Carbon Farming and Drought Resilience

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This project is supported by Climate Friendly, through funding from the Australian Government's Future Drought Fund.

Australian Government
Department of Agriculture, Water and the Environment

Future Drought Fund

1. Executive Summary

The purpose of this study was to understand the impacts of carbon farming on drought resilience. The research surveyed 120 farmers across Australia to understand whether carbon farming impacted their drought resilience and their experience of drought as a result of the carbon farming activities, with a 61% completion rate. The sample was focused in NSW (42.5%), Victoria (26%) and Queensland (16.5%), with 15% from other states.

- 65% of respondents would recommend carbon farming as a drought mitigation tool, based on their net-promoter score.
- 73.3% of respondents that had a registered project or were engaged in carbon farming-like activities, strongly agreed that carbon farming had improved their preparedness for drought.
- 71% of respondents that had a registered project or were engaged carbon farming-like activities, agreed or strongly agreed that carbon farming reduced the severity of drought.
- Enhanced drought resilience was attributed to both the environmental benefits and financial benefits of carbon farming.
- Respondents used carbon farming revenue to reinvest back into the farm, including drought resilience activities, farm expansion and general farm activities. The data suggests that carbon farming revenues are used by farmers to support and enhance their traditional agricultural enterprise.
- 75% of carbon farming respondents indicated that the carbon farming revenue helped them meet their loan repayments during drought. Those respondents indicated they had stronger business stability during drought, as compared to those engaged in carbon farming-like activities that had not received carbon farming revenue.
- The speed with which decisions could be made relating to drought was also impacted by the carbon farming revenue, with those receiving revenue indicating they were better able to make quick decisions because of the revenue safety net.
- Farmers with a carbon farming project and those implementing carbon farming-like activities had a 6.5% increase in their locus of control over drought, as compared to non-carbon farmers. This is despite the majority of respondents with carbon farming projects coming from regions that are at higher risk of drought.
- 76% of respondents who had been paid for their Australian Carbon Credit Units (ACCUs) reported reduced stress during drought as compared to before being paid.
- Those engaged in carbon farming-like activities chose to implement on average three carbon farming-like activities. Whilst those with a registered carbon farming project

typically implemented one method. This suggests that if methods are no barrier, farmers choose to implement more than one carbon farming activity.

- Locus of control and drought planning increased for respondents implementing more than three carbon farming activities. The strongest drought resilience was seen in farms with more than three carbon farming activities, in areas of reducing stress and vulnerability, and improving locus of control and self-efficacy.
- The data suggests that more holistic carbon farming frameworks such as the Integrated Farm Management Method might further enhance the drought resilience benefits of carbon farming.
- The level of confidence in risk management strategies were higher for those with a carbon farming project (mean=5.50, s.d.=1.54), compared to those with no engagement with carbon farming (mean=4.91, s.d.=1.33).

The survey found that drought resilience is higher for those with a carbon farming project, as compared to those without a carbon farming project. Respondents indicated that carbon farming improved their farm performance during drought through financial and environmental improvements.

Farmers with a carbon farming project had a 6.5% increase in reported locus of control[1], indicated they are more likely to respond to drought impact through a measured plan, rather than react. There was a moderate increase in self-efficacy for farmers with a registered carbon farming project as well.

All farmers that received carbon farming revenue reinvested that money into general farm activities or into drought resilience activities. The carbon farming revenue provided farmers with funds to make improvements to their property, such as creating feed reserves, stock containments areas, and servicing farm debt. This revenue also provided greater confidence in early destocking and restocking during transitions into and out of drought.

Farmers also reported receiving environmental benefits from carbon farming and carbon farming-like activities that helped them prepare for, manage and recover from drought. Farmers engaged in carbon farming and carbon farming like activities reported faster regrowth of ground cover when dry seasons ended due to the improvements in soil health and water retention, and reduction of erosion. These comments were mostly made by those engaged in soil management and human induced regeneration (HIR). This improved their environmental resilience to drought, with respondents reporting positive results

[1] Drought resilience was measured through locus of control and self-efficacy. Locus of control measures the degree to which people feel they have control over the outcomes of an event, such as drought. The greater levels of control that are felt by the farmer, the more likely they are to implement drought plans and manage the impact of drought, rather than reacting to the impacts of drought.

compared with their neighbours. It was frequently reported that ground cover grew back much faster than neighbours ground cover.

The research project has established that differences do exist between those engaged in carbon farming and carbon farming like activities, and those not engaged in any carbon farming like activities. There are higher levels of drought resilience in those with carbon farming projects and carbon farming like activities, mostly focusing on environmental benefits and financial benefits. There is evidence to support that an integrated farm method with multiple carbon farming methods creates better environmental benefits for carbon farming. Whilst financial benefits of carbon farming improve capacity to manage the property during drought periods.

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3. Objective and scope

Carbon farming is an Australian Government framework that issues Australian Carbon Credit Units (ACCUs) to landholders, communities and businesses for capturing carbon within soil and plants, and reducing emissions from livestock, fire or industrial facilities. This program is enacted through the *Carbon Credits (Carbon Farming Initiative) Act 2011* for the purpose of reducing carbon emission and meeting carbon emission goals. At the time of writing,[2] there are a total of 1,328 registered carbon farming projects, with almost 117 million carbon credit units issued since December 2012 (Clean energy regulator, 2022). More than half of these projects are implemented in the land sector.

The objective of this study was to understand the impact of carbon farming on drought resilience. The analysis looked at farmers from across Australia, with a geographical focus on NSW and Victoria. The survey compared responses from three main target groups; (1) those with a registered carbon farming project, (2) those involved in carbon farming-like activities (such as tree planting and soil carbon sequestration), and (3) those not involved in carbon farming or carbon farming-like activities. The total sample size was 200 partially and fully completed surveys.

This report summarises the results of the study, as follows:

- Section 4 describes the conceptual model of the research and the survey design used to collect data.
- Section 5 sets data analysis of the survey results, relating to the conceptual model.
- Section 6 draws out implications of the research and areas for future research.

This survey received funding from the Australian Government Future Drought Fund.

[2] As of 22nd August 2022

4. Conceptual approach and data

This research has employed a survey approach to data collection, using tools that can be replicated and employed in future studies to gain greater insight. Measuring the impact of carbon farming programs has challenges relating to statistical significance because this market is hard-to-reach, and often results in smaller sample sizes. This data can be used as a tool for deeper understanding of the benefits of carbon farming related to drought resilience.

In this section the following will be discussed:

- Survey design and conceptual model
- Descriptive metrics identifying the differences between the three target groups

4.1. Research aim

The purpose of this research was to understand whether carbon farming can improve drought resilience. The research looked at whether carbon farming projects assisted farmers before, during and after a drought. We surveyed farmers engaged in carbon farming and carbon farming-like activities and those not engaged in any carbon farming activities. The survey participants came from across Australia, but mostly focused on NSW, Victoria and Queensland.

Australian farmers face extreme climatic variability, which can impact farm outcomes, such as production quality and quantity. Regions that have greater drought risk are those with more variable climates and higher proportions of cropping (Hughes, Burns, Soh, & Lawson, 2020). Carbon farming provides co-benefits that have the potential to improve drought resilience due to their environmental impact, and financial benefits through sale of carbon credits. Environmental co-benefits can include increased in water retention in soil (associated with increased soil carbon), increased tree cover providing shelter for livestock which can reduce heat stress in a drought, and reduced evapotranspiration for crops. Costs of carbon farming might include reduced flexibility of land use, and the cost of measurement and project administration.

Drought resilience, for the purpose of this research, is defined as the capacity to prepare, respond and recover from a drought event (Hughes et al., 2020). It is measured through locus of control, self-efficacy and vulnerability, which can measure the capacity of farmers to respond to drought. The capacity to prepare and respond to drought is measured through a preparedness scale, which was developed for the purpose of this project. It is

measuring the impact of carbon farming on preparation for drought, actions during drought and recovery from drought.

These measures are being employed to establish the impact of carbon farming on the experience of farmers and provide some comparison between those who are engaged in carbon farming or carbon farming like activities and those with no engaged in carbon farming or carbon farming like activities.

4.2. Survey design

A mixed method survey approach was adopted for data collection. The survey involved developing new measures for benefits of carbon farming in relation to financial, business and environmental performance before, during, and after drought. These questions were developed as a team, with the specific focus of usability and functionality. The survey was distributed to farmers across Australia through social media, email marketing, PR campaign and direct communication. This yielded a total sample of 120, with a 61% completion rate. The analysis below reflects this, as pairwise deletion[3] was employed to maximise the returned surveys.

The survey structure used skip logic to ensure each participant received questions that directly related to their experiences of carbon farming (or lack thereof). A summary of the skip logic is identified in Table 1.

Table 1 Survey structure showing which questions were applicable for each target group

	No Carbon farming	Engaged in carbon farming-like activities	Registered carbon farming project
Demographics of farm	☑	☑	☑
Knowledge/interest in carbon farming	☑		
Potential spending of carbon credit finances		☑	
Spending of carbon credit finances			☑
Bio-physical benefits of carbon farming		☑	☑
Socio-economic benefits of carbon farming		☑	☑
Financial benefits of carbon faring		☑	☑
Locus of control over drought	☑	☑	☑
Self-efficacy	☑	☑	☑
Drought preparedness	☑	☑	☑

[3] Pairwise deletion was employed to handle missing data.

The survey design involved self-reported reported results of participants, based on their experience of carbon farming and drought preparation and response. The timeframe for the data collection was December 2021 to February 2022, which was a high rainfall period for eastern and central NSW, eastern Queensland, parts of Western Australia and south-west Northern territory. Rainfall was below average in western Tasmania, south-west Victoria and south-east South Australia, and south-west Western Australia. This was preceded by low rainfall period from 2018 to late 2019. Climatic conditions at the time of survey likely influenced the self-reported results, as many survey respondents were in a period of recovery from drought.

4.2.1. Measurement tool used in the questionnaire

This section identifies the survey measures used in the distributed survey. The survey tool employed seven-point Likert scales to measure a range of variables, using pre-existing and new measures. These are summarised in Table 2, including citations of source methodologies.

4.2.1.1. Measuring drought resilience

Drought resilience for the purpose of this project, has been measured through locus of control, vulnerability and self-efficacy. Resilience is generally held as the reduced vulnerability to environmental risk experiences, overcoming stress, or a relatively good outcome despite risk experiences (Rutter, 2006). Rutter (2012, p. 335) stated that resilience should be viewed as a process rather than a fixed attribute of an individual. It can be conceptualised as a reduction in vulnerability to a risk and an increase in capacity to cope or recover from the risk (Rutter, 2006).

Previous research has established a link between these variables and resilience. The variables have been adjusted to focus on a drought context, allowing them to be considered together in the form of drought resilience. Examples of previous studies include in health research, psychology and business and management. Health research by Shin and Kang (2015) found that there are links between locus of control and resilience, with positive impacts on health behaviours. Another study by Cazan and Dumitrescu (2016), on adolescent resilience, found an increase in internal LOC for those with high resilience.

Table 2 Breakdown of survey constructs

Construct of interest	Source methodology	Basis of scale	Areas addressed
Locus of Control (LOC)	Structure used by Mueller and Thomas (2001)	The scale looks at whether an individual perceives the outcome of an event as being either within their control (internal LOC) or beyond their personal control (external LOC).	Measures internal and external LOC
Self-efficacy	Structure used by Martin, Bender, and Raish (2007)	The scale measures confidence in managing a property through drought via a range of drought actions. These actions were established through a review of drought preparation studies.	*Confidence in managing drought through (identified by Webster, Small, Miles, and Falepau (2020):* • Preparing a formal drought plan • Infrustructure improvement • Process improvements • Awareness of market place • Awareness of seasonal changes • Income from other investments • Income from other business activities
Drought severity		Scale measures the perceived severity of the most recent drought.	*Severity on:* • Local region • Business • Family
Vulnerability	From Webster et al. (2020)	The purpose of the scale is to evaluate the vulnerability of the farm in terms of key risk factors. This scale was modified in discussion industry professionals	Measures: • Financial/Business • Infrastructure • Soil health • Pasture quality and quantity • Water supply • Region • Livestock/crop
Benefits of carbon farming for drought (BCFD)		Created by author in consultation with industry professionals	*Impact of carbon farming:* • Before drought • During drought • After drought *Scales measured:* • Financial impact • Environmental impact • Business impact
General demographics	Demographic and geographic data		Gender Age Revenue Postcode

4.2.1.2. Benefits of carbon farming for drought

The *benefit of carbon farming for drought* (BCFD) was a new tool developed for the purpose of this research project. A summary of the tool structure is outlined in Table 3. This tool was developed through a literature review on carbon farming co-benefits, and in consultation with industry professionals. The purpose of this measurement tool was to look at the business, financial and environmental benefits of carbon farming before, during and after drought. The underlying reason was to gain a picture of how carbon farming has impacted farmers across their experience of drought. A summary of this survey tool is in the appendix.

Table 3 Benefits of Carbon Farming for Drought (BCFD) tool - breakdown of questions

Scale	Items	Purpose
Benefit of carbon farming in preparing for drought	3	One question per concept; (1) environmental impact, (2) business impact, and (3) financial impact
Benefit of carbon farming during drought	13	Questions per concept: Environmental impact – four questions Business impact – four questions Financial impact – five questions, with one being only for those receiving revenue from the project
Benefit of carbon farming after drought	3	One question per concept; (1) environmental impact, (2) business impact, and (3) financial impact

5. Data analysis

The data was analysed using descriptive statistics by comparing the mean and percentage difference between survey responses of the three survey target groups; (1) those with a Registered Carbon Farming Project (RCFP), (2) those involved in Carbon Farming-Like Activities (CFLA), and (3) those Not Involved in Carbon Farming (NICF) (including carbon farming-like activities). By comparing experiences, an understanding of the impact that carbon farming can have on drought activities and experiences can be understood.

During the analysis, to maximise the collected data, pairwise deletion was employed to handle missing data. In this method instead of discarding all cases with any missing values, data for a variable pertinent to a specific assessment are included, even if values for the same individual on other variables are missing (Malhotra, Hall, Shaw, & Oppenheim, 2006; VandenBos, 2007). This maximises all data available on an analysis-by-analysis basis, however, it does mean that total values may change between analyses.

In addition to these comparisons, respondents were asked a series of short answer questions to elaborate on their experience of carbon farming and carbon farming like activities. These are analysed using a thematic analysis to identify the key themes that exist and provided further context to the quantitative findings.

The main results that will be discussed in this section are:

- Demographics of participants
- Carbon farmers practice in preparation, experience and recovery from drought
- Comparison of drought resilience, through locus of control, self-efficacy and vulnerability to drought
- Comparison of preparation for drought
- Review of short answer questions relating to experiences of carbon farming

5.1. Participant demographics and geographic

The three groups that were surveyed are; carbon farmers (n=27), farmers engaged in carbon farming-like activities (n=53) and non-carbon farmers (n=40). A summary of this is provided in Table 4. There was a response rate of 120 participants, with a 61% completion rate. Pairwise deletion was employed to analyse the data, as to maximise the available

information. As such, the numbers will vary across the analysis due to the number of incomplete questions on the returned surveys.

Table 4 Breakdown of survey groups

	Count	Percent
Registered carbon farming project (RCFP)	27	22.5%
Engaging in carbon farming-like activities (CFLA)	53	44.2%
Not involved with carbon farming or carbon farming-like activities (NICF)	40	33.3%
Total	120	100%

The type of carbon farming projects and carbon farming-like activities that participants were engaged in are summarised in are summarised in Table 5. Participants were mostly engaged in soil management (29.8%), Human Induced Regeneration (HIR) (22%) and environmental plantings (19%). Some participants were engaged in multiple activities. Those with a registered project were mostly engaged in HIR (66.7%). Those engaged in carbon farming-like activities were mostly engaged with soil management (88.2%), environmental plantings (60.8%) and HIR (41.2%).

Table 5 Breakdown of target groups by carbon farming activity type

	Registered carbon farming project		Engaged in carbon farming-like activities		Total	
	No.	%	No.	%	N	%
Soil management	5	20.8%	45	88.2%	50	29.80%
Avoid deforestation	4	16.7%	17	33.3%	21	12.50%
Human induced regeneration	16	66.7%	21	41.2%	37	22.00%
Plantation Forestry	1	4.2%	9	17.6%	10	6.00%
Savanna fire management	1	4.2%	2	3.9%	3	1.80%
Environmental plantings	1	4.2%	31	60.8%	32	19.00%
Other	1	4.2%	13	25.5%	15	8.90%
Total number of respondents	*24*		*51*		168[4]	100.00%

Soil management and avoiding deforestation (AD) are two of the largest samples collected, however, there is higher sample for CFLA than RCFP. This is taken into consideration when analysing the data below and comparisons should be taken with this sample disparity in mind.

The majority of participants were located in NSW (42%), followed by Victoria (26%) and Queensland (16%) (Table 6). Of those engaged in carbon farming 41% were in NSW

[4] Some respondents selected multiple methods, making the total larger than the sample size.

and Queensland. Those engaged in carbon farming-like activities were mostly located in NSW (40%) and Victoria (37%).

	Registered carbon farming project		Engaged in carbon farming-like activities		No engagement with carbon farming		Total Count
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**
NSW	7	41%	12	40%	12	46%	31
Victoria	2	12%	11	37%	6	23%	19
Queensland	7	41%	3	10%	2	8%	12
South Australia	0	0%	3	10%	3	12%	6
Western Australia	1	6%	1	3%	2	8%	4
Tasmania	0	0%	0	0%	1	4%	1
Total	*17*		*30*		*26*		*73*

Table 6 Breakdown of target groups by state

Those with no engagement with carbon farming or carbon farming-like activities were mostly located in NSW (46%) and Victoria (23%). Given the small sample size from South Australia, Western Australian and Tasmania, the location of these three States have been combined as described as “other” for the remainder of this report.

Most carbon farming respondents had been engaged in carbon farming for between five to eight years. With many receiving revenues from their project for over four years. Respondents engaged in HIR method were mostly likely to have received revenue from their project. A summary of these findings can be found in Table 7. The first year a carbon farming project was registered was in 2011 for HIR, with the first revenue being received in 2013. Avoiding deforestation and soil management were the other two popular methods that had also received revenue. Soil management was registered in 2014, with revenue received in 2016. Whilst the avoiding deforestation method was first registered in 2015, and received first income in 2017.

Table 7 Year carbon farming project was registered by year first carbon farming revenue was received

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Soil management	Registered CF project	-	-	-	1	1	-	1	-	-	1	1
	First received revenue	-	-	-	-	-	1	2	-	-	-	1
Avoid deforestation	Registered CF project	-	-	-	-	1	1	1	1	-	-	-
	First received revenue	-	-	-	-	-	-	2	-	1	1	-
Human induced regeneration	Registered CF project	1	-	-	3	4	3	2	1	1	-	1
	First received revenue	-	-	1	-	2	5	2	3	-	2	-
Plantation Forestry	Registered CF project	-	-	-	-	1	-	-	-	-	-	-
	First received revenue	-	-	-	-	-	1	-	-	-	-	-
Savanna fire management	Registered CF project	-	-	-	-	-	-	1	-	-	-	-
	First received revenue	-	-	-	-	-	-	1	-	-	-	-
Environmental plantings	Registered CF project	-	-	-	-	1	-	-	-	-	-	-
	First received revenue	-	-	-	-	-	-	-	-	-	1	-

Survey responses were also analysed by Statistical Area 4 (SA4) regions (see Figure 1). Most respondents engaged in carbon farming were located in the Far West and Orana Regions of NSW and Queensland Outback in Queensland. Both these regions are at higher risk to drought for livestock farmers (Hughes et al., 2020).

