Contributed paper for presentation at the 57th AARES Annual Conference, 5-8 February 2013, Sydney

Community values for the benefits of carbon farming: a choice experiment study

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Abstract: The Australian Government's Carbon Farming Initiative provides carbon credit incentives for farmers to encourage climate change mitigation on agricultural land. In addition to carbon sequestration or reduced emissions, carbon farming activities often generate ancillary benefits, such as creation of native habitat or erosion prevention. We conduct a choice experiment study to estimate community values for climate change mitigation, and the ancillary effects of carbon farming. Respondents' WTP depends on their perceptions of climate change and on age, income and political preferences. Respondents who believe in climate change are willing to pay $7.56 per 1% reduction in Australia's overall greenhouse gas emissions. Respondents are willing to pay $16.88 per 1% increase in the area of native vegetation on farmland, and $2.89 per 1% reduction in soil erosion. The value estimates will allow for more targeted development of carbon farming policies.

Keywords: Agriculture, Climate Change Mitigation, Carbon Farming, Choice Modelling.

1. BACKGROUND

The agricultural sector generated 14% of Australia's greenhouse gas emissions (GHG) in 2011 [1]. The Carbon Farming Initiative (CFI) is a policy that aims to reduce agricultural emissions by creating monetary incentives for rural landholders to undertake mitigation activities [2].

'Carbon farming' refers to a group of activities undertaken on farms, which aim to sequester carbon or reduce emissions [3]. For example, changing to no-till management (Fig. 1) can encourage storage of organic carbon in the soil [4, 5], while changing fertiliser management may reduce emissions.

Fig 1. No till farming practices

Under the CFI, potential carbon farming projects are examined by the Domestic Offsets Integrity Committee, who judge whether a project satisfies requirements such as additionality, permanence, measurability and verifiability of sequestration [6]. Farmers can receive tradable carbon credits for the carbon stored as a result of the project. Currently, most approved projects are based on livestock or waste management, but there is an increasing body of research suggesting that management changes in broadacre farming systems can reduce GHGs [7, 8, 9, 10].

Carbon farming can have impacts beyond the intended climate change mitigation, which need to be considered when evaluating its benefits. Some potential ancillary effects of carbon farming activities include impacts on water quality, yield changes, impacts on soil erosion, or biodiversity impacts. Previous studies have shown that co-benefits can form a significant proportion of the overall benefits of carbon sequestration projects [11].

Australia's policy focus on carbon farming, and the suggested importance of examining co-benefits, justifies research into the values of the benefits arising from carbon farming in Australia. The study described here aims to estimate non-market values for carbon sequestration and potential co-benefits of carbon farming practices.

2. METHOD

We use choice experiments (CEs) to estimate respondents' values for different aspects of carbon farming projects. CEs are a stated preference non-market valuation technique, which operate by describing the non-market good as a set of attributes. Respondents were presented with six choice questions, comprised of three alternatives with varying levels of the non-market attributes and a cost attribute. These attributes and their levels (Table 1) were chosen based on literature review, interviews with experts and community focus groups.

Respondents were asked to choose their preferred option, thus implicitly making trade-offs between the different attribute levels. A researcher can analyse these trade-offs and infer how much of a given attribute respondents are willing to sacrifice in order to gain some of another [12].

The survey first presented information about climate change and carbon farming, with questions regarding respondents' perspectives about climate change. The choice task was then explained to respondents, and they were shown six choice sets each. The third alternative in each choice set represented a 'do nothing' or status-quo scenario (Fig. 2). The final part of the survey included follow-up questions about respondents' agreement with and understanding of the information provided, and socio demographic questions.

Attribute	Description	Levels#
Emissions reduction/ carbon storage	The predicted reductions in Australian annual greenhouse gas emissions as a result of carbon farming. Current Australian emissions are 546 million tonnes of CO_2-equivalent per year.	0, 1.4, 3.6, 7.2 (% of Australia's annual greenhouse gas emission) Equivalent to emissions generated to power 0, 1.35, 3.5, 6.8 or million homes
Increase in native vegetation	The area of new native vegetation that is created on farmland under carbon farming. The current area of native vegetation on farmland in Australia is 33 million hectares (ha).	0, 2, 5, 8 (% increase in area) Equivalent to 0, 0.7, 1.6 or 2.6 million hectares
Reduction in soil erosion	Some carbon farming activities can decrease soil erosion by wind or water, and improve soil quality to varying extents. Current soil erosion on farmland is approximately 1,760 million tonnes per year (t/yr).	0, 2, 7, 20 (% reduction in tonnes of annual erosion) Equivalent to 0, 35.3, 123 or 325 million t/yr
Annual net cost to your household	Farmers will need to be compensated for the changes they make. This money will need to come from an increase in annual taxes for all Australians.	0, 20, 50, 150, 300 ($)

Table 1. Attributes and levels presented in the carbon farming survey

Status quo =0 for all attributes

Impacts	Alternative 1	Alternative 2	Alternative 3 – no action
Emissions reduction / carbon storage	1.4% (1.35 million households)	3.6% (3.4 million households)	No emission reduction or carbon storage
Increase in native vegetation	2% (0.7 million ha)	5% (1.6 million ha)	No increase in native vegetation
Reduction in erosion	20% (352 million t/yr)	2% (35.3 million t/yr)	No reduction in erosion
Annual net cost to your household	$150	$300	$0
My preference:			

Fig 2. Example choice question included in the carbon farming survey

The survey was distributed via an online research panel in August 2012. Respondents consisted of a case-study sample of NSW residents, filtered to ensure a 30% rural representation, and a representative range of age and education levels.

