hands to people who have bought those properties on a carbon basis. They're not now being run as commercial enterprises like they were. So hence the sheep and cattle and, sheep, cattle and goats basically aren't there, and that's not happening like it was. Those numbers aren't there. Hence there's reduced numbers of shearers for the sheep, and contract musters, all that sort of thing. So, a definite impact on requiring less humans".

Major findings from other studies in Australia were that there was uncertainty or misinterpretation of the carbon farming methods registered with the Clean Energy Regulator, like absentee carbon projects where farms were no longer managed [9,31]. Absenteeism or lack of active land management was an issue that community members rallied around—arguing against non-active carbon farming projects from receiving benefits for doing nothing. Interviewees also argued that these non-managed corporate businesses contributed little to the neighboring businesses and community. Some also associated un-managed farms with the prevalence of pests in the region.

Within communities where some landholders are eligible for carbon projects, whilst others are not, tensions have flared. Several interviewees referred to the secrecy within the community of which producers had taken on active carbon projects, noting that some were required to sign confidentiality agreements by carbon brokers. Some of the interviewees perceived carbon farming as an "us versus them" situation, creating division within communities. Distributional fairness in regard to some farms being eligible while others were not, formed a large section of another studies' focus describing an ongoing source of dissent within the Australian region of Bourke, New South Wales [38]. Points of tension related to the eligibility of carbon projects with some interviewee's perceptions that poor land managers are being rewarded, whilst those who have put considerable effort into building their land are ineligible. A producer in Stanthorpe explains that a "[producers'] best opportunity to build carbon is [on] run down [meaning: degraded] country that you've mined so to speak, and so you're just getting paid to rehabilitate it." Another producer from Roma also commented that "I still think there's a little bit of ostracization that goes on, like, you know, people that are doing this, it'd be less than 2 or 3% of farmers that are actually executing projects. And they, there's a level of, um, difference between them and their community. And I still see that a bit. I see that they then become the outliers in their communities. So, in terms of social impact and the reluctance to uptake is, yeah, they sort of stick out of their community a bit in terms of that".

Carbon farming initiatives that community members considered led to greater levels of rural flight, with families selling off their farm and relocating to larger regional and urban centers, are consistent with longer-term internal migration patterns [39]. Whether carbon farming has led to an acceleration of these trends is not known and, as highlighted above, is an obvious site of contention within the community as the location of commercial enterprises, and governmental services such as schools and medical services are based on current and future population estimates.

To reduce these tensions in communities, some researchers have recommended community information sessions and workshops to dispel some of the misinformation circulating about carbon farming schemes. Others suggest an upskilling or capacity building

of local NRM groups perceived to be the "honest brokers" by community members [14]. In view of these tensions, farmer-led non-government organizations (NGOs) such as the National Farmers Federation (NFF) have raised some concerns regarding the current way that carbon farming policies are taking shape on the ground [40]. The NFF have previously advocated for a prime agricultural land policy, popular in the EU to restrict development, which again features in their recent concerns about potential land-use conflicts arising from the ERF's methods for obtaining carbon credits [22].

A media release from the NFF CEO Tony Mahar, following the 2023 review of the Safeguard Mechanism, has stated that the demand for future carbon credits required by Safeguard facilities could "escalate land-use conflict, with pressure to turn food and fiber producing land into carbon sinks", arguing that it is critically important that government avoids a mass buy up of productive land [22,41,42]. The NFF have also identified a need for improved extension services to support farmers to make informed business decisions and, in more recent years, have become a firm advocate for sustainably balancing opportunities for farmers to engage in carbon and environmental markets, whilst retaining Australia's food security [42].

5. Discussion

Planning for future food security needs whilst ensuring that Australia contributes to global scale initiatives to address ongoing climate change is not without complexity. Each of the issues raised above point towards significant socio-cultural issues and policy–practice ambiguities that require further investigation in the emerging "agri-carbon landscape" [4]. Many of our findings are reflective of the Australian rural context experienced at the local scale, and accordingly, solutions and clarifications of carbon farming policies and associated practice should similarly be focused at this scale.

There are, however, some common factors that contribute to decision-making regarding engagement in carbon markets around the world. These include levels of access to land, labor, and capital resources, and how these combine with access to technology and innovation [43], uneven cost–benefit distributions within and between households [44], negative impacts on labor burdens and associated lower production of farm yields, particularly in the short term [45,46].

In each of these different agricultural contexts, there are complex interactions between livelihoods drivers and existing resource management and production systems with emerging carbon and environmental offsetting markets that are diverse and nuanced. Clarification of policy settings, certainties regarding the durability and longevity of key policy instruments, like the Safeguard Mechanisms, and assistance to raise initial capital if required, obtain climate-related insurances and undertake pragmatic and reasoned succession planning are things that can be addressed and implemented in the short term.

More challenging are issues that relate to land-use conflicts and the need to secure prime agricultural land and resources that maintain food security and the production of fiber. To provide these insights, future research could incorporate the concept of scenario frameworks that would enable mapping of alternative land-use planning, policy and socio-economic behavioral pathways, adopted in climate change studies [47]. An understanding of the diverse forms of trade-offs at different temporal scales for major stakeholder groups would additionally provide useful information when considering the outcomes of each scenario of land-use planning. Further, opportunities for co-benefits anchored in local realities and sensitive to local contexts require further exploration and local input, with the goal to connect carbon farming with environmental best practices and outcomes [45,48].

6. Conclusions

Based on the findings presented above, engaging in carbon markets offers potential benefits for rural producers, including opportunities for diversifying income, particularly valuable during drought periods. However, the study clearly identifies a complex landscape of significant barriers that discourage participation. A primary obstacle is the high cost associated with initiating and implementing carbon projects, and the financial risks for producers who may invest considerable sums only to find a project is not feasible or have projects affected by climate-related disasters, which due to climate change, are increasingly common.

Beyond financial concerns, accessing accurate and trusted information poses a significant challenge, compounded by a low level of trust in brokers. Producers voiced concerns about the quality of advice received and whether it truly aligned with their best interests or the scheme's environmental purpose. Furthermore, policy uncertainties and a lack of clarity regarding the future trajectory of carbon policies create risk and skepticism, particularly concerns about potentially needing to repurchase credits in the future at a higher price or being left financially exposed if sequestration efforts decline due to natural events. The requirement for long-term commitments, such as permanence periods of 25 or 100 years, is also a disincentive, leading to a perceived loss of future land-use flexibility with implications for succession planning and land values.

The study also highlights profound social impacts and community division arising from carbon farming projects. The scaling up of corporate carbon farms can lead to a reduction in traditional agricultural activity and associated services, impacting local economies and labor requirements. Concerns exist regarding "absentee carbon projects" that contribute little to the local community and a perceived lack of distributional fairness, where some community members feel poor land managers are rewarded while those who have invested in improving their land are ineligible. Secrecy around participation can further exacerbate tensions and lead to ostracization. Addressing these multifaceted barriers—financial, informational, policy-related, and social—is crucial for fostering broader and more equitable engagement of rural producers in carbon markets. This requires addressing the prohibitive costs of entry, improving the availability and trust in information sources, providing policy certainty, and actively working to build social license and community cohesion.

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