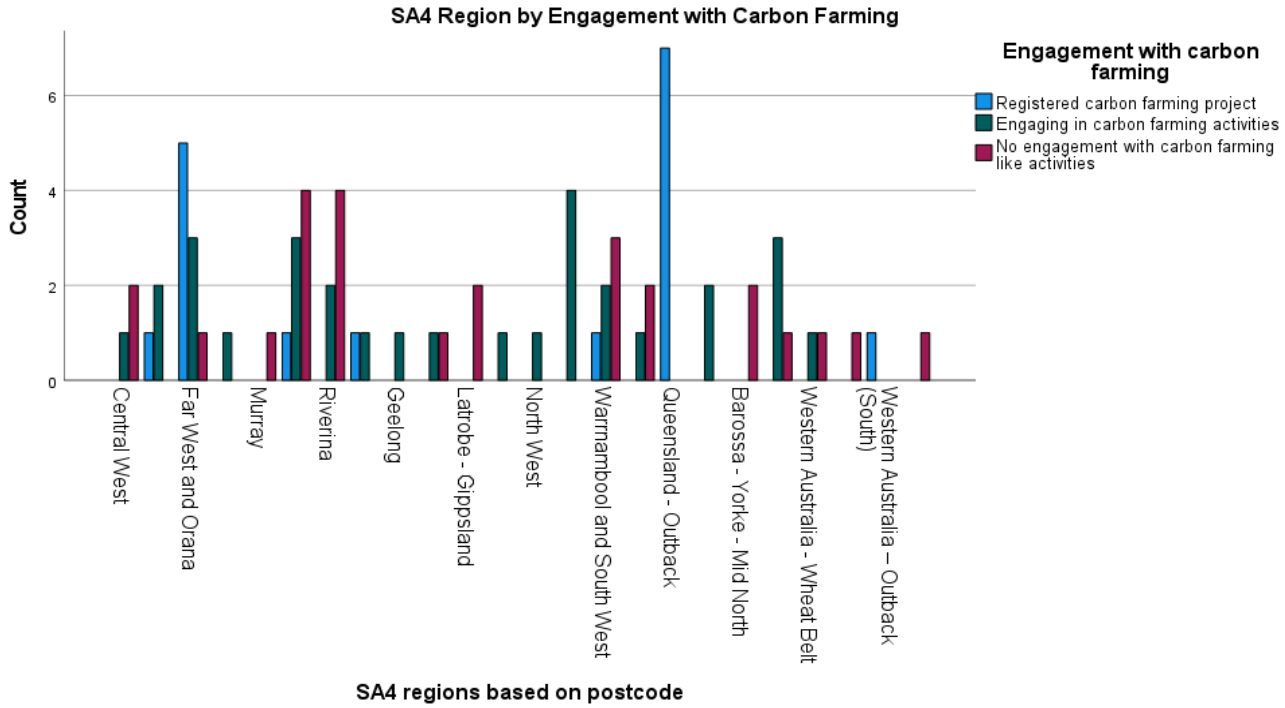

Figure 1 Breakdown of target groups by SA4 region and engagement with carbon farming

The type of agricultural production varied among the sample, with the majority being engaged in livestock production (74%), followed by broadacre crops (17%). Of those engaged in carbon farming 92% were engaged in livestock production, which appears to align with the agricultural production enterprise predominantly engaged in carbon farming projects. Those with carbon farming-like activities were mostly livestock production (69%) followed by broadacre crops (16%). Those with no engagement in carbon farming or carbon farming-like activities were engaged mostly in livestock production (73%), followed by broadacre crops (21%).

Table 8 Breakdown of target groups by primary production enterprise, and engagement with carbon farming

Primary production enterprise type	Registered carbon farming project		Engaged in carbon farming-like activities		No engagement with carbon farming		Total Count
	No.	%	No.	%	No.	%	No.
Livestock	24	92%	46	69%	38	73%	108
Horticulture e.g., vegetables, fruit and nuts, grapes intended for wine production	0	0%	6	9%	2	4%	8
Cereals and other broadacre crops (including cotton and sugar cane)	2	8%	11	16%	11	21%	24
Nurseries, cut flowers and cultivated turf	0	0%	0	0%	0	0%	0
Other	0	0%	4	6%	1	2%	5
Total	26		67		52		145

5.2. Carbon farmer experience of drought

This section reviews the experiences of carbon farmers in relation to their preparation, performance and recovery for drought. This was measured on three scales; (1) bio-physical benefits, (2) financial benefits, and (3) business performance benefits. This section will also discuss the use of carbon farming revenue and the carbon farming experience in relation to drought.

5.2.1. Recommendation of carbon farming as a drought mitigation tool

From the survey 65% of respondents were promoters of carbon farming as a drought mitigation tool. This score was similar for those with a registered carbon farming project and those without a registered project, indicating the experience of both groups was relatively similar. A summary of this finding can be found in Figure 2. This was measured using the Net Promoter Score (NPS) method[5], by asking *'How likely are you to recommend carbon farming as a drought mitigation tool?'*

[5] The net promoter score is used to understand the underlying feelings consumers have towards a specific product or service. In the context of this research, it has been used to understand the underlying feelings farmers have towards carbon farming as a drought mitigation tool. Measured on a Likert scale from one to 11, it assumes anyone ranking in the top three scores (9-11) are promoters, and anyone in the bottom 6 scores (1-6) are detractors.

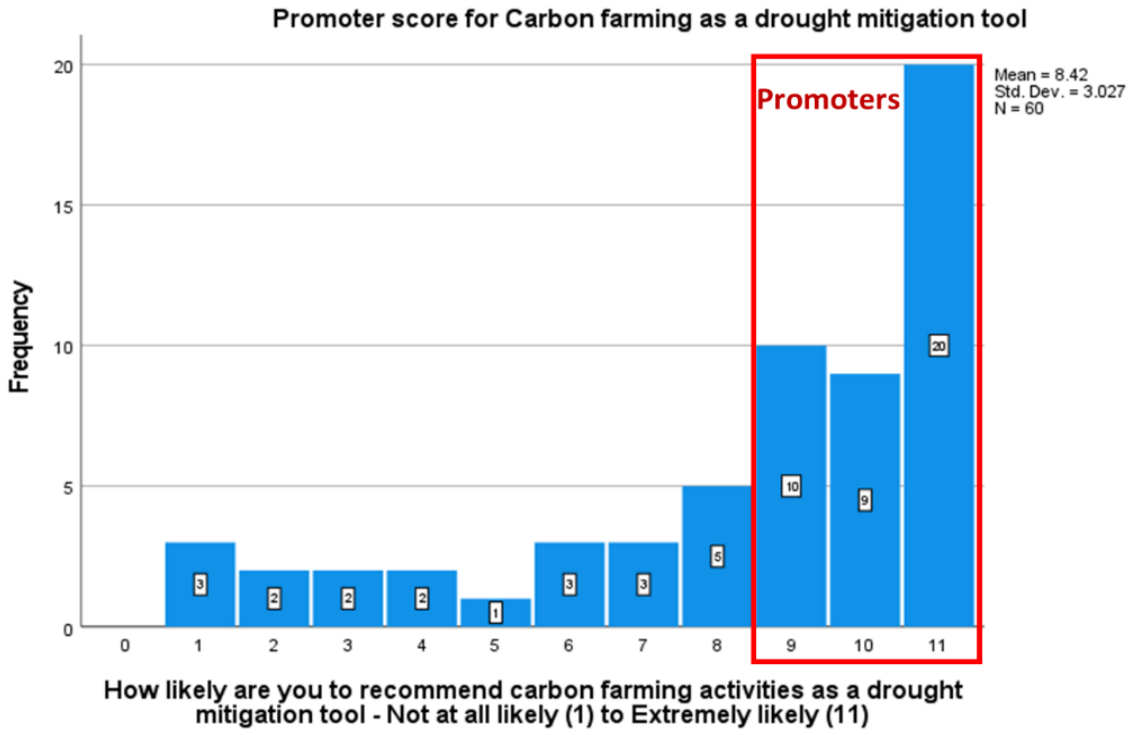

Figure 2 Net promoter score of carbon farming as a drought resilience mitigation tool

This finding is supported by free-text comments made by farmers with a registered project and engaged in carbon farming-like activities (n=60). When asked if carbon farming has improved their preparedness for drought 73.3% of respondents, both with a registered project and engaged carbon farming-like activities, agreed to strongly agreed with the statement. Similarly, when asked if the activities reduced the severity of drought 71% of respondents agreed to strongly agreed.

This score was affected by the number of carbon farming methods employed on the property. Farmers that undertook more than one carbon farming activity recorded a higher average score than those below them. Farmers implementing one carbon farming activity recorded an average net promoter score of 8.5/11, as compared with a score of 9.2/11 for those implementing three or more carbon farming activities.

Of the carbon farming methods, soil management (62.5% promoters) and HIR (66.7% promoters) had the highest recommendation score for carbon farming as a drought mitigation tool. These were also the two largest method types that were measured and the most common method type for a registered project.

Regions with the strongest recommendation for carbon farming as a drought mitigation tool (with more than one farm in the region) were Bendigo (mean=10.5), Wide Bay (mean=10.5), Shepparton (mean=10), Coffs Harbour/Grafton (mean=9.67), and Far West

and Orana (mean=9.38). Of these regions, Far West and Orana had the largest group of farmers with a registered carbon farming project.

5.2.2. Use of carbon farming revenue

Of those with a registered carbon farming project, 23 of them had received revenue from sale of the carbon credits. The survey asked questions about the use of carbon farming revenue to understand where it was being invested. All responses to this question indicate that revenue was being reinvested back in to the farm. The revenue was used to fund drought projects and general farm activities, as outlined in Table 9. Respondents also indicated they used the funds to help purchase additional properties (response categorised under 'other'). None of the respondents use the revenue for non-farm related activities.

Table 9 Reinvestment of carbon farming revenue

	Did you reinvest CF revenue back into the farm? - No			Did you reinvest CF revenue back into the farm? - Yes		
	Off-farm expenses, e.g., supporting family home	Savings, farm deposits or off-farm investments	Other	Projects directly related to drought resilience	General farm activities	Other
Count	0	0	1	10	11	1

Of those respondents receiving income from carbon farming, 65% had received their first carbon farming revenue during or prior to 2017. This indicates that 65% of respondents had income prior to the 2017 drought starting, and were in receipt of income during drought. While 35% of respondents only received their first income during drought from 2018-2021.

Figure 3 shows the perceived drought severity from between 2017-2020 by the first year that income from carbon farming was received. This provides evidence that those who received their carbon farming revenue, prior to drought starting in 2017, experienced lower drought severity that those who received revenue after 2017. This is also supported by reports that much carbon farming income was spent on 'projects directly related to drought resilience', as seen in Table 9. This finding supports that the additional income received from a carbon farming project can improve capacity to make decisions early and improve drought outcomes.

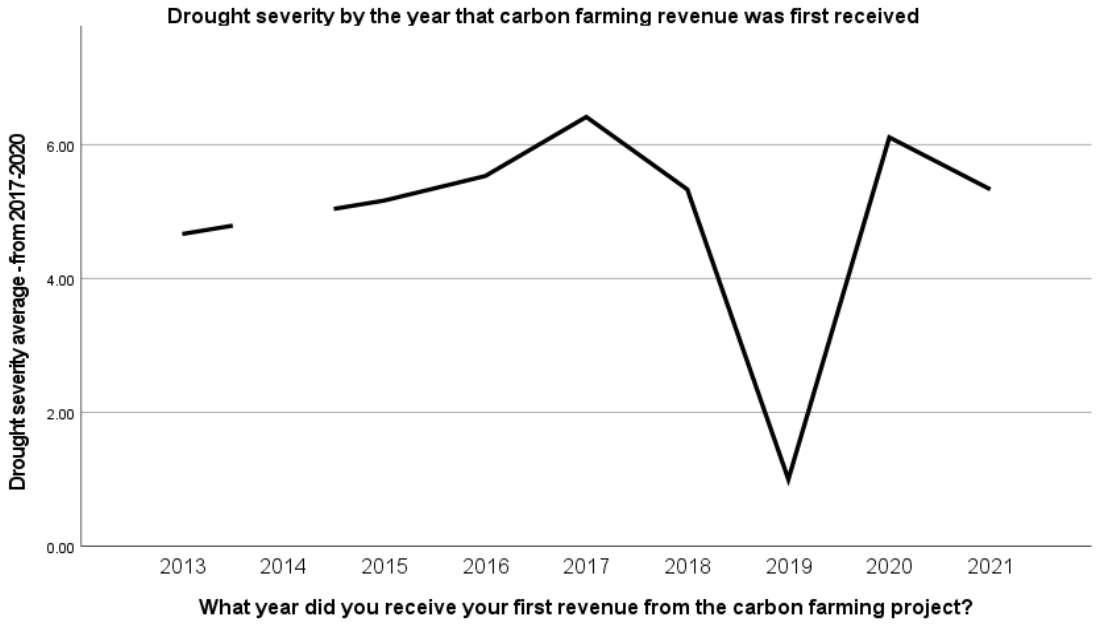

Figure 3 First year carbon farming was received by drought severity from 2017-2020

5.2.3. Preparation for drought

The pre-drought experience of farmers engaged in carbon farming (CF) or carbon farming-like activities (CFLA) indicated that overall carbon farmers were feeling better able to prepare for drought, with 70.8% of respondents agreeing that the environmental benefits improved capacity to prepare, 77.1% agreeing business performance benefits helped them prepare, and 62.5% agreeing the financial benefits helped them prepare. A summary of the preparation questions and their descriptive statistics is contained in Table 11.

The data suggests that different types of carbon farming activities offer different benefits prior to drought. HIR mainly provides financial benefits (HIR mean= 5.36) and business performance benefits (HIR mean= 5.36), while soil activities and AD mainly provide financial benefits (soil mean=6, AD mean=5.25). With soil management having the highest overall means for drought preparation across the three main groups for RCFP. A full breakdown of this data can be found in Table 10.

Table 10 Means for drought preparation by carbon farming activity

		Overall, the environmental benefits of the carbon farming project have improved our capacity to prepare for drought	Overall, the business performance benefits of the carbon farming project have improved our capacity to prepare for drought	Overall, the financial benefits of the carbon farming project have improved our capacity to prepare for drought
Soil management	Registered carbon farming project	5.75	5.75	6
	Engaging in carbon farming activities	5.44	5.41	4.67
Avoid deforestation	Registered carbon farming project	4.5	3.25	5.25
	Engaging in carbon farming activities	5.27	5.36	4.55
Human induced regeneration	Registered carbon farming project	4.91	5.36	5.36
	Engaging in carbon farming activities	5.73	5.82	5.09
Plantation Forestry	Registered carbon farming project	6	6	6
	Engaging in carbon farming activities	6.5	6	5.25
Savanna fire management	Registered carbon farming project	5	5	6
	Engaging in carbon farming activities	6	6	6
Environmental plantings	Registered carbon farming project	4	2	6
	Engaging in carbon farming activities	5.18	5.12	4.35
Other	Registered carbon farming project	4	4	4
	Engaging in carbon farming activities	5.78	5.67	5.11

The environmental and business performance benefits for preparation for drought, both had a similar trend. The mean for both those benefits before drought were higher for those engaged in CFLA, compared to those with a RCFP, as can be seen in Table 11.

The financial benefit in preparing for drought was much stronger for RCFP (mean=5.3, s.d.=1.3) when compared to CFLA (mean=4.5, s.d.=1.5). This is reflection of the fact that almost all RCFP respondents had received some carbon farming income at the time of data collection, of which some was used for drought resilience projects (see Table 9).

Table 11 CF and CFLA differences in preparation for drought

		Overall, the environmental benefits of the carbon farming project have improved our capacity to prepare for drought	Overall, the business performance benefits of the carbon farming project have improved our capacity to prepare for drought	Overall, the financial benefits of the carbon farming project have improved our capacity to prepare for drought
Registered carbon farming project	N	19	19	19
	Mean	4.9474	4.9474	5.3684
	Median	6	6	6
	Std. Deviation	1.71509	1.74718	1.34208
Engaged in carbon farming-like activities	N	29	29	29
	Mean	5.3793	5.3103	4.5862
	Median	6	6	5
	Std. Deviation	1.37357	1.25651	1.54728
Total	N	48	48	48
	Mean	5.2083	5.1667	4.8958
	Median	6	6	5.5
	Std. Deviation	1.51529	1.4635	1.50516

5.2.4. Experience of drought

The experience of farmers during drought was asked through 13 questions related to the environment, business and financial benefits. This section will be broken down into environmental benefits, business benefits and financial benefits, with a conclusion at the end.

5.2.4.1. Environmental benefits of carbon farming

A summary of environmental benefit responses is included in Table 12. RCFP projects had a positive skew to the benefits of environmental impact in terms of lowering the farm costs through environmental impacts (mean=4.05, s.d.=1.9) and environmental benefits outside of carbon revenue (mean=3.58, s.d.=2.4). Whilst CFLA had a higher mean overall, but with a negative skew.

Notably both those with a RCFP (mean=4.7, s.d.=2.0) and CFLA (mean=4.9, s.d.=1.6) indicated that carbon farming reduced the negative environmental impacts of drought during the drought. 63.6% of respondents agreed to strongly agreed that this was the case.

Table 12 Environmental benefits of carbon farming during drought

		Carbon farming has reduced the negative environmental impacts on the farm during drought	The positive environmental impact of carbon farming has improved the revenue potential of the farm during drought	The positive environmental impact of carbon farming has lowered costs on the farm during drought	The environmental benefits from the carbon farming project during drought are worth it even if I didn't receive carbon farming revenue
Registered carbon farming project	N	20	20	20	20
	Mean	4.65	5	4.05	3.8
	Median	6	5	4	4
	Std. Deviation	2.033	1.654	1.877	2.375
Engaged in carbon farming-like activities	N	35	35	35	34
	Mean	4.86	4.4	4.66	5.68
	Median	5	4	4	6
	Std. Deviation	1.648	1.649	1.679	1.364
Total	N	55	55	55	54
	Mean	4.78	4.62	4.44	4.98
	Median	5	5	4	5.5
	Std. Deviation	1.781	1.661	1.761	2.005

When broken down by activity type Table 13, those with a RCFP engaged in soil management had the strongest environmental benefits (mean=5.25), followed by HIR (mean=4) and AD (mean=3.75). This is similar to those engaged in CFLA, with HIR (mean=5.25), soil management (mean=5) and AD (mean=4.75).

Table 13 Environmental benefits of carbon farming during drought by carbon farming activity type

		Carbon farming has reduced the negative environmental impacts on the farm during drought	The positive environmental impact of carbon farming has improved the revenue potential of the farm during drought	The positive environmental impact of carbon farming has lowered costs on the farm during drought	The environmental benefits from the carbon farming project during drought are worth it even if I didn't receive income
Soil management	Registered carbon farming project	6	6	4.25	5
	Engaging in carbon farming activities	4.97	4.48	4.77	5.73
Avoid deforestation	Registered carbon farming project	3.75	4.5	2.75	2.75
	Engaging in carbon farming activities	4.67	4	4.25	5.64
Human induced regeneration	Registered carbon farming project	4.42	4.75	4.08	3.25
	Engaging in carbon farming activities	5.14	4.57	4.71	5.77
Plantation Forestry	Registered carbon farming project	6	7	3	6
	Engaging in carbon farming activities	4.8	4.4	4.8	5.8
Savanna fire management	Registered carbon farming project	6	6	3	1
	Engaging in carbon farming activities	5	5	6	6
Environmental plantings	Registered carbon farming project	4	5	3	5
	Engaging in carbon farming activities	4.26	4	4.16	5.11
Other	Registered carbon farming project	7	7	7	7
	Engaging in carbon farming activities	5.3	4.4	5.2	5.6

5.2.4.2. Business benefits of carbon farming

A summary of business benefits is outlined in Table 14, with some differences existing between RCFP projects and CFLA groups. These differences were focused on areas of environmental impacts of production efficiencies, impacts on revenue, capacity to make quick changes and business stability. Those with a RCFP recorded stronger assurance in *making changes to the business when drought starts* (mean=4.5), compared to those engaged in CFLA (mean=2.52). They also recorded strong business stability provided by the carbon farming income (mean=5). The speed with which decisions could be made relating to drought were improved with carbon farming income as a safety net (mean=4.5, s.d.=1.9).

Table 14 Business benefits of carbon farming during drought

		The carbon farming project improved farm business outcomes during drought, e.g., with pasture reserves	Carbon farming revenue gave us the assurance we needed to make changes to the business when the drought started	Carbon farming has created production efficiencies through environmental improvements that reduced the impacts of drought	Carbon revenue provided business stability during drought
Registered carbon farming project	N	20	20	20	20
	Mean	4.15	4.5	3.9	5
	Median	4	5	4	5
	Std. Deviation	1.899	1.85	1.971	1.556
Engaged in carbon farming-like activities	N	34	33	34	33
	Mean	4.44	2.52	4.53	2.18
	Median	4	2	5	2
	Std. Deviation	1.744	1.623	1.727	1.357
Total	N	54	53	54	53
	Mean	4.33	3.26	4.3	3.25
	Median	4	3	4	3
	Std. Deviation	1.791	1.953	1.829	1.98

When compared by carbon farming method in Table 15, HIR for those with a RCFP has the recorded *improved business stability during drought due to the carbon farming income* (mean=6), with carbon farming revenue allowing them to *make changes to the business as needed when drought starts* (mean=5). This is the inverse for those engaged in CFLA, with carbon farming *improving business outcomes during drought* (mean=4) and *creating production efficiencies* (mean=5).