3. RESULTS

The survey was completed by 103 respondents. 87% of respondents believed climate change was occurring, and 67% thought humans were contributing to climate change or causing it. 64% of respondents stated that they believed it was appropriate to encourage rural landholders to change their management practices to increase climate change mitigation, while 17% believed such a policy is inappropriate.

A conditional logit model was estimated that included attributes in a linear utility specification. Significant socio-economic variables were interacted with the ASC. Interaction terms were also included for a respondent's beliefs about the existence of climate change with the level of carbon storage. The output of the model is shown in Table 2.

Table 2 Conditional logit model results.

Attributes	Coefficient	Std. Error
Cost	-0.0059***	0.0009
Vegetation increase	0.1004***	0.0175
Erosion reduction	0.0172**	0.0084
Carbon storage:		
Non- climate change believer	-0.0918	0.0646
Climate change believer	0.0450*	0.0231
ASC (= 1 for status quo)	-1.3110***	0.2402
Age x ASC	-0.0502***	0.0119
Income x ASC	5.63e-6*	3.36e-6
Voting Labour/Greens x ASC	-0.9156**	0.3629
n = 474	Pseudo R^2 = 0.214	

*** = significant at 1% level; ** = significant at 5% level; * = significant at 10% level

Respondents who believe that climate change is occurring are willing to pay $7.56 to reduce Australia's annual carbon emissions by 1% (Table 3).Respondents are WTP $16.88 for a 1% increase in native vegetation, and $2.89 for a 1% reduction in soil erosion. Note that carbon reduction WTP is only significant at a 10% level, while native vegetation is more significant.

Table 3. Willingness to pay estimates for carbon farming attributes

Attribute	WTP	Std.Error
Vegetation increase ($ / 1% increase in area of native vegetation on farmland)	16.88***	3.75
Erosion reduction ($ / 1% erosion reduction)	2.89 **	1.31
Carbon reduction ($ / 1% reduction in Australia's overall annual carbon emissions):		
Non-climate change believer	-15.43	11.17
Climate change believer	7.56*	3.96

4. DISCUSSION

The following example illustrates how the public benefits estimated in this study measure up to the costs of undertaking a carbon farming project.

We first need to convert our WTP estimates from % to t CO_2-e. The WTP of the whole NSW population is then $3.02 per t CO2-e, or $8.18 per t CO2-e for the entire Australian population. Converting the WTP estimates for % native vegetation into hectares, the total WTP for the entire Australian population would be about $340/ha.

Now let's look at an example of a farmer who revegetates 10 ha of farmland. The net carbon sequestration of this revegetation after 5 years would be approximately 125 t CO2-e.

Hence, the social benefits of the resulting carbon sequestration to the Australian population would be approximately $1,022 for 10 ha. If the area would be revegetated with native vegetation, the social benefits of this project would increase to $4,430. Given that the cost of revegetating 10ha of farmland in Australia has been estimated at $14,860 [13], the social benefits for revegetation—as a form of carbon sequestration under the CFI—do not outweigh the costs (even less so if we take into account the opportunity cost of the land use).

However, there may be instances where carbon farming projects are more viable.

Firstly, many carbon farming projects, including some already approved by the DOIC such as capture of GHGs from piggeries, involve ‘simple’ changes to farm management. Relatively minor management changes may achieve climate change mitigation more cost-effectively, though they may also have lower levels of co-benefits.

Secondly, the above example only looks at the carbon sequestration and native vegetation benefits of revegetating farm lands. A project may have other valuable co-benefits that are not considered in this study. Additional co-benefits may increase the social values provided by a management change.

The practical application of the WTP values estimated in this study is limited by the uncertainty surrounding the level of cobenefits a given carbon farming method can actually achieve. Biophysical modelling or case study experiments to determine this will allow community WTP estimates for cobenefits to be used in guiding policy and methods towards projects that will yield maximum public benefit.

5. CONCLUSION

The NSW public holds significant values for carbon farming benefits: carbon sequestration, increasing native vegetation and reducing erosion. Carbon storage or reduced emissions are valued at \$3.02 per tonne of CO_2, while revegetation of farmland with native vegetation is valued at \$125.11 per hectare, and reduced erosion is valued at \$0.41 per tonne.

There was a divide in survey respondents’ climate change perspectives: the majority believed that climate change is occurring and supported a carbon farming policy, but a noticeable group did not believe in climate change and displayed different values. This polarisation of community perceptions and views has been observed in previous studies, [14, 11] and could complicate the implementation of climate change mitigation policies.

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