Table 15 Business benefits of carbon farming during drought by carbon farming activity type

		The carbon farming project improved farm business outcomes during drought	Carbon farming revenue gave us the assurance we needed to make changes to the business when the drought started	Carbon farming has created production efficiencies through environmental improvements that reduced the impacts of drought	Carbon revenue provided business stability during drought
Soil management	Registered carbon farming project	4.75	4.75	4.5	5
	Engaging in carbon farming activities	4.63	2.45	4.5	2.17
Avoid deforestation	Registered carbon farming project	2.25	3.5	2	4
	Engaging in carbon farming activities	3.64	2	4.18	2.1
Human induced regeneration	Registered carbon farming project	4.25	4.75	4.17	5.5
	Engaging in carbon farming activities	4.38	2.42	4.77	2.42
Plantation Forestry	Registered carbon farming project	6	6	6	6
	Engaging in carbon farming activities	4.75	3	5.75	1.75
Savanna fire management	Registered carbon farming project	2	4	2	6
	Engaging in carbon farming activities	5	3	5	2
Environmental plantings	Registered carbon farming project	2	5	3	5
	Engaging in carbon farming activities	4	2.5	4.33	2.44
Other	Registered carbon farming project	6	4	4	4
	Engaging in carbon farming activities	4.9	3	4.5	2.22

5.2.4.3. Financial benefits of carbon farming

A summary of financial benefits is outlined in Table 16. 75% of CF respondents indicated that the carbon farming revenue helps them to meet their loan repayments during drought (mean=4.9, s.d.=2.1). Those with a RCFP recorded higher financial benefit from carbon farming during drought due to the carbon farming revenue, and this was predominantly due to revenue from sale of carbon credits rather than improved performance

of the agricultural enterprise. There was also a financial benefit to those engaged in CFLA. This indicates that during drought CFLA can also improve farming practices to produce a financial benefit to production.

Table 16 Financial benefits of carbon farming during drought

		Carbon farming revenue allowed us to meet our loan repayments during drought	Carbon farming improves the farms financial performance during drought, other than receiving carbon revenue	Carbon farming has helped maintain the cash flow of the farm during drought	Carbon farming eases the financial demands on the property during drought	Carbon farming provided financial stability during drought, other than through carbon revenue
Registered carbon farming project	N	16	20	20	20	20
	Mean	4.88	3.9	4.9	4.55	4.2
	Median	5.5	4.5	6	5	4.5
	Std. Deviation	2.094	1.99737	1.88903	1.95946	1.73509
Engaged in carbon farming-like activities	N		33	32	33	33
	Mean		4.3939	3.5312	4.3333	4.2727
	Median		4	4	4	4
	Std. Deviation		2.04541	2.01581	1.97906	1.94089
Total	N	16	53	52	53	53
	Mean	4.88	4.2075	4.0577	4.4151	4.2453
	Median	5.5	4	4	5	4
	Std. Deviation	2.094	2.02255	2.06192	1.9556	1.84918

Table 17 provides a comparison of the financial benefits of carbon farming by the activity types. This comparison supports that the strongest financial benefit appears to be from soil management group, however, this group was a small sample size for those with a RCFP (n=5, as per Table 5), and at the time of data collection only one soil carbon project has been issued carbon credits under the ERF. After this, HIR had the strongest financial benefit, particularly in terms of *meeting loading repayments* (mean=5), *maintaining cash flow during drought* (mean=6) and *easing the financial demands on the property* (mean=5).

Those engaged in CFLA did record some financial benefits from their carbon farming activities, although with lower results that those with a RCFP. For those engaged in CFLA in HIR activities, the financial benefits were more keening experienced for *improving financial stability during drought* (other than receiving carbon revenue) and *easing financial demands on the property*. Soil management also reported stronger financial benefits through *improving financial performance during drought* (other than receiving carbon revenue) for

those engaged in CFLA. This could reflect improved biophysical factors caused by the carbon farming activities.

Table 17 Financial benefits of carbon farming during drought by carbon farming activity type

		Carbon farming revenue allowed us to meet our loan repayments during drought	Carbon farming improves the farms financial performance during drought, other than receiving carbon revenue	Carbon farming has helped maintain the cash flow of the farm during drought	Carbon farming eases the financial demands on the property during drought,	Carbon farming provided financial stability during drought, other than through carbon revenue
Soil management	Registered carbon farming project	4.67	4.5	4.75	4.75	5.25
	Engaging in carbon farming activities	.	4.55	3.57	4.45	4.38
Avoid deforestation	Registered carbon farming project	4.5	2.25	4.25	4	4.5
	Engaging in carbon farming activities	.	3.55	3	3.73	3.82
Human induced regeneration	Registered carbon farming project	5.3	3.92	5.58	4.67	4
	Engaging in carbon farming activities	.	4.23	3.25	4.54	4.54
Plantation Forestry	Registered carbon farming project	6	6	6	6	6
	Engaging in carbon farming activities	.	5.25	4.25	5.25	4.5
Savanna fire management	Registered carbon farming project	7	2	6	7	7
	Engaging in carbon farming activities	.	6	5	6	5
Environmental plantings	Registered carbon farming project	5	2	5	4	6
	Engaging in carbon farming activities	.	4	3.28	3.83	3.78
Other	Registered carbon farming project	.	6	1	7	4
	Engaging in carbon farming activities	.	4.6	3.11	4.7	3.6

5.2.4.4. Summary of findings on impact of carbon farming during drought

The data suggests that different carbon farming methods offer different types of drought assistance during drought, with AD and HIR activities mainly providing financial drought resilience, while soil activities mainly providing environmental and business performance benefits. This might be because at the time of writing, only one soil carbon project has been issued carbon credits under the ERF.

The results for soil management projects did appear to be an anomaly as only one soil carbon project has been issued with carbon credits under the ERF. However, the data in this section suggests that financial benefits are being experienced, even without receiving an income from carbon farming. This is seen through the results for those engaged in CFLA,

and the effect could also exist for those with a RCFP. This could reflect the flow on of the biophysical benefits farmers receive from carbon farming during drought, demonstrating that even without income from the activity there is a real impact on farm outcomes.

Table 18 Summary of means of benefits of carbon farming during drought

		Environmental benefits mean	Business benefits mean	Financial benefits mean
Soil management	Registered carbon farming project	5.25	5	5
	Engaging in carbon farming activities	5	3.25	4.25
Avoid deforestation	Registered carbon farming project	3.75	3	4
	Engaging in carbon farming activities	4.75	3	3.75
Human induced regeneration	Registered carbon farming project	4	4.75	4.8
	Engaging in carbon farming activities	5.25	3.25	4.25
Plantation Forestry	Registered carbon farming project	5.5	6	6
	Engaging in carbon farming activities	5	4	4.75
Savanna fire management	Registered carbon farming project	4	3.5	5.8
	Engaging in carbon farming activities	5.5	3.75	5.5
Environmental plantings	Registered carbon farming project	4.25	3.75	4.4
	Engaging in carbon farming activities	4.25	3.25	3.75
Other	Registered carbon farming project	7	4.5	4.5
	Engaging in carbon farming activities	5	3.75	4.25

5.2.5. Recovery from drought

The recovery from drought was reported as being improved by carbon farming activities for both RCFP and CFLA projects. Similar to previous results for drought preparation and during drought, the environmental benefits of carbon farming are stronger for those with CFLA (mean=5.8, s.d.=1.2) than with a RCFP (mean=4.7, s.d.=1.8). Farms with CF projects (mean=5.3, s.d.=1.4) and CFLA (mean=5.25, s.d.=1.3) have both seen business performance improvements that have helped in drought recovery.

Table 19 CF and CFLA differences in recovery from drought

		Overall, the environmental benefits of the carbon farming project have improved our recovery from drought	Overall, the business performance benefits of the carbon farming project have improved our recovery from drought	Overall, the financial benefits of the carbon farming activities have improved our recovery from drought
Registered carbon farming project	N	19	18	18
	Mean	4.6842	5.2778	5.3333
	Median	5	6	6
	Std. Deviation	1.82734	1.44733	1.45521
Engaged in carbon farming-like activities	N	32	32	32
	Mean	5.7812	5.25	4.9063
	Median	6	5.5	5
	Std. Deviation	1.15659	1.34404	1.71068
Total	N	51	50	50
	Mean	5.3725	5.26	5.06
	Median	6	6	6
	Std. Deviation	1.52264	1.3674	1.62141

A breakdown of carbon farming method by drought recovery can be seen in Table 20. Soil management and HIR had the highest environmental benefits for those RCFP during drought recovery. Similar to the trends seen across preparation and experience of drought, the environmental benefits are stronger for those engaged in CFLA than those with a RCFP. However, generally those engaged in CFLA recovered moderately high drought recover across all three areas of environmental benefits, business performance benefits and financial benefits, with an average mean ≥5.00.

Table 20 Means for drought recovery by carbon farming activity

		Overall, the environmental benefits of the carbon farming project have improved our recovery from drought	Overall, the business performance benefits of the carbon farming project have improved our recovery from drought	Overall, the financial benefits of the carbon farming activities have improved our recovery from drought
Soil management	Registered carbon farming project	4.50	5.50	5.75
	Engaging in carbon farming activities	5.89	5.39	5.00
Avoid deforestation	Registered carbon farming project	3.25	4.75	4.25

	Engaging in carbon farming activities	5.64	5.18	4.73
Human induced regeneration	Registered carbon farming project	4.82	5.40	5.70
	Engaging in carbon farming activities	5.77	5.38	5.00
Plantation Forestry	Registered carbon farming project	5.00	5.00	5.00
	Engaging in carbon farming activities	6.00	5.50	5.50
Savanna fire management	Registered carbon farming project	1.00	6.00	7.00
	Engaging in carbon farming activities	6.00	6.00	6.00
Environmental plantings	Registered carbon farming project	3.00	7.00	4.00
	Engaging in carbon farming activities	5.44	5.06	4.61
Other	Registered carbon farming project	6.00	6.00	6.00
	Engaging in carbon farming activities	6.30	6.00	5.90

5.2.6. Impact of carbon farming on stress during drought

Farmers engaged in a carbon farming project were asked whether the income from that project reduced the stress put on their family during times of drought. 76% of respondents who had been paid for their Australian Carbon Credit Units (ACCUs) reported reduced stress during drought as compared to before being paid. With those who had been paid earlier than 2017 generally reporting lower levels of stress, which can be seen in Figure 4.

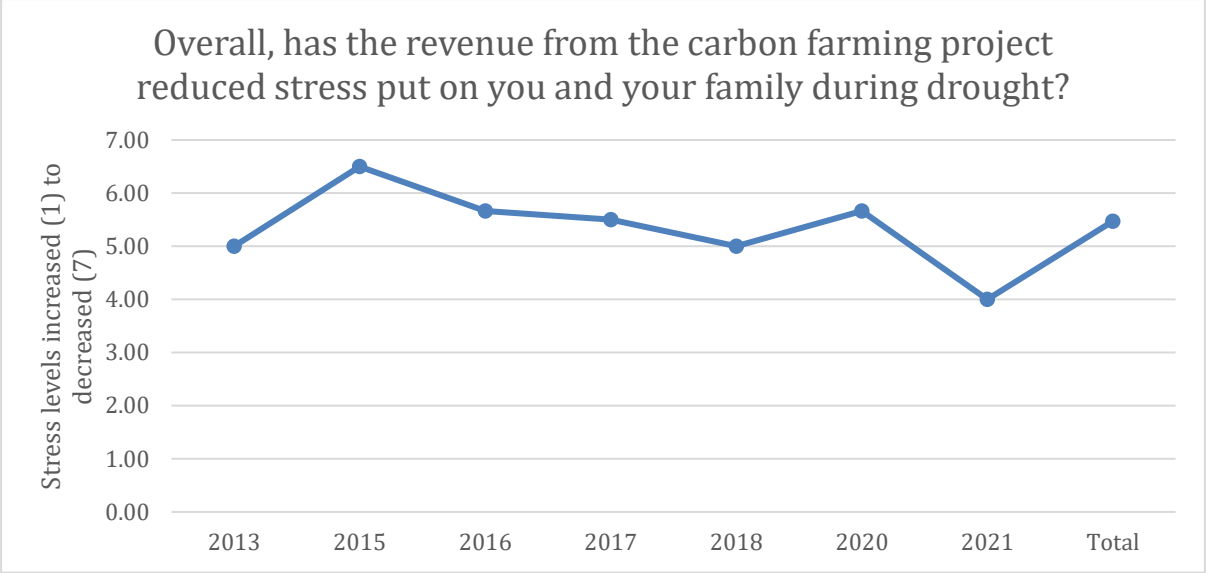

Figure 4 Stress levels by year first income for ACCUs was received

Respondents engaged in carbon farming for this survey were predominantly engaged in HIR, followed by soil management and avoiding deforestation. HIR respondents indicated that the income from carbon farming greatly reduced their stress during drought. Though all those engaged in carbon farming agreed that the income did to some degree reduce the stress on their family during drought. Details of these results can be seen in Table 21.

Table 21 Stress levels by carbon farming project method

Overall, has the revenue from the carbon farming project reduced stress put on you and your family during drought?					
	Neutral	Somewhat decreased stress	Moderately decreased stress	Greatly reduced stress	Total
Soil management	2	0	2	0	4
Avoid deforestation	1	0	2	0	3
Human induced regeneration	2	3	5	2	12
Plantation Forestry	0	0	1	0	1
Savanna fire management	0	0	1	0	1
Environmental plantings	1	0	0	0	1
Total	4	3	8	2	17

Respondents engaged in carbon farming like activities were also asked whether a diversified income from their activities would reduce the stress on their family during drought. The responses were more diverse than those who were receiving income. Most of these respondents were in soil management and HIR. The majority agreed that it would reduce their stress, however, many were neutral about the impact on whether it would change their stress levels during drought. Detailed results can be seen in Table 22.

Table 22 Stress levels by carbon farming like activity method

Do you think that diversified income, e.g., from a carbon farming project, would reduce the stress put on you and your family during drought?	Moderately increased	Somewhat increased stress	Neutral	Somewhat decreased stress	Moderately decreased stress	Greatly reduced stress	Total
Soil management	1	1	12	9	6	7	36
Avoid deforestation	1	1	2	5	1	3	13
Human induced regeneration	1	0	3	7	2	5	18
Plantation Forestry	0	0	2	1	1	3	7
Savanna fire management	0	0	0	1	0	1	2
Environmental plantings	0	0	8	6	2	7	23
Other	1	1	4	3	3	1	13
Total	1	1	13	10	7	10	42

5.3. Drought resilience

The following section looks at drought resilience through locus of control, self-efficacy and control of drought outcomes through risk management. These measures have been used to look at the perceptions of the farmer in terms of how drought can be managed on their property. Locus of control measures the degree to which an individual feels they have control over the outcome of an event, such as drought (Mueller & Thomas, 2001). Self-efficacy measures the belief in their capacity to manage and reach specific goals (Heslin & Klehe, 2006). The survey measured the confidence farmers feel in using a risk management approach to manage drought risk and the vulnerability of farmers in terms of several key components.

Table 23 Descriptive statistics of locus of control and self-efficacy by engagement with carbon farming

		Locus of control average	Self-efficacy average
Registered carbon farming project	N	18	17
	Mean	5.7889	4.4034
	Median	5.8	4.4286
	Std. Deviation	0.71116	0.61907
Engaged in carbon farming-like activities	N	29	30
	Mean	5.669	4.3095
	Median	5.8	4.1429
	Std. Deviation	0.73635	0.60619
No engagement with carbon farming-like activities	N	27	26
	Mean	5.4296	4.3736
	Median	5.4	4.2143
	Std. Deviation	0.83104	0.7678
Total	N	74	73

	Mean	5.6108	4.3542
	Median	5.7	4.2857
	Std. Deviation	0.77009	0.66288

The section compares the responses of the three groups of participants (RCFP, CFLA, NICF), to identify if any group has more or less drought resilience (Table 23). In addition, comparisons are also drawn between carbon farming method, with a focus on soil management, AD and HIR, as these are the three largest groups from the data collected (Table 24).

Table 24 Locus of control and self-efficacy average by carbon farming method

		Locus of control average	Self-efficacy average
Soil management	Mean	5.7	4.419
	N	29	30
	Std. Deviation	0.73241	0.5211
Avoid deforestation	Mean	5.7923	4.2967
	N	13	13
	Std. Deviation	0.74996	0.48607
Human induced regeneration	Mean	5.6478	4.3506
	N	23	22
	Std. Deviation	0.75671	0.60565
Plantation Forestry	Mean	5.42	4.4
	N	5	5
	Std. Deviation	0.60992	0.66548
Savanna fire management	Mean	5.15	4
	N	2	2
	Std. Deviation	1.06066	0
Environmental plantings	Mean	5.5813	4.0179
	N	16	16
	Std. Deviation	0.71388	0.56635
Other	Mean	5.9091	4.4405
	N	11	12
	Std. Deviation	0.52812	0.46574

5.3.1. Locus of Control

Farmers with a RCFP had a 6.5% stronger locus of control that those without a registered project. The distribution of the results indicates that generally those with a RCFP

and CFLA reported a stronger locus of control, whilst those NICF generally had a slight decrease, as shown Table 23.

There were no significant differences between carbon farming activity and locus of control. However, some methods did have stronger locus of control that others, with the top three being avoiding deforestation (AD) (mean=5.79), soil management (mean=5.7) and HIR (mean=5.64).

The variation in locus of control across the three groups is shown in Figure 5. The responses from those with a RCFP and engaged in CFLA were clustered towards the higher end of the scale, with a normal distribution. Those with no carbon farming engagement had more variation in their responses, with a lower locus of control. Education did not appear to impact the locus of control.

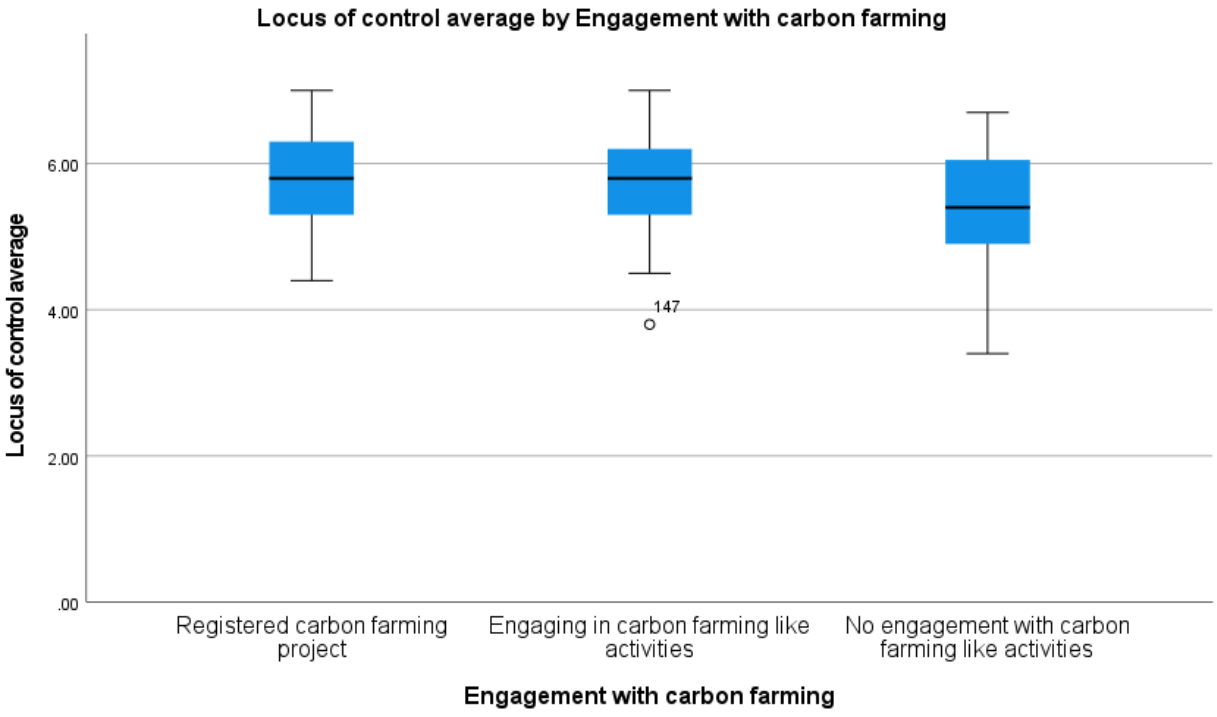

Figure 5 Box-plot of locus of control by engagement in carbon farming

Whilst there were not significant differences between locus of control and the method of carbon farming, there was a trend for locus of control to increase as the number of carbon farming activities increased. This suggests there is an additive benefit of carbon farming activities on drought resilience.

The differences in locus of control between RCFP, CFLA and NICF within regions varied. Not all regions had respondents in each category and the category sizes varied from one to eight depending on the region. Regions that did have respondents in all three groups were Far West and Orana, New England and North West, and Warrnambool and South

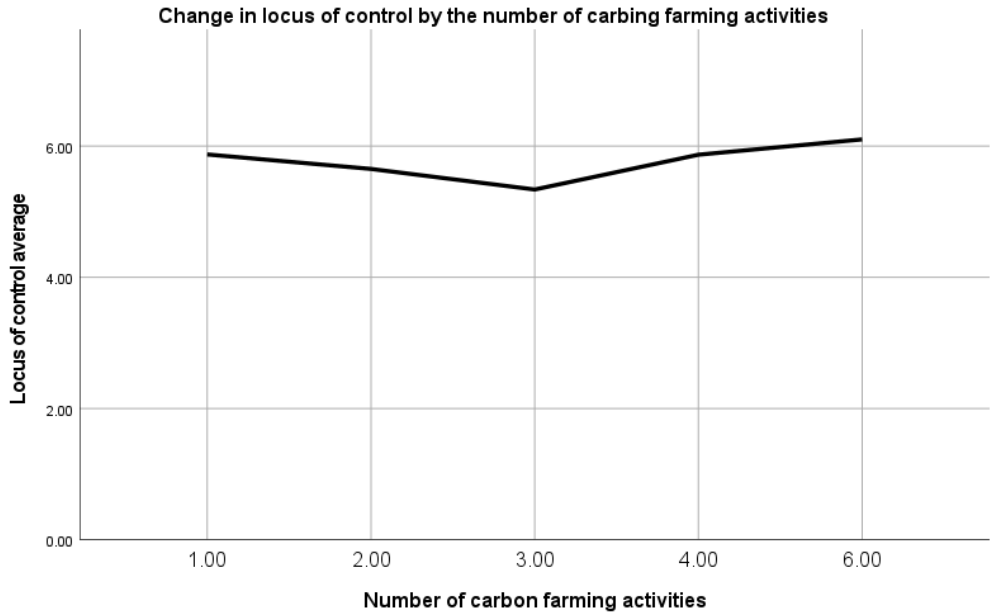

Figure 6 Change in locus of control by the number of carbon farming activities employed on a

West. The results for locus of control mean are summarised in Table 25. New England and North West, and Warrnambool and South West recorded higher locus of control for those engaged in carbon farming or carbon farming like activities. While the Far West and Orana reflected an opposing trend with a lower locus of control for RCFP and CFLA, when compared to NICF. This finding is contrary to the general comparison between the three main groups; however, it should be noted that locus of control for the Far West and Orana RCFP group is still comparatively high (mean=5.43) and close to the other two groups. Further qualitative analysis may be useful to help explain this phenomenon in more detail.

Table 25 Comparison of LOC by region by engagement in carbon farming

		Locus of control
Far West and Orana	Registered carbon farming project	5.43
	Engaging in carbon farming activities	5.77
	No engagement with carbon farming like activities	6.30
New England and North West	Registered carbon farming project	6.00
	Engaging in carbon farming activities	6.10
	No engagement with carbon farming like activities	4.93
Warrnambool and South West	Registered carbon farming project	6.30
	Engaging in carbon farming activities	5.35
	No engagement with carbon farming like activities	5.60

5.3.2. Self-efficacy

Self-efficacy was measured on a 7-point Likert scale, similar to all other items in this survey. They were asked about their confidence in managing drought risk through a number of strategies, including preparing a drought plan, infrastructure improvements, process improvements, awareness of the market place, awareness of seasonal changes, income from other investments, and income from other business activities. This is following items identified by Webster et al. (2020).

Self-efficacy was similar across the three groups, as can been in Figure 7. The mean results were all similar as can be seen in Table 23. Though those with a carbon farming project reported a higher level of self-efficacy overall, with 29% of responses indicating they were confident in managing drought risks.

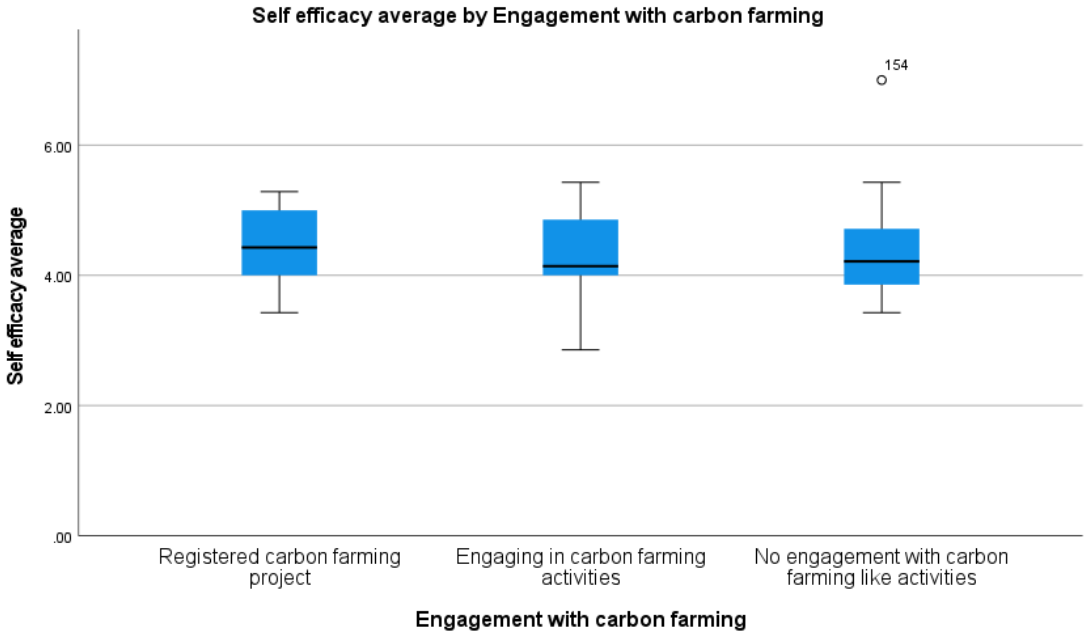

Figure 7 Box plot of self-efficacy by engagement with carbon farming

The results for self-efficacy were similar across the three groups, as can be seen in Table 26. However, notably those with a registered carbon farming project had generally higher results in each category, except for *income from other investments* and *income from other business activities*. This could be reflected in infrastructure improvements and process improvements, where much of the carbon farming income is being spent, as per Table 9.

Table 26 Self-efficacy measures for confidence in managing drought risk

		Preparing a formal drought plan	Infrastructure improvements	Process improvements	Awareness of the market place	Awareness of seasonal changes	Income from other investments	Income from other business activities
Registered carbon farming project	Mean	4.63	4.85	4.56	4.79	4.63	3.79	3.89
	N	19	20	18	19	19	19	19
	Std. Deviation	0.831	0.988	1.504	0.918	0.895	1.182	1.243
Engaging in carbon farming activities	Mean	4.33	4.57	4.23	4.43	4.2	4.03	4.37
	N	30	30	30	30	30	30	30
	Std. Deviation	1.213	0.858	0.935	1.073	0.761	0.89	1.189
No engagement with carbon farming like activities	Mean	4.22	4.74	4.37	4.31	4.52	4.33	4.15
	N	27	27	27	26	27	27	27
	Std. Deviation	1.34	1.023	1.079	1.123	1.051	1.359	1.292
Total	Mean	4.37	4.7	4.36	4.48	4.42	4.08	4.17
	N	76	77	75	75	76	76	76
	Std. Deviation	1.176	0.947	1.135	1.057	0.913	1.152	1.237

As shown in the locus of control measure, the comparison within regions demonstrated that New England and North West, and Warrnambool and South West recorded higher self-efficacy for those engaged in carbon farming or carbon farming like activities. While the Far West and Orana reflected an opposing trend with a lower locus of control for RCFP and CFLA, when compared to NICF. These results are summarised in Table 27. This reflects differences in confidence in managing drought risk, which could reflect a number of mitigating factors, such as rising costs and extent of drought exposure. Further qualitative analysis may shed light of the differences that are present between the regional comparisons and general comparison of carbon farming engagement.

Table 27 Comparison of Self-efficacy by region by engagement in carbon farming

		Self-efficacy
Far West and Orana	Registered carbon farming project	3.97
	Engaging in carbon farming activities	4.24
	No engagement with carbon farming like activities	4.71
New England and North West	Registered carbon farming project	5.14
	Engaging in carbon farming activities	4.62
	No engagement with carbon farming like activities	4.71
Warrnambool and South West	Registered carbon farming project	4.43
	Engaging in carbon farming activities	3.93
	No engagement with carbon farming like activities	3.71

5.3.3. Confidence in risk management strategies

This question was asked using a single bi-polar question on a seven-point scale, from one (we cannot control the impact of drought) to seven (by using risk management strategies we can control the impact of drought). A summary of these results can be seen in Table 28. As can be seen the confidence in the use of risk management strategies was stronger for those with a RCFP (mean=5.5, s.d.=1.54) and those engaged in CFLA (mean=5.32, s.d. 1.37), compared to those with NICF (mean=4.91, s.d.=1.33).

Table 28 Confidence in using risk management strategies to reduce drought risk

How much control do you have to reducing the impact of drought?		
Registered carbon farming project	Mean	5.5
	N	20
	Std. Deviation	1.539
	Median	6
Engaging in carbon farming activities	Mean	5.32
	N	41
	Std. Deviation	1.368
	Median	5
No engagement with carbon farming-like activities	Mean	4.91
	N	32
	Std. Deviation	1.329
	Median	5
Total	Mean	5.22
	N	93
	Std. Deviation	1.398
	Median	5

The cluster of responses for those with carbon farming project and carbon farming-like activities was at the higher range, as can be seen in Figure 8, although the range was similar for the three groups. Those engaged in CFLA had a stronger cluster of responses being more confident in the use of risk management strategies to reduce drought impact. This may reflect the type of people engaging in these activities, where they are inclined towards risk management strategies. Education did not appear to have an impact on the confidence in risk management strategies.

Those with a carbon farming project had an 11.3% increase in their confidence of using risk-management tools. With 72.3% of respondents having agreed to strongly agreed that they had some level of control on the outcome of drought through risk management strategies.

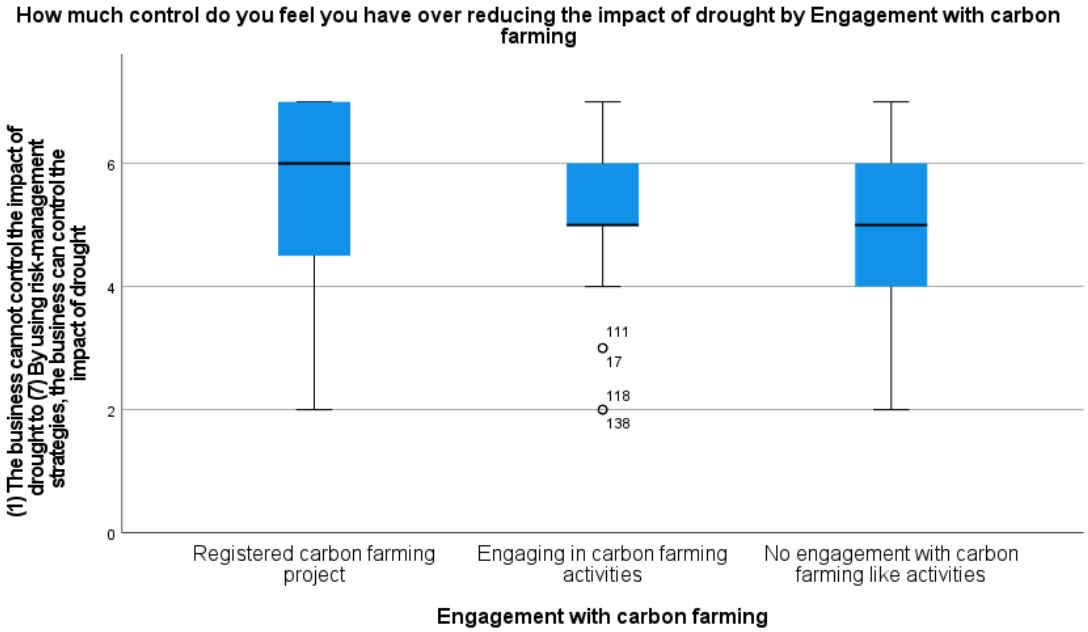

Figure 8 Box-plot of confidence in risk management to reduce drought impact by engagement with

There was a similar trend in risk management strategies as locus of control, where the number of carbon farming activities employed on a farm reflected an upward trend in the positive perception of risk management strategies, as can be seen in Figure 9. This could also explain why those engaged in CFLA reflected a different distribution of results compared to those with a CF project and no engagement in carbon farming. As those engaged in CFLA generally had more carbon farming methods than those with a registered project.

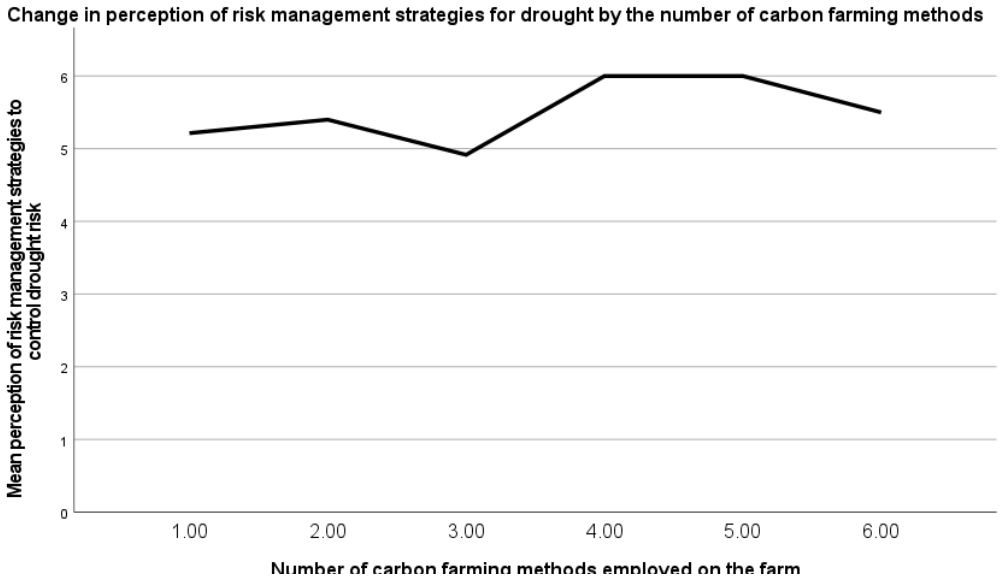

Figure 9 Change in positive perception of risk management strategies by the number of carbon farming methods

5.3.4. Vulnerability

It is expected that Australian farmers will indicate some level of vulnerability and the purpose of this question was to understand whether carbon farming indicated a difference between the groups. Vulnerability was asked on a 7-point Likert scale from not at all vulnerable (1) to extremely vulnerable (7), and was measured in seven areas: financial, infrastructure, soil health, pasture quality and quantity, water supply, regional vulnerability, and crops/livestock processes.

Typically, farmers located in Queensland (mean=5.9, s.d.=0.876) and NSW (mean=5.63, s.d.=1.299) reported their local region having higher level of vulnerability to drought. These two also had more responses from those engaged in carbon farming. Regional comparison at an SA4 level showed the different vulnerability to drought between regions. Given the climatic variability that exists between regions and the cluster of carbon farming projects within rangeland areas, the higher rate of vulnerability for carbon farmers is not surprising. As can be seen in Figure 10[6], the vulnerability within the region is similar

[6] Details of the regions can be found in Appendix 1 - Table 38 and

		Financial /Business vulnerability	Property infrastructure	Property soil health	Property pasture quality and quantity	Properties water supply	The region in which we operate	Livestock/crop is vulnerable
		Mean	Mean	Mean	Mean	Mean	Mean	Mean
Central West	Soil management	4	2	3	4	6	6	1
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
Coffs Harbour - Grafton	Soil management	4	2	4	6	4	5	5
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	5	1	5	7	6	5	7
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	5	1	4	7	6	5	7
Far West and Orana	Soil management	5	2	5	6	3	7	5
	Avoid deforestation	5	2	5	5	3	7	5

	Human induced regeneration	4	2	5	6	4	6	5
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management							
	Environmental plantings	3	2	4	4	3	6	4
	Other	6	2	6	6	3	7	6
Mid-North Coast	Soil management	2	2	4	5	6	3	6
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
New England and North West	Soil management	3	2	4	5	5	5	5
	Avoid deforestation	1	1	4	6	7	4	4
	Human induced regeneration	1	1	4	6	7	4	4
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	3	5	5	4	6	5
	Other	3	2	4	5	4	6	5

Riverina	Soil management	6	3			7	7	
	Avoid deforestation	6	3			7	7	
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	6	4	4	6	6	6	6
	Other	-	-	-	-	-	-	-
Bendigo	Soil management	7	4	6	5	6	7	6
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	7	2	7	7	5	7	7
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	5	4	3	3	5	5	4
Geelong	Soil management	-	-	-	-	-	-	-
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-

	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	1	4	6		4	6
	Other	-	-	-	-	-	-	-
Hume	Soil management	3	2	4	4	2	3	5
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	3	2	4	4	2	3	5
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	3	2	4	4	2	3	5
	Other	3	2	4	4	2	3	5
Melbourne - North East	Soil management	4	3	4	7	6	5	7
	Avoid deforestation	4	3	4	7	6	5	7
	Human induced regeneration	4	3	4	7	6	5	7
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
North West	Soil management	4	4	4	6	4	6	4
	Avoid deforestation	-	-	-	-	-	-	-

	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	4	4	6	4	6	4
	Other	-	-	-	-	-	-	-
Shepparton	Soil management	5	3	6	5	5	5	5
	Avoid deforestation	6	2	6	6	6	5	6
	Human induced regeneration	6	5	6	6	7	6	6
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	5	4	5	5	5	5	5
	Other	-	-	-	-	-	-	-
Warrnambool and South West	Soil management	5	3	4	5	6	6	5
	Avoid deforestation	5	2	3	3	5	6	5
	Human induced regeneration	5	2	4	4	6	6	5
	Plantation Forestry	5	2	4	4	6	6	5
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	5	2	4	4	6	6	5
	Other	5	2	3	3	5	6	5

Darling Downs - Maranoa	Soil management	5	1	3	5	6	6	
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	5	1	3	5	6	6	
Queensland - Outback	Soil management	7	7	4				
	Avoid deforestation	7	5	4	2	2	5	7
	Human induced regeneration	6	3	6	7	3	6	6
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	7	7	4	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
Wide Bay	Soil management	3	2	4	4	3	6	4
	Avoid deforestation	1	1	2	2	4	6	2
	Human induced regeneration	3	2	4	4	3	6	4
	Plantation Forestry	-	-	-	-	-	-	-

	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	3	6	5	1	6	6
	Other	1	1	2	2	4	6	2
South Australia - South East	Soil management	3	4	4	5	4	5	4
	Avoid deforestation	3	4	4	5	3	5	4
	Human induced regeneration	3	4	4	5	3	5	4
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	3	4	3	3	4	3	3
	Environmental plantings	4	4	5	6	4	6	5
	Other	-	-	-	-	-	-	-
Western Australia - Wheat Belt	Soil management	3	3	6	-	-	-	6
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	3	3	6	-	-	-	6
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	3	3	6	-	-	-	6
	Other	-	-	-	-	-	-	-
Western Australia – Outback (South)	Soil management	-	-	-	-	-	-	-
	Avoid deforestation	-	-	-	-	-	-	-

across the three groups. The bulk of carbon farming projects were in the Far West and Orana region and Queensland outback. Some regions only included those with CFLA or NICF, but this is consistent with the national distribution of carbon farming projects being clustered in rangeland areas (Clean energy regulator, 2022).

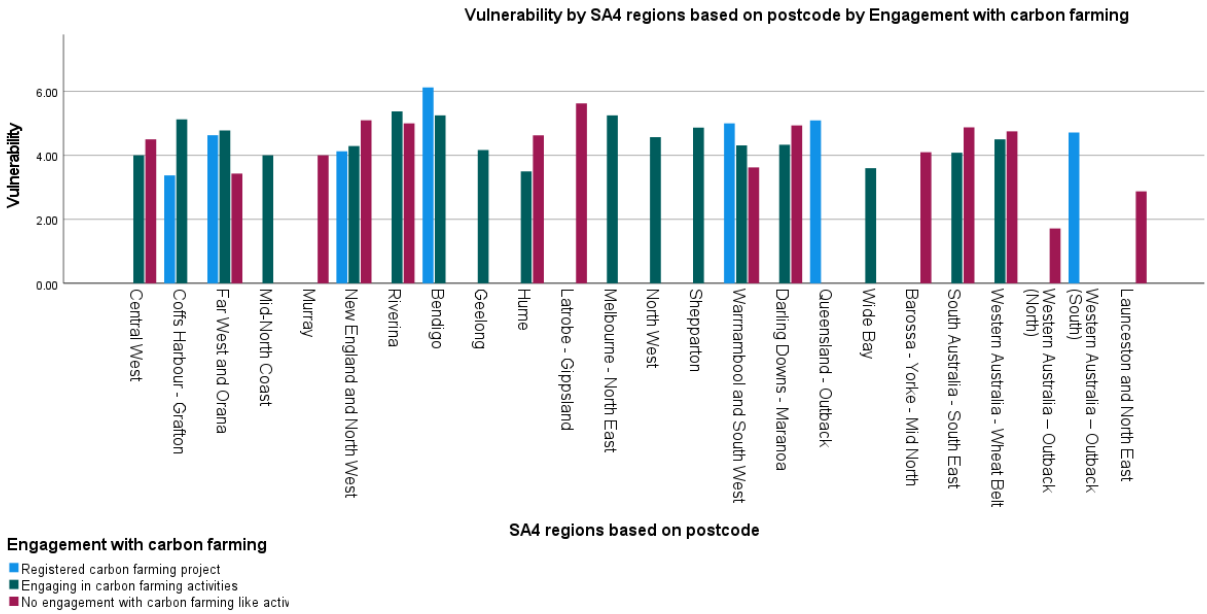

Figure 10 Vulnerability by region by engagement with carbon farming

Those with a registered carbon farming project recorded a higher level of financial vulnerability to drought (mean=4.82), compared to those with carbon farming-like activities (mean=4.5) and no engagement with carbon farming (mean=4.38). This is a similar trend across other areas of vulnerability, including soil health, property infrastructure, and the region in which the property is located (as seen in Table 32). These differences could be due

	Human induced regeneration	3	2	5	7	6	3	7
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-

Table 39

to the regions in which respondents' properties were located. As most of the RCFP respondents were in rangelands in NSW and Queensland, where there is more vulnerability to drought and climate variability (Phelps & Kelly, 2019).

The *pasture quality and quantity vulnerability* measure, though similar between the three groups, was slightly higher for those with a RCFP and those engaged in CFLA. Vulnerability was higher for those with a RCFP (mean=5.67) compared to those engaged in carbon farming-like activities (mean=5.21) and those with no carbon farming engagement (mean=4.79). Typically, this would be seen for farmers in areas of poor soil quality, such as rangelands, where most of those with a RCFP were located. Farms with soil management activities did record lower levels of pasture quality and quantity vulnerability when doing regional comparisons of carbon farming activity type (Appendix 1 -

		Financial /Business vulnerability	Property infrastructure	Property soil health	Property pasture quality and quantity	Properties water supply	The region in which we operate	Livestock/crop is vulnerable
		Mean	Mean	Mean	Mean	Mean	Mean	Mean
Central West	Soil management	4	2	3	4	6	6	1
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
Coffs Harbour - Grafton	Soil management	4	2	4	6	4	5	5
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	5	1	5	7	6	5	7
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	5	1	4	7	6	5	7
Far West and Orana	Soil management	5	2	5	6	3	7	5
	Avoid deforestation	5	2	5	5	3	7	5
	Human induced regeneration	4	2	5	6	4	6	5
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management							

	Environmental plantings	3	2	4	4	3	6	4
	Other	6	2	6	6	3	7	6
Mid-North Coast	Soil management	2	2	4	5	6	3	6
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
New England and North West	Soil management	3	2	4	5	5	5	5
	Avoid deforestation	1	1	4	6	7	4	4
	Human induced regeneration	1	1	4	6	7	4	4
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	3	5	5	4	6	5
	Other	3	2	4	5	4	6	5
Riverina	Soil management	6	3			7	7	
	Avoid deforestation	6	3			7	7	
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-

	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	6	4	4	6	6	6	6
	Other	-	-	-	-	-	-	-
Bendigo	Soil management	7	4	6	5	6	7	6
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	7	2	7	7	5	7	7
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	5	4	3	3	5	5	4
Geelong	Soil management	-	-	-	-	-	-	-
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	1	4	6		4	6
	Other	-	-	-	-	-	-	-
Hume	Soil management	3	2	4	4	2	3	5
	Avoid deforestation	-	-	-	-	-	-	-

	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	3	2	4	4	2	3	5
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	3	2	4	4	2	3	5
	Other	3	2	4	4	2	3	5
Melbourne - North East	Soil management	4	3	4	7	6	5	7
	Avoid deforestation	4	3	4	7	6	5	7
	Human induced regeneration	4	3	4	7	6	5	7
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
North West	Soil management	4	4	4	6	4	6	4
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	4	4	6	4	6	4
	Other	-	-	-	-	-	-	-

Shepparton	Soil management	5	3	6	5	5	5	5
	Avoid deforestation	6	2	6	6	6	5	6
	Human induced regeneration	6	5	6	6	7	6	6
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	5	4	5	5	5	5	5
	Other	-	-	-	-	-	-	-
Warrnambool and South West	Soil management	5	3	4	5	6	6	5
	Avoid deforestation	5	2	3	3	5	6	5
	Human induced regeneration	5	2	4	4	6	6	5
	Plantation Forestry	5	2	4	4	6	6	5
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	5	2	4	4	6	6	5
	Other	5	2	3	3	5	6	5
Darling Downs - Maranoa	Soil management	5	1	3	5	6	6	
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-

	Environmental plantings	-	-	-	-	-	-	-
	Other	5	1	3	5	6	6	
Queensland - Outback	Soil management	7	7	4				
	Avoid deforestation	7	5	4	2	2	5	7
	Human induced regeneration	6	3	6	7	3	6	6
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	7	7	4	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
Wide Bay	Soil management	3	2	4	4	3	6	4
	Avoid deforestation	1	1	2	2	4	6	2
	Human induced regeneration	3	2	4	4	3	6	4
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	3	6	5	1	6	6
	Other	1	1	2	2	4	6	2
South Australia - South East	Soil management	3	4	4	5	4	5	4
	Avoid deforestation	3	4	4	5	3	5	4
	Human induced regeneration	3	4	4	5	3	5	4
	Plantation Forestry	-	-	-	-	-	-	-

	Savanna fire management	3	4	3	3	4	3	3
	Environmental plantings	4	4	5	6	4	6	5
	Other	-	-	-	-	-	-	-
Western Australia - Wheat Belt	Soil management	3	3	6	-	-	-	6
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	3	3	6	-	-	-	6
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	3	3	6	-	-	-	6
	Other	-	-	-	-	-	-	-
Western Australia – Outback (South)	Soil management	-	-	-	-	-	-	-
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	3	2	5	7	6	3	7
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-

Table 39).

Table 29 Vulnerability means by carbon farming method by type of carbon farming engagement

		Financial /Business vulnerability	Property infrastructure	Property soil health	Property pasture quality and quantity	Properties water supply	The region in which we operate	Livestock /crop is vulnerable
Soil management	Registered carbon farming project	5	4	5	6	4	5	5
	Engaging in carbon farming activities	4	3	5	5	5	6	5
Avoid deforestation	Registered carbon farming project	5	4	3	4	3	6	5
	Engaging in carbon farming activities	4	3	5	5	5	6	5
Human induced regeneration	Registered carbon farming project	5	3	5	6	4	5	5
	Engaging in carbon farming activities	4	3	5	5	5	5	5
Plantation Forestry	Registered carbon farming project	7	2	7	7	5	7	7
	Engaging in carbon farming activities	4	3	5	4	5	5	5
Savanna fire management	Registered carbon farming project	7	7	4	-	-	-	-
	Engaging in carbon farming activities	5	4	3	3	5	4	3
Environmental plantings	Registered carbon farming project	3	5	4	6	4	6	3
	Engaging in carbon farming activities	5	3	5	5	5	5	5

Other	Registered carbon farming project	4	1	3	3	1	7	7
	Engaging in carbon farming activities	4	2	4	4	5	5	5

Vulnerability of water supply was 17% lower for those with a registered carbon farming project than the overall mean of the three groups (mean=4.24, s.d.=1.86). This is one of the few instances of where vulnerability was lowest for this with a carbon farming project. This is likely due to the revenue from carbon farming, as most participant are using their funds for drought resilience projects such as investing in water points.

Vulnerability between carbon farming method was similar across the groups, though the number of carbon farming methods did have an impact on vulnerability. Up to three carbon farming methods there was a rise in vulnerability, but this dropped off at four and more carbon farming methods.

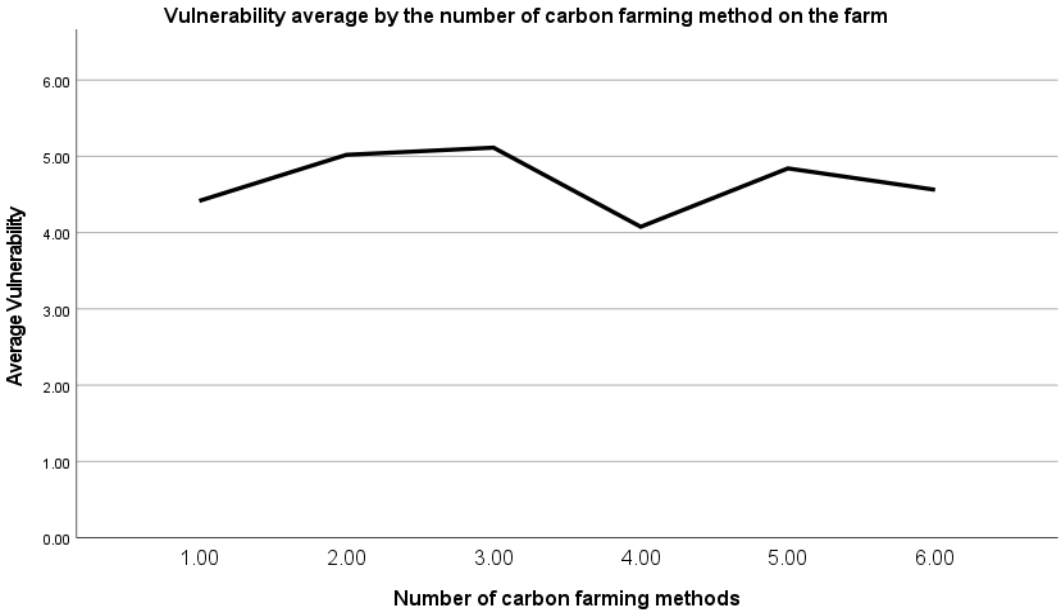

Figure 11 Vulnerability by the number of carbon farming methods on a farm

The three largest carbon farming methods; soil management, avoid deforestation, and HIR, were comparatively similar across most areas of vulnerability, a summary can be seen in Table 30. There were no significant differences between these groups. Some items of note are that *livestock/crop vulnerability* (mean=5.23, s.d.=1.7) and *property pasture quality and quantity* (mean=5.54, s.d.=1.6) was higher for HIR. Avoiding deforestation has

recorded having the lowest vulnerability in terms of *property pasture quality and quantity* (mean=5, s.d.=1.8).

Table 30 Carbon farming method by vulnerability measures

		Financial /Business vulnerability	Property infrastructure	Property soil health	Property pasture quality and quantity	Properties water supply	The region in which we operate	Livestock /crop is vulnerable
Soil management	Mean	4.53	2.81	4.73	5.19	4.66	5.49	5.03
	N	43	43	40	37	38	41	39
	Std. Deviation	1.623	1.435	1.358	1.411	1.820	1.227	1.446
Avoid deforestation	Mean	4.47	2.89	4.25	5.00	4.76	5.59	5.00
	N	19	19	16	14	17	17	15
	Std. Deviation	1.896	1.560	1.653	1.797	1.786	1.176	1.558
Human induced regeneration	Mean	4.34	2.58	4.93	5.54	4.39	5.30	5.23
	N	32	31	29	28	31	30	30
	Std. Deviation	1.537	1.232	1.307	1.575	1.961	1.343	1.701
Plantation Forestry	Mean	4.50	2.75	5.00	4.80	4.67	5.00	5.57
	N	8	8	6	5	6	7	7
	Std. Deviation	1.512	0.886	1.549	1.483	1.862	1.528	0.932
Savanna fire management	Mean	5.33	4.67	3.50	3.00	5.00	4.00	3.00
	N	3	3	2	1	2	2	1
	Std. Deviation	2.082	2.082	0.707		1.414	1.414	
Environmental plantings	Mean	4.44	3.07	4.96	5.22	4.58	5.38	5.28
	N	27	27	24	23	24	26	25
	Std. Deviation	1.340	1.269	1.122	1.126	1.998	1.203	1.090
Other	Mean	3.79	2.07	3.93	4.14	4.14	5.14	4.88
	N	14	14	14	14	14	14	13
	Std. Deviation	1.762	1.328	1.269	1.562	1.748	1.460	1.543

When looking at Table 31, there are some differences between RCFP and CFLA. The soil management group showed lower vulnerability to drought in the CFLA group. While AD and HIR had similar vulnerability scores between RCFP and CFLA group.

Table 31 Vulnerability by carbon farming method by carbon farming engagement

	Vulnerability		
	Count	Mean	Std. Deviation

Soil management	Registered carbon farming project	5	5.13	1.27
	Engaging in carbon farming activities	45	4.66	0.92
Avoid deforestation	Registered carbon farming project	4	4.13	1.55
	Engaging in carbon farming activities	17	4.74	1.05
Human induced regeneration	Registered carbon farming project	16	4.69	0.79
	Engaging in carbon farming activities	21	4.59	1.01
Plantation Forestry	Registered carbon farming project	1	6.13	
	Engaging in carbon farming activities	9	4.47	0.61
Savanna fire management	Registered carbon farming project	1	6.00	
	Engaging in carbon farming activities	2	4.13	1.24
Environmental plantings	Registered carbon farming project	1	4.43	
	Engaging in carbon farming activities	31	4.78	0.84
Other	Registered carbon farming project	1	4.13	
	Engaging in carbon farming activities	13	4.23	0.82

The *region in which we operate* variable was higher across all groups, except for NICF. The lower vulnerability between the region and other variables in carbon farming group supports that carbon farming does improve resilience to drought by decreasing vulnerability. The main vulnerability measures that have been decreased are water supply, soil health and financial. Those with a RCFP reported a 36% decrease in water supply vulnerability (mean=3.52), 15% decrease in soil health vulnerability (mean=4.67) and 12% decrease in financial vulnerability (mean=4.82) from the local region vulnerability (mean=5.5). Those with CFLA reported a 13% decrease in water supply vulnerability (mean=4.69), 12% decrease in soil health vulnerability (mean=4.71) and 16% decrease in financial vulnerability (mean=4.5) from the local region vulnerability (mean=5.37). The NICF group reported similar vulnerability across all variables, except for property infrastructure, which was consistently low between all three groups.

Further research should be done into the impact of carbon farming revenue and overall drought vulnerability. There appears to be a downward trend between the average

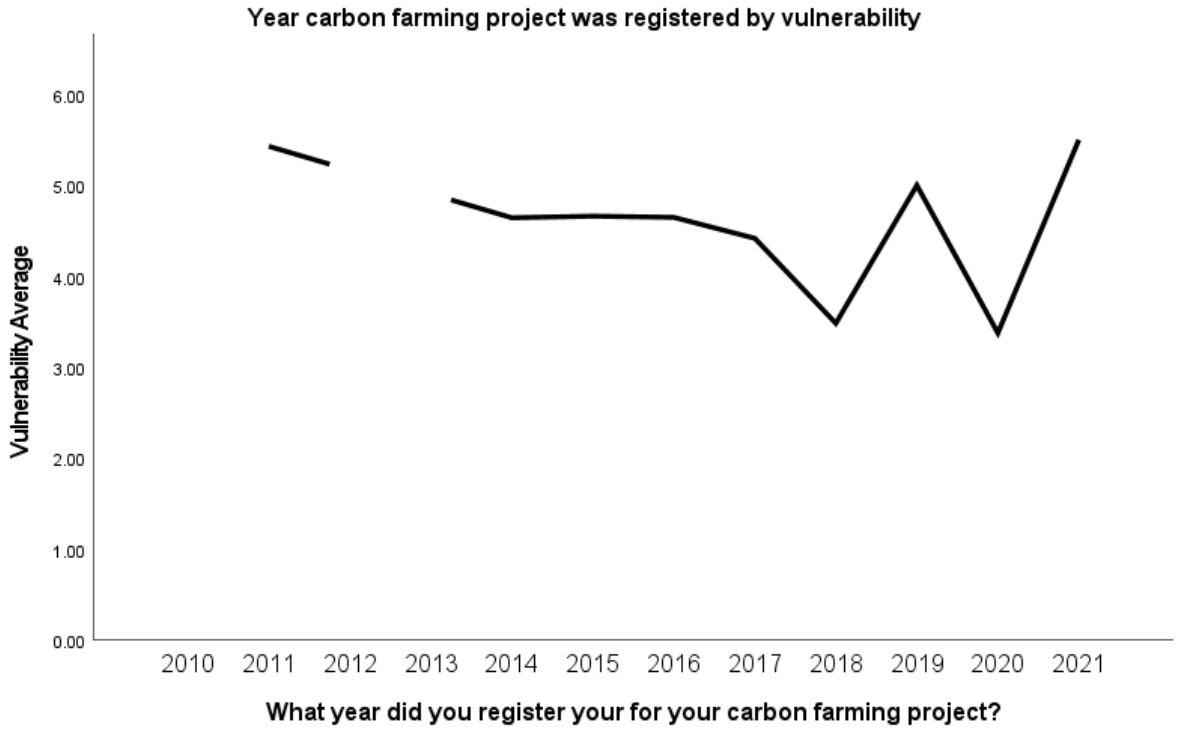

Figure 12 Vulnerability by the year a carbon farming project was registered

vulnerability and the year in which the first carbon farming revenue was received (Figure 13) and the year a project was registered (Figure 12). This is contrary to what was expected, however, this could also reflect the drought impact in rangelands and outback areas where drought lasts longer and the effects felt more keenly. A larger sample size or additional qualitative data could provide more information on this finding.

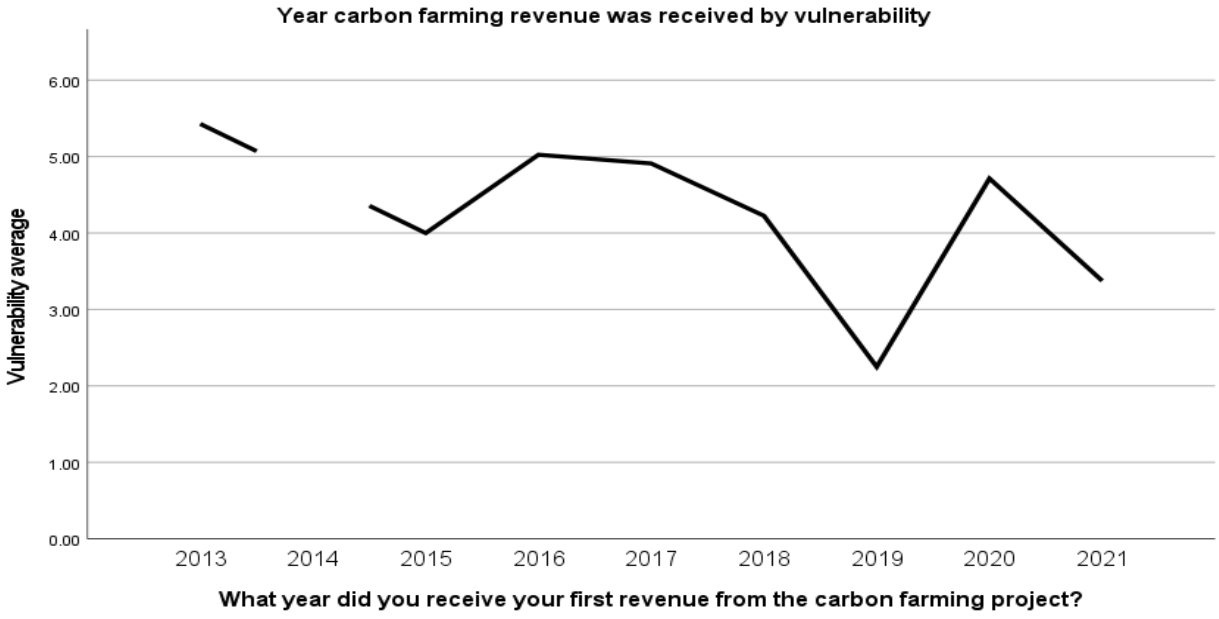

Figure 13 Vulnerability by the year carbon farming revenue was first received

Table 32 Engagement with carbon farming activity by vulnerability

Engagement with carbon farming		Area impacted by drought						
		The region in which we operate	Financial	Property infrastructure	Property soil health	Property pasture quality and quantity	Properties water supply	Livestock and Cropping processes
Registered carbon farming project	Mean	5.5	4.82	2.86	4.67	5.67	3.52	5.34
	N	18	22	21	21	18	21	19
	Std. Deviation	1.425	1.368	1.59	1.56	1.609	1.778	1.849
	Skewness	-0.481	0.482	0.917	-0.43	-1.007	0.399	-1.061
Engaging in carbon farming-like activities	Mean	5.37	4.5	2.66	4.71	5.21	4.69	5.12
	N	43	44	44	41	39	39	41
	Std. Deviation	1.215	1.517	1.328	1.289	1.38	1.823	1.413
	Skewness	-0.521	-0.335	0.357	0.066	-0.516	-0.285	-1.085
No engagement with carbon farming	Mean	4.64	4.38	2.97	4.18	4.79	4.16	4.67
	N	33	32	33	33	33	32	33
	Std. Deviation	1.868	1.338	1.531	1.357	1.576	1.851	1.503
	Skewness	-0.412	-0.576	0.221	-0.111	-0.391	-0.016	-0.291
Total	Mean	5.14	4.53	2.81	4.52	5.14	4.24	5.01
	N	94	98	98	95	90	92	93
	Std. Deviation	1.542	1.423	1.448	1.383	1.518	1.86	1.547
	Skewness	-0.686	-0.238	0.472	-0.132	-0.526	-0.033	-0.714

Table 33 Vulnerability to drought by state

State		The region in which we operate	Financial	Property infrastructure	Property soil health	Property pasture quality and quantity	Properties water supply	Livestock and Cropping processes
NSW	Mean	5.63	4.55	2.57	4.62	5.28	4.37	5.12
	N	30	31	30	29	29	30	29
	Std. Deviation	1.299	1.287	1.382	1.147	1.437	1.847	1.48
Victoria	Mean	4.7	4.55	3	4.3	5.16	4.61	5.15
	N	20	20	20	20	19	18	20
	Std. Deviation	1.72	1.538	1.522	1.261	1.425	1.852	1.16
Queensland	Mean	5.9	5.33	2.58	4.67	5.3	3.45	5.65
	N	10	12	12	12	10	11	10
	Std. Deviation	0.876	1.67	1.881	1.557	1.947	1.968	1.473
Other	Mean	4.1	3.55	3	4.09	4.6	3.89	4.5
	N	10	11	11	11	10	9	11
	Std. Deviation	1.287	1.293	1.183	1.375	1.578	2.028	1.597
Total	Mean	5.19	4.53	2.75	4.46	5.15	4.22	5.11
	N	70	74	73	72	68	68	70
	Std. Deviation	1.497	1.483	1.47	1.278	1.519	1.891	1.419

5.4. Preparation for drought

Respondents were asked about their preparation and planning strategies in place for drought. These questions focused on written plans, strategies for before, during and after drought, and preparation financially and environmentally for drought. The following section is a comparison of these strategies between those with a registered CF project, those with CFLA and no carbon farming engagement. An overview of the results can be seen in Table 34.

Table 34 Summary of preparation for drought by engagement in carbon farming

		Do you have a drought plan in place?	Use of indicators and triggers in the drought plan	Strategies for transitioning into drought from good seasons	Strategies for maintaining farm performance during drought	Strategies to assist in drought recovery	Preparations during good years for financial stability	Preparations during good years for environmental/biophysical stability
Registered carbon farming project	Mean	5.33	4.35	5.2	5.25	5.29	5.57	5.55
	N	21	20	20	20	21	21	20
	Std. Deviation	1.528	2.033	1.361	1.552	1.554	1.599	1.82
Engaging in carbon farming activities	Mean	4.76	5.15	4.59	4.8	4.83	5.07	5.41
	N	41	39	41	41	41	41	41
	Std. Deviation	1.609	1.348	1.688	1.52	1.377	1.571	1.483
No engagement with carbon farming-like activities	Mean	4.06	4.69	4.33	4.42	4.64	5	4.73
	N	32	26	33	33	33	33	33
	Std. Deviation	1.831	1.225	1.652	1.521	1.41	1.639	1.567
Total	Mean	4.65	4.82	4.63	4.77	4.86	5.16	5.2
	N	94	85	94	94	95	95	94
	Std. Deviation	1.721	1.521	1.626	1.541	1.434	1.6	1.61

Having a formal written drought plan in place was more common for those with a CF project (mean=5.33), than those engaged in CFLA (mean=4.76) and no carbon farming engagement (mean=4.06). However, the use of indicators and triggers was more common for those with CFLA, than those with a CF project, as can be seen in Table 34. 55% of CF

respondents had incorporated indicators and triggers into their drought plan, compared to 74% who were engaged in CFLA.

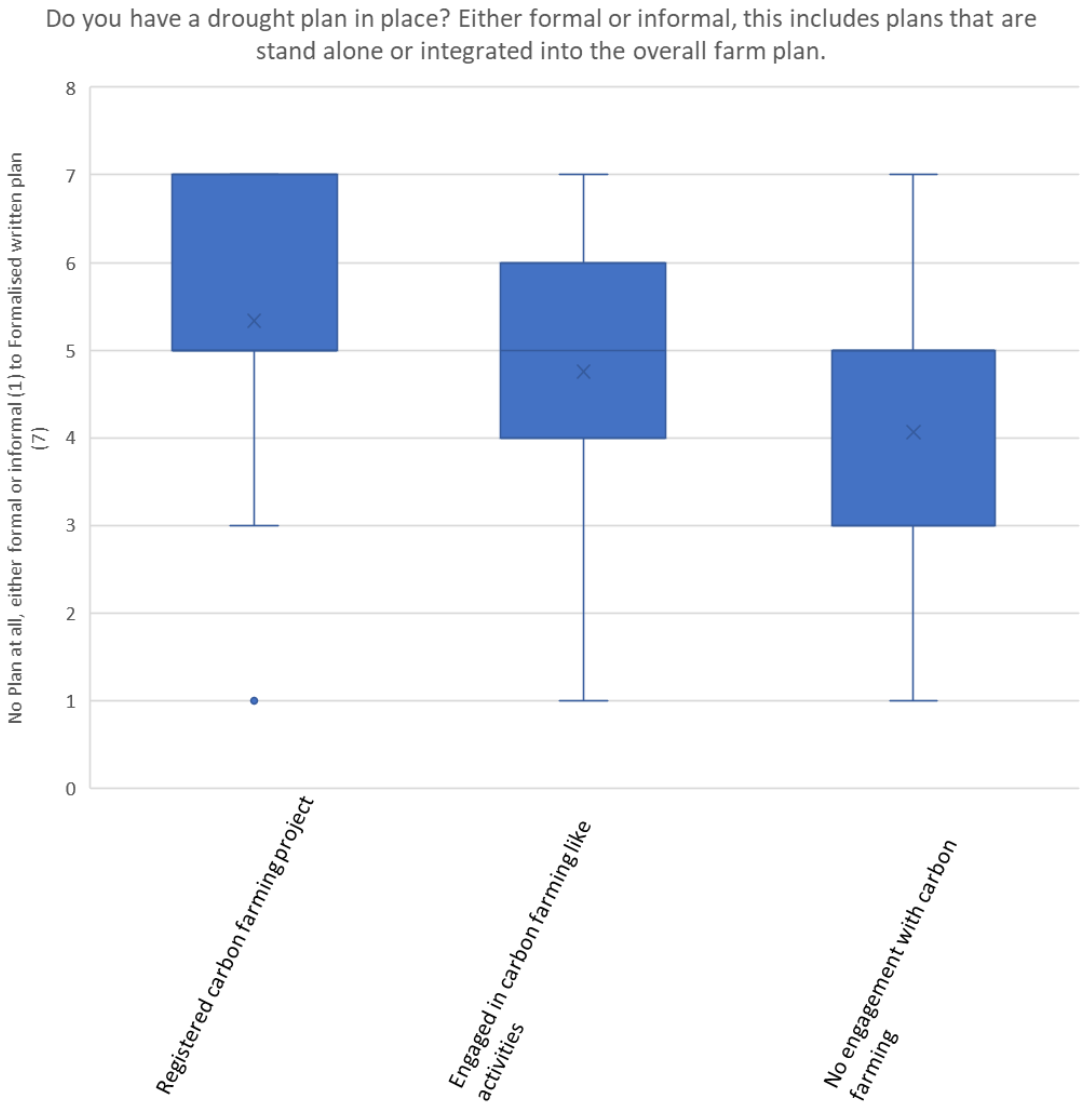

Figure 14 Formality of drought plan by level of engagement with carbon farming

The use of strategies for planning, operating and recovering from drought were more common for those with a CF project, than those with CLFA and no carbon farming engagement. 60% (mean= 5.2) of respondents with a registered CF project indicated they had considered strategies for transitioning into drought, compared to 58.5% (mean=4.59) of CFLA respondents

and 45.5% (mean=4.33) of non-CF respondents. These results are indicating that a stronger focus on transitioning into drought exists with those with a CF project than those without.

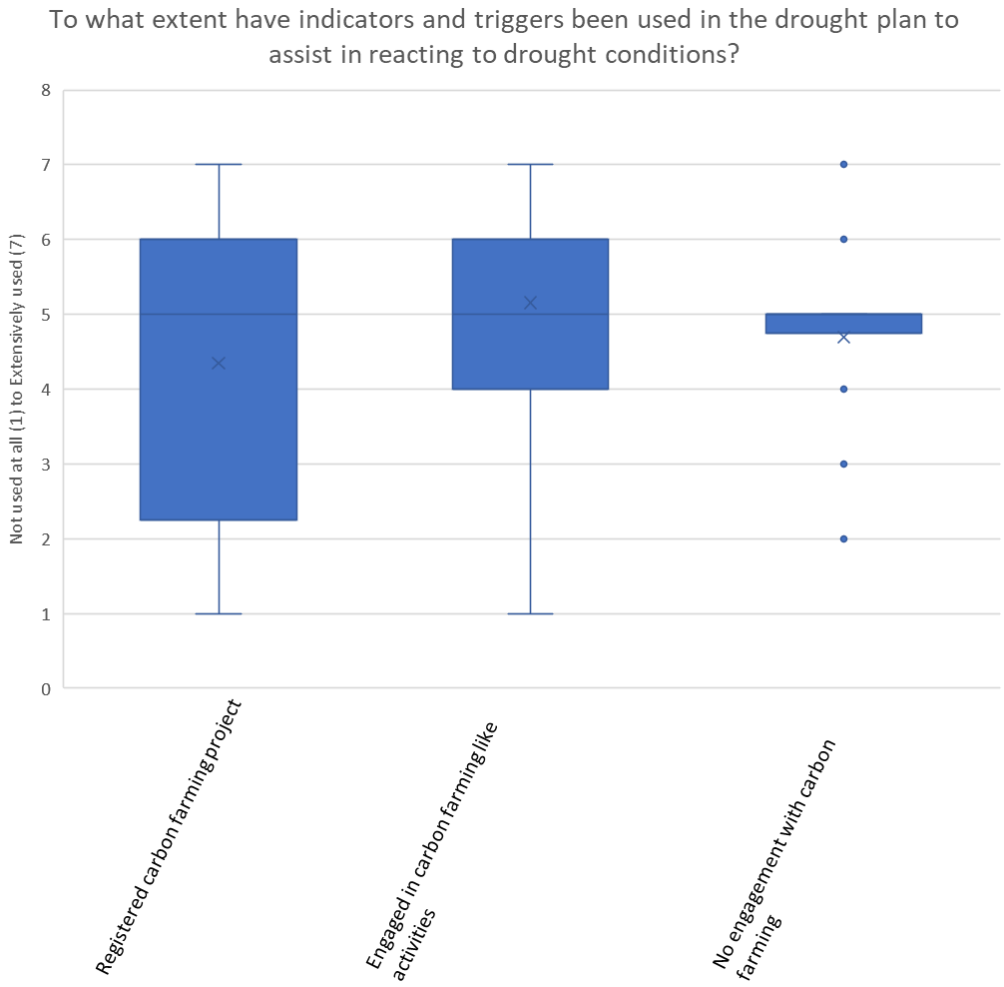

Figure 15 Use of indicators and triggers by carbon farming engagement

In terms of strategies for maintaining performance drought, 65% (mean=5.25) respondents with a registered CF project, 63.4% (mean=4.8) of CFLA respondents and 45.5% (mean=4.64) of non-CF respondents had considered these strategies in their drought plan to a strong extent. Strategies for recovering from drought were very strongly considered for those with a CF project, but not as strongly considered for those without a CF project. 71.4% (mean= 5.29) of respondents with a CF project strongly considered recovery strategies in their drought plan, whilst only 58.5% (mean=4.83) of those with CFLA and 57.6% (mean=4.64) of non-CF respondents considered these strategies in their drought plan.

Financial preparation for drought was strong for all three groups with an average of 5.16/7 across all groups. Whilst environmental preparation was stronger for those with a CF project (mean=5.55) and CFLA (mean=5.41), compared to non-CF (mean=4.73).

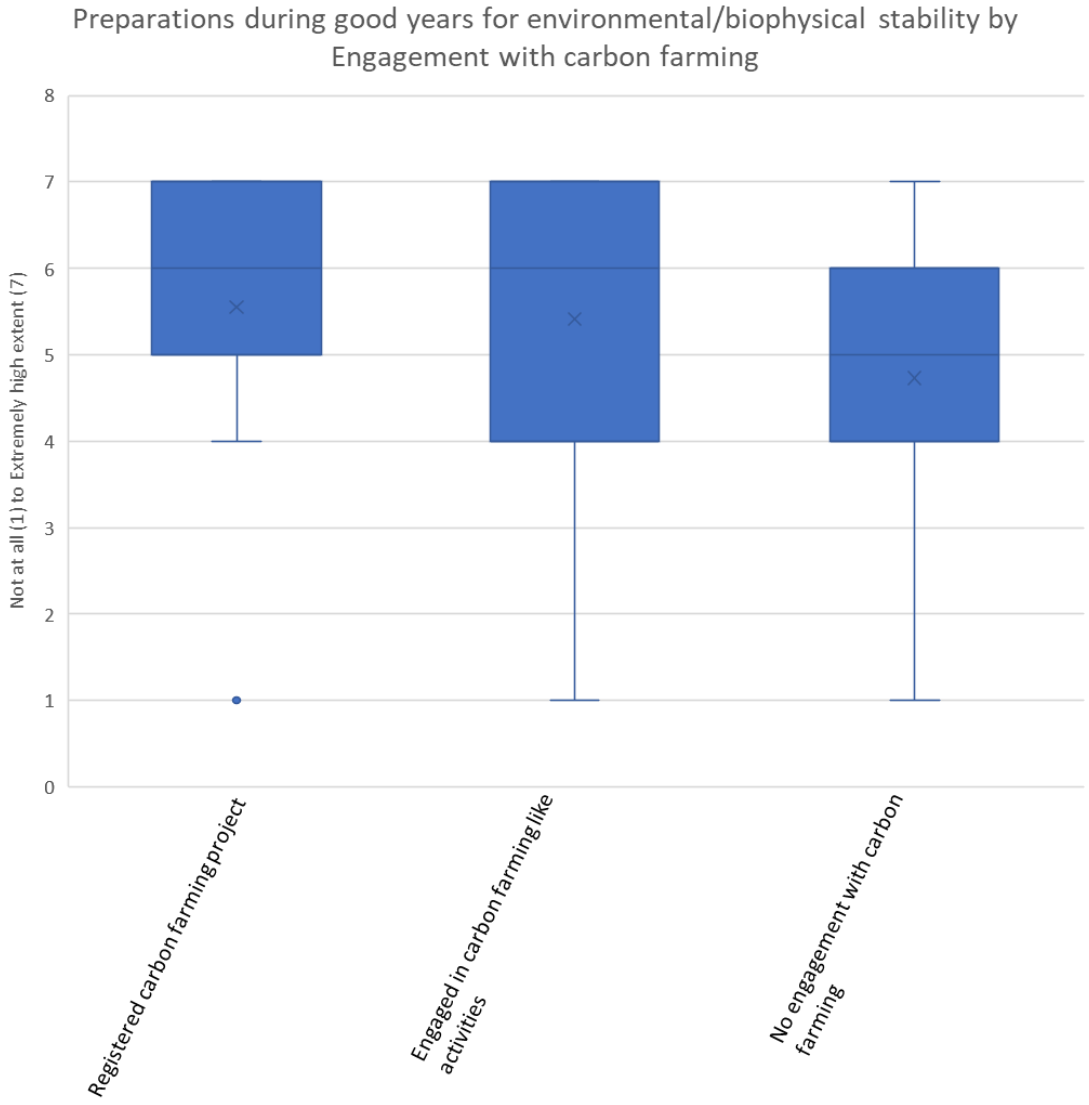

Figure 16 Preparation through environmental stability by engagement with carbon farming

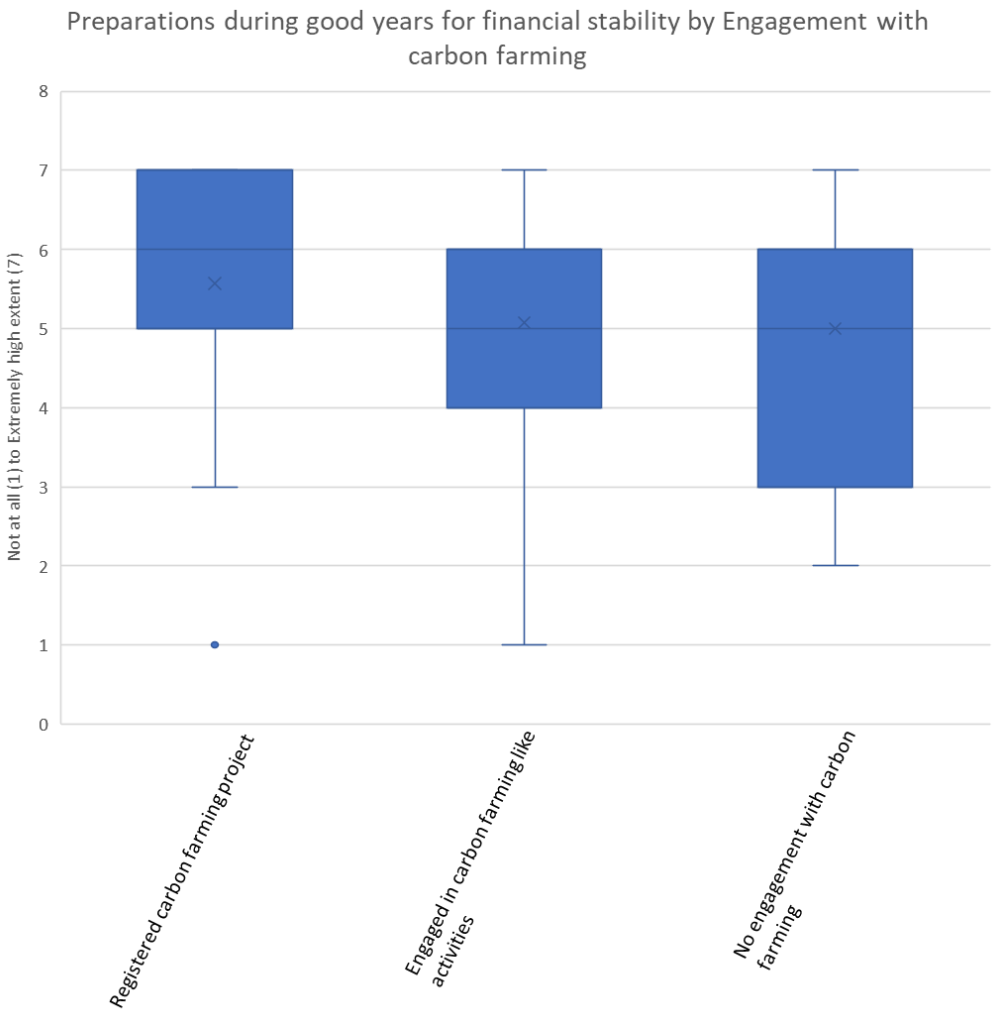

Figure 17 Preparation through financial stability by engagement with carbon farming

5.5. Short answer questions

Qualitative data was collected to obtain insights into the impact of carbon farming on the farm in relation to the benefits and disbenefits, and how carbon farming helped with drought preparation. Qualitative questions were asked in relation to (1) how carbon farming revenue was used to assist preparation and recovery from drought, and during drought, (2) unexpected benefits from a registered carbon farming project, (3) unexpected benefits from carbon farming-like activities, and (4) actions taken to help prepare for drought.

The analysis of this section involved conducting a thematic analysis of the responses to identify common themes on the experience of carbon farming. Thematic analysis was most appropriate in this context, as it can provide an overview of general themes that existed within the short answer responses and is suitable for small datasets. The responses were short, often

less than 10 words, for which thematic analysis allows a formulation of a concise theme that can contribute to the overall story. These insights here are helping to formulate the story of those engaged in carbon farming and provide more detailed support for the quantitative analysis above.

5.5.1. Actions taken to manage drought response

All respondents were asked about actions they took to manage their drought response. This was asked across the three groups; RCFP, CFLA and NICF. A full list of responses can be found in Appendix 6 - Table 44.

The most common response was destocking and increasing feed reserves. The RCFP group recorded that the income from carbon farming was used to help *"reduce [stock] numbers"*, *"purchase additional land"* and *"put money in reserve to prepare for another dry period"*. Supporting that the income used for drought preparation activities helped to make quicker changes and early changes to prepare for drought. Similarly, farmers in the CFLA and NICF groups recorded de-stocking and ensuring water entitlements or reserves as actions for drought preparation.

5.5.2. Unexpected Benefits of carbon farming

The survey includes a short answer question on the most unexpected benefits that farmers received from the carbon farming project and carbon farming-like activities. A full list of the responses to these questions are contained in Table 40, within the Appendix. Some examples of responses are included in Table 36.

The answers between the two groups (RCFP vs. CFLA). There were five main themes for those with a RCFP; (1) productivity, (2) drought recovery, (3) biodiversity, (4) financial benefits, and (5) people. *Productivity* is defined as any improvements in soil, water retention, capacity to adjust stock levels. *Drought recovery* any discussion of recovery of improved regrowth of feed or ground cover. *Biodiversity* is identified as any discussion of increased natural habitats, increased wildlife, or increase in worms and insects. *Financial benefits* are defined as the effects on revenue and income potential. *People* is defined as the creation of new networks or growth of existing networks.

There were six main themes for those engaged in CFLA; (1) soil health, (2) pest management, (3) drought recovery, (4) biodiversity, (5) financial benefits, and (6) people. *Soil*

health is identified by any discussion of improved water retention, reduced erosion, or direct discussion of improved soil health. *Pest management* was identified by any mention of reduction in pests, improved pest control or reduction of parasites. All other definitions are the same as above.

Table 35 outlines the frequency of these themes within the responses. For those in a RCFP the financial benefits were the strongest, followed by improvements in drought recovery. For those engaged in CFLA, the common theme was drought recovery and improvements in biodiversity. The different themes reflect the differing experiences of the two groups in terms of the carbon farming activities. Those in CFLA appear to be more reflective on the environmental benefits of carbon farming, and improving their capacity to recover from drought. While those who are receiving carbon farming income noted the strongest benefit being the increasing income from the carbon farming project, e.g., *the extra income gives stability* and *increase in ACCU price*.

The benefit of carbon farming in terms of drought recovery needs to highlighted. It was a common theme across both groups and supports that carbon farming activities can provide co-benefits in terms of improved drought recovery. Common suggests were the faster regrowth of ground cover when compared to their neighbours. This suggests that drought resilience has been improved through biophysical features enhanced through the carbon farming activities, which contribute to drought recovery.

Table 35 Frequency of themes for benefits of carbon farming responses

Registered carbon farming project	Productivity	Drought recovery	Biodiversity	Finance	People / psychological	
	3	5	2	9	3	
Engaged in Carbon farming like activities	Pest management	Drought recovery	Biodiversity	Finance	People / psychological	Soil Health
	3	7	6	2	5	8
Total of cross over themes	Pest management	Drought recovery	Biodiversity	Finance	People / psychological	
	3	12	8	11	8	

The distinction between those with a carbon farming project and those utilising carbon farming-like activities was the shift in focus from financial and business benefits to environmental and psychological benefits. Those engaged with carbon farming-like activities indicates they had improved recovery from drought, as rainfall yielded faster growth.

Psychological benefits of making improvements to the property were also identified, through seeing property improvements and livestock doing better.

Table 36 Responses on benefits of carbon farming

Registered carbon farming project	Carbon farming-like activities
We have definitely noticed a big increase in ground cover after the implementation of the carbon project. This has allowed for better moisture holding ability in the soil. We have also noticed greater biodiversity, especially when the drought broke. Much more active bird life has been a pleasant result.	Knee high grass in 3 weeks after drought breaking rain. Recovered so quickly. Water runs clear 3 days after rain, seeps out of our hills
Reduction of economic pressure on the business and owners' ability to stock more lightly, and thus allow quicker recovery	Excellent drought recovery
The extra income gives stability and lessens the financial pressure	Psychological benefits of doing something great for our farm, soils and livestock
Immediate productivity benefits and ecosystem resilience	String of many indigenous plant species has led to increase plant biodiversity and it seems increase in bird diversity.
Meeting new people	Drought recovery was exceptional after drought broke- from 20% CC [Carrying Capacity] without feeding to 80% CC and fattening stock for sale in 11 weeks. Recovery was much better than expected
You look at the land differently and are incentivized to do more regenerative work on the property, plus you now have the capacity to spend money on rehydration projects	Change is species in the pasture with increased diversity. Significant decrease in on farm wind speed. Soil harvesting during dust storms from neighbors drifting farms. Increase bird life and diversity. Decreased pest animals (mice) from increase predation

5.5.3. Carbon revenue use for drought resilience

This question was only shown to farmers who had a RCFP. Respondents were asked to identify how carbon farming revenue has helped them to prepare, respond and recover from drought. Response fell into four themes; (1) funding improvements, (2) financial relief, (3) planning, and (4) farm activities. Table 41 in the appendix includes all the responses to this question.

Funding improvements were identified in any discussion that discussed improvements on the property, e.g., increasing water storage. *Financial relief* was identified after any mentions of base income, relief from debt, and reduced financial pressure. *Planning* was identified through discussion of future proofing the property, such as succession planning, new investments (other than infrastructure improvements). *Farm activities* was the discussion of their capacity to maintain farm activities and adjust in response to drought. A breakdown of these responses is contained in Table 37.

Table 37 Themes for use of carbon farming income for drought resilience

Funding improvements	Financial relief	Planning	Farm activities
6	7	5	4

Carbon farmers were mostly recorded stating that carbon farming income provided financial relief and capacity to make improvements to the property. The income also supported planning during drought and maintain general farm activities. These activities could include succession planning, not destocking fully and purchase feed and improve cattle performance. Some examples are provided in Figure 18. These benefits help the farm to maintain its capacity to operate during drought with a base level of income, whilst also making improvements to help them get through dry seasons.

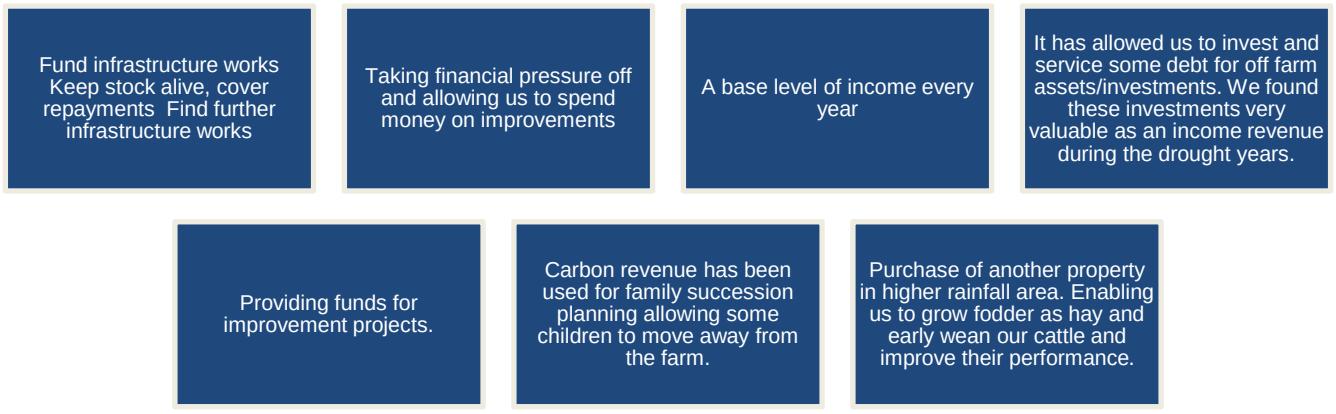

Figure 18 Use of revenue from carbon farming to improve drought preparation

5.5.4. Potential use of carbon revenue

Farmers that were engaged in CFLA were asked if they were in receipt of $50,000 from carbon revenue, how would they use these funds? A full list of responses is contained in Appendix 3, Table 42.

Common responses were improvements in water infrastructure, tree planting and improving farm infrastructure. This provides evidence that the use of carbon farming revenue by Australian farms goes back into the property to assist in the main form of agricultural production.

5.5.5. Interest in registering for a carbon farming project

Those who were not engaged in carbon farming or CFLA were asked if they had heard of carbon farming and what were their barriers to entry. 79.3% of respondents had heard of carbon farming and of that 73.7% (14 of 29), would consider engaging in a carbon farming project. Some barriers to entry included (1) ongoing administrative costs, (2) uncertainty of the carbon market, (3) land size required, and (4) lack of education or training. A full list of responses is included in Appendix 4, Table 43.

6. Results

The results of this study support that carbon farming can increase drought resilience through bio-physical and financial benefits. The nature of the drought resilience benefit appears to differ between carbon farming activity type, with HIR predominantly providing financial benefits, while soil activities provide environmental benefits. Other influencing factors include the number of carbon farming methods employed on the farm and the length of the carbon farming project. It is important to note that causation was not measured in this study and that some of these characteristics may be endemic to farmers with a proclivity towards carbon farming and alternative regeneration methods than traditional farming methods. However, certain relationships were present and supported by short answer responses from participants.

Farmers are interested in maintaining their property for the purpose of agricultural production, while carbon farming is being used as additional income and for the bio-physical benefits. This is particularly evident with respondents stating that carbon farming allowed them to maintain a base level of income and meet their financial needs during drought. In addition, many engaged in CFLA reported that pest management was improved through the use of carbon farming. This helps provide context for the cross over between environmental and financial benefits of carbon farming, with the potential of reduced spending on other risk factors.

Respondents reported that carbon farming does help with drought mitigation, from both a financial and environmental perspective. The majority (65%) of those engaged in a carbon farming project and carbon farming-like activities confirmed they would recommend carbon farming as a drought mitigation tool. The farmers that employed more than one carbon farming method also recorded a higher recommendation score for carbon farming as a drought mitigation tool. Further supported by short answer responses that carbon farming income was used to cover costs, such as addition stock feed, during drought. In addition, the income from the carbon farming project provided them with confidence to reduce their stock early in the drought, improving their overall outcomes.

Respondents indicated that carbon farming does assist them through preparation, experience and recovery from drought. Those engaged in CFLA reported stronger benefits in preparing for drought in environmental benefits, particularly those in soil management (mean=5.44) and HIR (mean=5.73). A similar trend was seen with RCFP, with soil management (mean=5.75) and HIR (mean=4.91) experiencing stronger environmental benefits in preparation for drought. When considering the experience during drought, many agreed that the

environmental benefits are worth it even without carbon farming revenue (mean= 5.68). This was a particularly strong sentiment from those engaged in soil management (RCFP mean=5, CFLA mean=5.73), which the other two groups saw a much lower sentiment. The HIR and soil groups with RCFP both had a strong sentiment towards the environmental benefits decreasing the farm costs during drought through its environmental impact (HIR mean=4.08, soil mean=4.25). Farmers with a RCFP recorded stronger financial and business performance benefits from carbon farming. The strongest business performance benefit was improved business stability during drought thanks to the carbon farming income (mean=5). While financially it has helped maintain cash flow, meet loan repayments, and ease financial demands. This is particularly strong for those in soil management and HIR.

Respondents recorded that carbon farming did improve their overall performance during drought. The financial, business performance and environmental benefits demonstrate that carbon farming provides benefits beyond just additional income, but presents opportunities for infrastructure improvements, faster responses to dry conditions and bio-physical improvements. During drought the farms had less ground cover and natural feed for stock, this is particularly difficult in areas that are more prone to climatic variations, such as the Far West and Orana region of NSW. Most farmers with RCFP were located in these high-risk areas, which recorded lower vulnerability compared to NICF groups within the same region. This further supports that greater drought resilience coming from carbon farming.

Farms that had multiple carbon farming-like activities, for example, running soil management, HIR and environmental planting projects at once, generally reported stronger environmental benefits relating to drought, than those that just had one project. The implication here is that an integrated farm method with multiple carbon farming methods creates better environmental benefits for carbon farming.

Farmers that had a registered carbon farming project generally reported higher levels of control and capacity to manage drought risks than those without a registered project. Those with a CF project and CFLA also reported higher results overall than those without engagement in any carbon farming activities. This would need to be investigated further and in a larger sample size to test these relationships further. These results do indicate that drought resilience is higher for those with a carbon farming project, this is likely as a result of the financial benefits they are receiving from their project.

Those engaged in CFLA also recorded higher levels of drought resilience. There were consistent results in drought resilience to support that this could be due to the increased number

of carbon farming projects that this group are running. Generally, what was found was that the more methods a farmer was employing the stronger their drought resilience. This is supported further by the short answer questions indicating faster regrowth of pastures after rain, compared to previous dry seasons and neighbouring properties.

7. Implications

A number of factors appeared to impact the drought resilience of farmers, when comparing the experience of those with a carbon farming project and those without a carbon farming project. The factors that will be discussed here are listed below;

- Financial benefits of carbon farming on drought resilience, including early receipt of carbon farming revenue, and reinvestment back in the farm;
- Environmental benefits of carbon farming on drought resilience, including benefits by method type;
- The value added by multiple carbon farming activities on one farm.

Farms that had a registered carbon farming project saw improved outcomes during drought, particularly if they received funding before or during the drought. They were able to make improvements to prepare for drought before it started, including improved water storage. Water storage and access was one areas of vulnerability that those with a carbon farming project recorded lower than those engaged in carbon farming-like activities or with no engagement in carbon farming. All of those that received carbon farming revenue, reinvested that money back in the farm, or used the money to buy another farm. Three quarters of CF respondents indicated that the carbon farming revenue helps them to meet their loan repayments during drought. This finding does not support some criticisms of carbon farming, for example that it has negative impacts on agricultural production or leads to rural depopulation.[7]

At the time of writing, the Australian Government is reviewing its national drought plan. It is recommended that the Australian Government drought plan recognize that the carbon farming framework provides a cost-effective way to deliver long term drought resilience in the agriculture sector.

Across the board, the environmental benefits of carbon farming can be seen through improvements in soil health, improved pest management and increasing farm bio-diversity. Farmers also report faster regrowth of ground cover after drought breaking rains and improved performance of their property over their neighbours. These benefits are experienced before, during and after drought, assisting in all areas of change for the farm. During drought farmers reported that the environmental benefits did improve the financial performance of the farm, with

[7] For example: https://www.abc.net.au/news/rural/2021-04-10/rural-community-fights-against-corporate-carbon-farning/100048920

this being further supported by financial benefits of carbon farming, even when carbon farming revenue had not been received. These also improved the drought preparation and recovery on farms, with environmental benefits being the strongest of the three benefits (environmental, business and financial) in terms of drought recovery for those engaged in CFLA.

Carbon farming does improve drought resilience, with an increase in locus of control and self-efficacy, and a lower level of vulnerability. The three main carbon farming methods from this study were avoiding deforestation (n=21), soil management (n=50) and HIR (n=37). There were no significant differences between these groups, however, soil management did generally have higher scores across the three categories; business performance, financial and environmental.

The variation that exists between farmers with more than one carbon farming method supports the use of stacking carbon farming methods to form one project. This approach is more accessible for farmers wanting to engage in the carbon farming space and has greater drought resilience benefits when compared to those with only one method of carbon farming. The current approach to design of carbon farming methods should be expanded, extending the breadth of carbon farming projects to include new participants and more regions. It is understood that this activity is already occurring, via the Integrated Farm Management Method, which is under development by the Clean Energy Regulator at the time of writing.

It is likely that those engaged in carbon farming-like activities and can have multiple methods of carbon farming will experience greater drought resilience. This is likely due to the environmental benefits that they received from the methods employed. These methods were described as improving the regrowth of ground cover after rain. This could be having an impact of reducing the spend on feed for farmers and reducing some costs of drought, which is supported by the financial benefit recorded by those engaged in carbon farming-like activities.

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Appendices

1. Vulnerability by SA4 Regions

Table 38 SA4 region by engagement with carbon farming by vulnerability

		The region in which we operate	Financial and Business vulnerability	Property infrastructure	Property soil health	Property pasture quality and quantity	Properties water supply	Livestock and Crops
Coffs Harbour - Grafton	Registered carbon farming project	4	3	3	3	5	2	3.5
	Engaging in carbon farming activities	4.5	5	1	5	7	5.5	7
	No engagement with carbon farming-like activities	.	.	.	.	.	.	.
Far West and Orana	Registered carbon farming project	6	4.6	2.5	5	6	3.6	5.75
	Engaging in carbon farming activities	6.67	5.33	1.67	5	5.67	3	5
	No engagement with carbon farming-like activities	7	5	1	3	2	2	4
New England and North West	Registered carbon farming project	7	4	1	3	3	1	7
	Engaging in carbon farming activities	5.33	3	2.33	4.33	5	4.67	4.83
	No engagement with carbon farming-like activities	5.75	4.5	4.25	5.5	5.5	5.5	5
Bendigo	Registered carbon farming project	7	7	2	7	7	5	7

	Engaging in carbon farming activities	6	7	5	4	3	6	5.5
	No engagement with carbon farming-like activities	.	.	.	.	.	.	.
Warrnambool and South West	Registered carbon farming project	5	4	4	5	6	6	5
	Engaging in carbon farming activities	5.5	4.5	2	3.5	4	6	4.5
	No engagement with carbon farming-like activities	1.67	3.67	3.33	3	5	3.33	4.5
Queensland - Outback	Registered carbon farming project	5.8	6.14	3.29	5.14	6	2.5	6.33
	Engaging in carbon farming activities	.	.	.	.	.	.	.
	No engagement with carbon farming-like activities	.	.	.	.	.	.	.

		Financial /Business vulnerability	Property infrastructure	Property soil health	Property pasture quality and quantity	Properties water supply	The region in which we operate	Livestock/crop is vulnerable
		Mean	Mean	Mean	Mean	Mean	Mean	Mean
Central West	Soil management	4	2	3	4	6	6	1
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
Coffs Harbour - Grafton	Soil management	4	2	4	6	4	5	5
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	5	1	5	7	6	5	7
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	5	1	4	7	6	5	7
Far West and Orana	Soil management	5	2	5	6	3	7	5
	Avoid deforestation	5	2	5	5	3	7	5
	Human induced regeneration	4	2	5	6	4	6	5
	Plantation Forestry	-	-	-	-	-	-	-

	Savanna fire management							
	Environmental plantings	3	2	4	4	3	6	4
	Other	6	2	6	6	3	7	6
Mid-North Coast	Soil management	2	2	4	5	6	3	6
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
New England and North West	Soil management	3	2	4	5	5	5	5
	Avoid deforestation	1	1	4	6	7	4	4
	Human induced regeneration	1	1	4	6	7	4	4
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	3	5	5	4	6	5
	Other	3	2	4	5	4	6	5
Riverina	Soil management	6	3			7	7	

	Avoid deforestation	6	3			7	7	
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	6	4	4	6	6	6	6
	Other	-	-	-	-	-	-	-
Bendigo	Soil management	7	4	6	5	6	7	6
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	7	2	7	7	5	7	7
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	5	4	3	3	5	5	4
Geelong	Soil management	-	-	-	-	-	-	-
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-

	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	1	4	6		4	6
	Other	-	-	-	-	-	-	-
Hume	Soil management	3	2	4	4	2	3	5
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	3	2	4	4	2	3	5
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	3	2	4	4	2	3	5
	Other	3	2	4	4	2	3	5
Melbourne - North East	Soil management	4	3	4	7	6	5	7
	Avoid deforestation	4	3	4	7	6	5	7
	Human induced regeneration	4	3	4	7	6	5	7
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
North West	Soil management	4	4	4	6	4	6	4

	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	4	4	6	4	6	4
	Other	-	-	-	-	-	-	-
Shepparton	Soil management	5	3	6	5	5	5	5
	Avoid deforestation	6	2	6	6	6	5	6
	Human induced regeneration	6	5	6	6	7	6	6
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	5	4	5	5	5	5	5
	Other	-	-	-	-	-	-	-
Warrnambool and South West	Soil management	5	3	4	5	6	6	5
	Avoid deforestation	5	2	3	3	5	6	5
	Human induced regeneration	5	2	4	4	6	6	5
	Plantation Forestry	5	2	4	4	6	6	5

	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	5	2	4	4	6	6	5
	Other	5	2	3	3	5	6	5
Darling Downs - Maranoa	Soil management	5	1	3	5	6	6	
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	5	1	3	5	6	6	
Queensland - Outback	Soil management	7	7	4				
	Avoid deforestation	7	5	4	2	2	5	7
	Human induced regeneration	6	3	6	7	3	6	6
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	7	7	4	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-
Wide Bay	Soil management	3	2	4	4	3	6	4

	Avoid deforestation	1	1	2	2	4	6	2
	Human induced regeneration	3	2	4	4	3	6	4
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	4	3	6	5	1	6	6
	Other	1	1	2	2	4	6	2
South Australia - South East	Soil management	3	4	4	5	4	5	4
	Avoid deforestation	3	4	4	5	3	5	4
	Human induced regeneration	3	4	4	5	3	5	4
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	3	4	3	3	4	3	3
	Environmental plantings	4	4	5	6	4	6	5
	Other	-	-	-	-	-	-	-
Western Australia - Wheat Belt	Soil management	3	3	6	-	-	-	6
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	-	-	-	-	-	-	-
	Plantation Forestry	3	3	6	-	-	-	6

	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	3	3	6	-	-	-	6
	Other	-	-	-	-	-	-	-
Western Australia – Outback (South)	Soil management	-	-	-	-	-	-	-
	Avoid deforestation	-	-	-	-	-	-	-
	Human induced regeneration	3	2	5	7	6	3	7
	Plantation Forestry	-	-	-	-	-	-	-
	Savanna fire management	-	-	-	-	-	-	-
	Environmental plantings	-	-	-	-	-	-	-
	Other	-	-	-	-	-	-	-

Table 39 SA4 regions by carbon farming activity by vulnerability

2. Benefits of carbon farming or carbon farming-like activities

Table 40 Breakdown of statements on the most unexpected benefits of carbon farming or carbon farming-like activities

What are the most unexpected benefits of the carbon farming project or carrying out carbon farming-like activities?			
Registered carbon farming project	Because of our carbon farming management program, the carbon and stock feed bank comes back 10 fold when it does rain.	**Engaging in carbon farming activities**	. Extent of reduction in animal parasite control . Extent of increase in carrying capacity / recovery from dry times
	Being able to sell stock when I want to not when l have too		All the benefits we have experience have been expected
	Government actions to enhance carbon prices.		Better water use

	Immediate productivity benefits and ecosystem resilience	Change is species in the pasture with increased diversity. Significant decrease in on farm wind speed. Soil harvesting during dust storms from neighbors drifting farms. Increase bird life and diversity. Decreased pest animals (mice) from increase predation.
	increase in the ACCU price	Diversity of plant life re-emerging
	Increased biodiversity.	Dormant pasture species we hadn't seen, coming back years after they were planted. Worms now present in each soil sample. Increased insect and spider evidence
	meeting new people	Drought recovery was exceptional after drought broke- from 20% CC without feeding to 80% CC and fattening stock for sale in 11 weeks. Recovery was much better than expected.
	recovery of pastures, trees due to reduced stocking	Excellent drought recovery
	Reduction of economic pressure on the business and owners Ability to stock more lightly, and thus allow quicker recovery	Growing season becomes longer
	Some income on matter what the seasonal conditions are like.	Haven’t been doing it long enough yet.
	The extra income gives stability and lessens the financial pressure.	Healthy long lasting pastures, reduced soil erosion
	We have definitely noticed a big increase in ground cover after the implementation of the carbon project. This has allowed for better moisture holding ability in the soil. We	Important to protect soils and pastures during drought to help with a quick recovery

	have also noticed greater biodiversity, especially when the drought broke. Much more active bird life has been a pleasant result.	
	We have just registered and haven't had any benefits as yet	increased biodiversity
	You look at the land differently and are incentivized to do more regenerative work on the property, plus you now have the capacity to spend money on rehydration projects	Increased bird, frog and other species diversity.
		Increased wildlife habitat for pollinators etc
		Knee high grass in 3 weeks after drought breaking rain. Recovered so quickly. Water runs clear 3 days after rain, seeps out of our hills
		no real suprises
		Not unexpected, but value if stick shelter in hot weather, and shelter in wi day and wet conditions
		Parasite reduction due to habitat improvement of predators
		Pleasure in working in shaded tree lined paddocks & alleys
		Psychological benefits of doing something great for our farm, soils and livestock
		reduction in the cost of production improved mental health less stress
		Shade, wind protection, privacy and aesthetics
		Still had green grass when all our neighbours didn't
		Strung of many indigenous plant species has lead to increase plant biodiversity and its seems increase in bird diversity.

	Water retention
	we try to keep pasture coverage over the soil. we are not in a carbon farming project.

3. Use of carbon farming revenue

Table 41 Responses to the use of carbon farming revenue

A base level of income every year
Allowed us to maintain existing infrastructure, plan and implement new infrastructure and gave us financial security to meet our commitments.
Carbon revenue has been used for family succession planning allowing some children to move away from the farm.
Cash Flow Meeting overheads
Fund infrastructure works Keep stock alive, cover repayments Find further infrastructure works
I was able to afford costs of desilting ground tanks and purchase feed to retain my flock without complete destocking
It has allowed us to invest and service some debt for off farm assets/investments. We found these investments very valuable as an income revenue during the drought years.
Just provided stable cash flow
Providing funds for improvement projects.
Purchase of another property in higher rainfall area. Enabling us to grow fodder as hay and early wean our cattle and improve their performance.
Revenue wasn't achieved until post drought
Taking financial pressure off and allowing us to spend money on improvements

4. Potential use of carbon farming revenue

Table 42 Potential use of carbon farming revenue

If you could receive carbon farming revenue, how would this income be spent or invested? e.g. if you received $50,000 in carbon revenue.	
. Paying fixed costs (rates, insurances) . Further pastures improvement . Machinery and ameliorate (like / calciprill) updating	Investing in establishment of more sandalwood plantations for long term benefits and value to the land price
1. Soil tests and Remineralise soils Pat Coleby style 2. Major tree planting across the whole farm for shelter belts and wildlife habitat 2. Water infrastructure project to whole farm to keep cattle out of dams and creeks to improving livestock health, riparian health and farm 3. Make and spread compost over whole farm 4. Inoculate whole farm with johnsone-su fungal brew 5. Learn bio-dynamics and spray farm accordingly. 6. Buy truck loads of seaweed to feed to the cattle instead of current mineral lick we use.	investment in more sustainable practices
Building more carbon levels	Just make farm more profitable
Buy more land to revegetate for seed, food and timber production - which is what we have done with previous grants.	Machinery to focus on soil, exclusion fencing & smaller paddocks
By wise investing for the future- water infrastructure, appropriate tree planting/regeneration or investment in family issues, holiday, new car, assisting next generation.	More trees, pasture improvements
Cash flow	not sure reinvest in new farming opportunities
Fencing & livestock, fences grow grass and livestock sequests more carbon in the soil	pay off debt

Fencing projects	pay off loan
go towards farm costs	Possibly invest further into this field.
Improve water infrastructure, fencing, increase herd size	Property improvement and purchasing of additional property
Improved equipment for enhancing carbon farming (compost turners, better direct drill for multi species cover cropping)	Property improvements
Improvements to water infrastructure ie dams and water catchment. Also debt recovery	Re investing in farm, take a holiday or buy a new car
improving farm infrastructure, solar power	Reinvest back in to property and water infrastructure to improve drought resilience
increased depth of dams	Reinvest in a direct drill to seed multi species cover crops
Invested	Some into debt reduction, some to superannuation, some to landscape rehydration.

Invested into pasture improvement for greater carbon sequestration and soil health	

5. Interest in registering for a carbon farming project

Table 43 Interest in carbon farming projects and barriers to entry

Would you consider a carbon farming project on your farm? And what would be barriers to this? Carbon farming activities can include tree planting for shelter belts, regeneration of native forest, and using livestock or cropping to improve soil carbon.	
barrier would be lack of size of possible reveg area to achieve a carbon project	Native afforestation
Soil & Trees	The cost of benchmarking and the inability to meaningfully change the carbon level in soils in hot, dry conditions of the Central West. The information isn't very clear about what options are available. A lot farmers have already been doing many of the activities suggested above for good soil health and are aware of benefit of carbon in soil.
Yes Already tree planting and applying carbon rich fertilisers	Yes not sure of barriers, cost of implementation?
Yes, but would like to see a lot more information regarding the outcomes.	Yes. Maintenance of existing native stringy bark scrub should be included, not just establishment. It is very easy to destroy it by simply stocking it. There should be carbon incentives to maintain it, to encourage its survival. Planting trees can be a furphy. The quickest way to regenerate here is to simply fence existing stands of red gums off from the paddock and allow abundant seedlings to grow.
Have considered, but a this point in time, it seems very costly and difficult to decipher all the information out there as to how to do it. Where to start and how to keep moving forward.	Lots of science from years of research indicates soil carbon is a slow steady process in dryland regions of Australia. The focus in our business is on soil organic matter & the productivity it can help us achieve with sustainability, WUE & profit targets. Happy to stay out of soil carbon schemes given the volatile nature of the climate and uncertainty around carbon trading we will watch with interest.

Would be interested	Would consider but have only a small area.
Yes I would but the initial paperwork and cost up front for tests is a major stumbling block . I have a passion for biochar which doesn't seem to count in the system	yes using livestock to improve soil carbon. Lack of courses or easily accessible information in my region
Yes. Property too small and low rainfall.	Yes. A barrier would be the expense of baselining over 26,000 hectares.
Yes. But it is all too difficult at the moment & when price increases definately interested.	Probably not
Yes, barriers would be required labour and investment, expected return on investment, impact on our current farming program and if these are worth the return on investment	Yes

6. Actions taken to respond to drought

Table 44 Short answer responses to actions taken to respond to drought

Registered carbon farming project	
RCFP	Reduced stocking cattle De stocked sheep Fodder harvesting Supplementary feeding Increase water infrastructure Under took earlier weaning program Transferee young stick to agistment
RCFP	Destocking leading up to or after the first year of drought. Restructure debt to reduce outgoings
RCFP	Building rehydration projects like ponding banks and whoa boys Off station income HIR Carbon Project allows us to reduce numbers and manage drought Purchased land in reliable rainfall area to offload cattle
RCFP	Destocked, internal ringlock fencing to preserve what little pastures we had. Our carbon farming payments subside our income due to decrease in stock production as well as enabled us to put money in reserve to prepare for another dry period.
RCFP	Restocking all weaner cattle Buying hay Installing waterpoints
RCFP	Destocking, Increase cash reserves (FMD), Conservative stocking numbers,
RCFP	Reduced stocking Move stock onto mulga Reduce overheads and expenditure Fodder harvesting Wean early

RCFP	We both destocked and transferred stock between several properties. We also made hay on another property and purchased hay to keep breeding stock alive. We also bought forward weaning calves at a younger age and generally sold stock at a younger age than usual.
RCFP	Destock, and purchase hay
RCFP	Destocking leading up to or after the first year of drought
RCFP	Destocking, commenced fencing program, started program improving water storage.
RCFP	not affected by drought in our area have a lot of hay and silage in storage
RCFP	Graze planning and forecasting using Maia Grazing Informed timely destocking decisions Which informed our written drought plan
RCFP	Removal of livestock to other properties not drought affected
RCFP	We have a mulga property which we move our cows to and are able to feed them very economically so that when the drought breaks we are able to move back to full production quite quickly. Sale cattle numbers may be brought forward to reduce stocking pressure on grower country.
RCFP	Strategic rotational grazing, resting pastures Adjusting stock numbers start of Autumn to match feed supply from summer rains Early weaning to maintain breeding cow condition Supplementary feeding (urea supplement cotton seed and hay
RCFP	Desilting ground tanks. And purchasing hay
RCFP	Destocking 66% of livestock sold in early 2018 which reduced the amount of feed and water required to keep the remaining stock adequately fed and watered. Income received from our Carbon project was used to purchase stock feed and to pay on - going business and household expenses.
Carbon farming like activities	
CFLA	Reduced stock levels continually as drought encroached Fodder reserves for 18 months, drought went longer Had reasonable equity in property
CFLA	Destocked with Nil feeding when feed became low
CFLA	*Rotational planned grazing to reduce stock impact on ground cover *manage rotation to avoid poor quality dam water *purchasing silage prior to need *no farm capital expenditure *sell weaners and take a low price as we couldn't feed them * wean early to allow cows recovery as on poorer pasture
CFLA	Destocking early, increase cash reserve.
CFLA	Extended water system with 2km pipe to troughs to better utilise remaining pasture, carted water to header tank to feed trough system when dams dried, keyline ploughed the contour on slopes to help minimise erosion when the rain did arrive, prepared for fire as best as possible to try and save remaining pasture ground cover

CFLA	smaller paddocks for longer recovery periods - diversified income stream- farm store, value added offtakes, cafe - NSF contouring (plantings begun) - improved water systems solar pumps, pipe to more paddocks. - soil amendments like Biochar & Paloganite fed through lick. - cover cropping in less productive areas for better utilisation - soil health focus
CFLA	Match stocking rate to carrying capacity Rotational grazing Leaky weirs
CFLA	Destocking leading up to drought to 20% normal- this allowed excellent recovery and back to 80% SR in 11 weeks from drought breaking, with feed to spare. Quickly fattened livestock for sale so improved cash flow. Planting trees for shelter belts Generally proactive management principles- not reactive. This gave a profit for 2019/20 for lessee and lessor- equated to 3-4% return on capital (land and working) for whole farm.
CFLA	building sacrifice paddock increase cash reserve for increased feed and water costs trying to build a feed wedge after the rain does come prepare for post drought problems such as dystocia
CFLA	Matching stocking rate to available feed ensuring ground cover is maintained Grazing management to ensure a drought reserve of feed.
CFLA	Destocking Heavy mulching of horticulture crop
CFLA	Off farm income to provide drought security. Diversification of places to harvest native seed. Increased planting of native vegetation to cover the whole property. Increasing diversity of plantings and adding in Quandong and Sandalwood to diversify future income.Focus on increasing soil carbon levels over time.
CFLA	De stocked cattle numbers and fenced off some areas of the property
CFLA	Early destocking Match sr to cc Long term shelter plantings Proactive management across financial, operational and environmental issues
CFLA	#Purchase fodder before drought, #Stock containment areas built prior. # subscribed to long range weather forecaster twenty years ago. To have knowledge of what weather was coming. # Didn't join ewes that year.
CFLA	1. Confinement feeding 2. Destocking to core breeding stock 3. Fill hay shed 4. Fill silos with grain
CFLA	Matching stocking rate to feed supply, both quality and quantity. Gradual destocking.
CFLA	Destocking early - before everyone else, as our stocking rate is measured as % of rolling ave rainfall. NO HAY FEEDING.
CFLA	Destocking leading up to or after the first year of drought Off farm investments for cashflow management
CFLA	Purchased grAin Destocking Maintaining ground cover Built drought lot
CFLA	Destock, containment feed breeders
CFLA	Tree planting, drought reserve, housed our cows to ensure better utilization of fodder.
CFLA	* Destocking in first year of drought

CFLA	Tree planting, water security, pasture management, stock rotation, manage stock numbers in non drought periods to ensure constant and good quality ground cover
CFLA	* slight adjustment to stock numbers * Regenerative Agriculture Farming is helping us to be more drought resilient * Fodder storage and conservation * Off farm income and cash reserves
CFLA	Destocking Weaning early to reduce feed demands of pregnant cows Purchase of hay (before and during drought at high cost). Enhancing water infrastructure to ensure trough system to most paddocks. Supplementary feeding of stock in 'sacrificial paddocks' which were marked for pasture renovation post drought. Saving fenced off tree lines for feed - until times of desperation - which occurred.
CFLA	Extensive planting of trees for shelter belts and fodder has protected the soil & crops from erosion, provided a cooler environment & shelter for stock as well as food for stock.
CFLA	Destocking prior to removing all ground cover
CFLA	hay and silage stored for summer feeding - have many areas of farm fenced off for plantations and emergency food reserves for stock - have large dam as back up water supply if bore fails
CFLA	destocking - planting tree belts - planting saltbush stands - purchasing water tanks
CFLA	Destocking Use of drought-lots to protect paddocks Realigning fences to protect fragile soils Redraw FMD's to buy feed and pay bills
CFLA	. Strict rotational grazing . Alternative income sources . Augmenting alternative water supplies (bore to troughs) . Destocking ….. . Native and improved pastures
CFLA	Notill keeping stubble
CFLA	Stock containment areas and surplus fodder supplies if possible
CFLA	don't manage specifically for drought manage farm to minimise all risks including drought/dry times in accordance with the processes that we have. i.e pasture/soil management stock management water management fodder management shelter management
CFLA	Destocking trees planted reserved pastures
CFLA	destocking, though one year we purchased hay & agistment, we've planted shelter belts, have reasonable cash reserves
CFLA	destocking cell grazing planting shelter trees diversifying into deep rooted perennial tree/plant crops(vines)
CFLA	reduced stock numbers - fodder reserves - used drought lot for feeding - reduced canola area/increased cereal area
No interest in carbon farming	
NICF	Biochar as a feed additive or ad-lib feeding showed gains to soil and animal health

NICF	Staged sell off of livestock over 12 months. Feeding of some breeding stock for about 3 months.....then they too were sold.
NICF	- Matched stocking rate to carrying capacity. We use SDH/100mm to monitor our stocking rate against our benchmark carrying capacity (also in SDH/100mm). As 12 month rolling rainfall decreases, this SDH/100mm increases and we use forecasting to see when we need to reduce numbers so that we don't exceed our country's carrying capacity. MaiaGrazing software was an extremely useful tool for us to do this. - if our forecasting showed that we would be over our benchmark (overstocked) within 2 months, then we would sell off animals. This would invariably be at a better price as other livestock producers had not started to sell down yet.
NICF	Destocking Fed core herd in cooler to save vulnerable pastures & maintain ground cover.
NICF	Fortunately we're under stocked anyway , which allowed us to move cattle around to where th e feed is . Unfortunately those areas were barren for water , we had to cart water fro 5months , every day , for 1/2 day up to 20km round trip . I held onto all my cattle as I could see the writing on the wall for demand from restockers
NICF	Destocking Careful management of grass regrowth/feed available
NICF	Destocking tree planting Feed stockpiling
NICF	Ensure I have enough water allocation and entitlement to cover water budget for the year
NICF	We are new landholders that moved to our new fa during the drought. We delayed stocking the property in response to the seasonal conditions. This have our land the best opportunity to maintain ground cover but did mean stocking was different due to rapid rise in stock prices as conditions improved
NICF	cash reserves, fodder purchase, destocking
NICF	purchase hay - planting shelter belts - increased tanks and dam size - cart water
NICF	•Containment feedlot •Fencing of native hills grazing •Changed cropping rotation to aid in livestock feed extra hay •
NICF	Destocking to maintain good ground cover. Feed stock in small paddocks on maintenance rations to take pressure off pastures. Store hay/protein meals before drought.
NICF	Containment feeding, purchase additional hay, used lower quality feed such as straw, harvested crops for hay instead of grain to feed stock, extended loan with bank
NICF	Purchase and storage of hay before drought occurs Increase cash reserves to assist with financial preparation
NICF	* Additional hay production and storage before drought hits * planting trees
NICF	Destock
NICF	Destocking everything not maternal. Stockpile hay and fodder while cheap. Intensive feeding (disused feed lot) available for use in drought scenario

NICF	De-stocking, match carrying capacity to stocking rate
NICF	Destocking leading up and during drought Storing fodder prior to drought to use through drought times Using good years to increase cash reserves Use a feed lot during drought
NICF	Destocking, maintain ground cover, fencing off dams that were at a critical point or not needed for livestock use
NICF	none
NICF	Purchase of Hay and storage of Hay. More Hay/silage produced due to downgraded crops. Feedlotting livestock where possible to maximise value
NICF	Destocking sheep storage of hay & grain before drought occurs Increase cash reserves through the use of Farm Management Deposit accounts Planting trees for shelter
NICF	storage of hay and grain planting dryland pastures to utilize out of season rain and increase soil health
NICF	Destocking after first year of drought Agisted 2/3 of livestock to other areas to reduce impacts of drought on livestock & property
NICF	Full stubble retention retain groundcover Drought lot - sheep containment Sell down cull sheep Cut canola for hay or silage as a fodder reserve Barley stored in silos - 18 months reserve Reduce spending on non essential inputs
NICF	Purchase and storage of hay and ensuring dam is retaining water