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What carbon farming activities are farmers likely to adopt? A best–worst scaling survey

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ABSTRACT

Transferring carbon from the atmosphere into terrestrial sinks through carbon sequestration practices (so-called 'carbon farming') has been proposed as an important component in Australia's efforts to mitigate greenhouse gas emissions. We use a Best–worst scaling survey to determine which carbon sequestration practices farmers would be most and least likely to adopt, and what factors were most important in any potential adoption decision. The survey was distributed to dryland cropping and mixed crop-livestock farmers in Western Australia. Farmers ranked improved soil quality and reduced soil erosion as the most important potential co-benefits of carbon farming. Factors discouraging farmers from participating in carbon farming contracts were policy and carbon price uncertainty and the uncertain impact of carbon farming practices on productivity and profitability. Farmers had strong preferences for stubble retention and no-till cropping practices as carbon farming strategies. The practices that farmers preferred least were applying biochar and planting trees. Farm and farmer characteristics, including (lack of) awareness of carbon farming policies and opinions about climate change, influence the potential willingness to adopt different carbon farming practices. Given recent policy uncertainty and farmer preferences revealed in this study, it is important to communicate potential co-benefits (rather than opportunities to earn compensation or carbon credits) to increase farmers' engagement in carbon sequestration activities.

1. Introduction

To limit the potential impacts of climate change, the Australian government has set national greenhouse gas (GHG) emissions reduction targets. The current reduction target (updated in August 2015) is 26–28% below 2005 emissions by 2030 (Department of the Environment, 2015a). The Australian agricultural industry is responsible for 15–16% of national emissions (Department of the Environment, 2015b). As such, the industry is expected to contribute to national efforts toward emissions reductions.

Carbon farming is one way for farmers to reduce greenhouse gas emissions. 'Carbon farming' refers to a range of land use and land management practices designed to reduce emissions from farming activities, or sequester carbon in natural sinks such as soil and vegetation (Smith et al., 2008). In Australia, there are policies in place that include incentives to stimulate the adoption of carbon farming practices by landholders. The initial policy, the Carbon Farming Initiative (CFI), was introduced in 2011 (Parliament of the Commonwealth of Australia, 2011). For a two year period between July 2012 and July 2014 the initiative was working alongside a carbon price. The carbon price (indirectly) provided a value for carbon sequestration or GHG emissions reductions achieved by farmers. In December 2014, the CFI was merged into the new policy framework: the Emissions Reduction Fund (ERF, Parliament of the Commonwealth of Australia, 2014). The ERF operates as a reverse auction scheme. Under this scheme, farmers are invited to submit project bids that specify the carbon farming practices they are willing to undertake, and the required price per tonne of emissions reductions or sequestration to undertake the practice(s). The government purchase the lowest cost projects. For the CFI and ERF to be successful in mitigating climate change, it is imperative that farmers propose projects to participate in the scheme. Proposed projects must follow specific guidelines to ensure emissions reductions are measureable and verifiable. Under the ERF, the guidelines

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for projects are referred to as 'methods'. Some carbon farming practices that are covered by these methods include: reforestation of cleared lands; protecting native vegetation from being cleared; sequestering soil carbon in grazing systems; reducing emissions from livestock through changes in feed; and reducing emissions through improved fire management in northern savanna regions.[1]

The public benefits of carbon farming, such as greenhouse gas mitigation and potential positive impacts on biodiversity and hydrology, are important (Macintosh, 2013). Several studies have estimated the nonmarket values that society derives from farmers participating in environmental stewardship and conservation activities. For example, Rodríguez-Entrena et al. (2014) found that individuals have a positive willingness to pay (WTP) for erosion reduction and biodiversity benefits from carbon farming in Andalusian olive groves. Glenk and Colombo (2011) estimated WTP values for biodiversity benefits from implementing a soil carbon sequestration program in Scotland. Their estimates ranged between GBP 4 and GBP 41 for an "improvement of farmland bird habitat", which was used as a proxy for biodiversity values. In a study on co-benefits from carbon offsets in the aviation industry, MacKerron et al. (2009) also found positive WTP values for a "conservation and biodiversity" benefit.

Given the potential to deliver public benefits, it is not surprising that the policy interest in carbon farming is high. But, participation in carbon farming and emissions abatement policies is voluntary. So, what is in it for the farmer? There exists a rich literature on farmers' adoption of environmental management or conservation farming practices (e.g., Barr and Cary, 2000; Knowler and Bradshaw, 2007; Pannell et al., 2006). Factors that are important in farmers' decisions to change agricultural management practices include the (monetary and non-monetary) investment costs of the new practice, the impacts of the new practice on farm profitability, whether the practice 'fits' in the current farming system, the farmer's financial situation and personal values, the social context in which the farmer operates, as well as the public co-benefits generated by adopting the practice (Pannell et al., 2006; Kragt et al., 2014; Morgan et al., 2015). Generally, if new practices fit these criteria and provide (or are perceived to provide) private production benefits, farmers will adopt them (Morgan et al., 2015; Page and Bellotti, 2015). Carbon sequestration in agricultural soils can help to improve soil structure, reduce erosion, increase soil moisture retention and plant available water, and improve nutrient storing capacity (Desjardins et al., 2005; Lal, 2004). These changes can have a positive impact on agricultural yields (Kragt et al., 2012). Likewise, returning land to native vegetation can contribute to reduced salinity, improved water quality, and improved habitat provision for native plants and animals (George et al., 2012; Perring et al., 2012; Bradshaw et al., 2013). So, do farmers know of these potential benefits of carbon farming and are they using them as a motivator to adopt new management practices?

Despite the Australian government's interests in carbon farming, and the likely benefits of adoption, there have been few studies that have investigated whether farmers are willing to participate in carbon farming, and none that have looked specifically at the likelihood of Australian farmers adopting carbon sequestration practices within the context of the CFI and ERF, relatively unique policies. In this study we use a best–worst scaling survey to determine what carbon farming practices broadacre farmers are most likely to adopt. The focus of our research is on dryland cropping and mixed crop-livestock farmers, who form a significant part (28%) of Australia's farming community (Australian Bureau of Statistics, 2012). We also aim to identify the co-benefits and other factors that motivate or discourage farmers from adopting carbon farming practices.

The following section describes the best–worst scaling method. This is followed by a description of the survey design, sampling procedure, and modelling approach in Section 3. Results of the survey and best–worst scaling models are presented in Section 4. In the concluding section (Section 5), we discuss the findings in light of the CFI and ERF policy frameworks and develop recommendations for further work.

2. The best–worst scaling method

Best–worst scaling (BWS) is a survey-based, stated preference technique that presents respondents with sets of alternatives from which a respondent chooses his or her 'superior' and 'inferior' options (Finn and Louviere, 1992). The choice task is repeated over a number of sets that contain different combinations of the elements,[2] as per an experimental design. The repetition of varied choice sets and the choice task provides information to calculate the preference scores of each respondent (Jones et al., 2013). The likelihood of choosing an option is relative to the other options presented in the choice sets. It is expected that the most preferred options will be chosen as 'superior' more often than the other options and a least favored option will be chosen more often as the 'inferior' option compared to the other alternatives.

An advantage of BWS is that choosing only a best and worst option from a set is often easier for respondents than ranking all the elements simultaneously. Another advantage is that the results typically show a greater discrimination between elements compared to alternative ranking techniques such as the Likert Scale (Finn and Louviere, 1992; Jones et al., 2013). Furthermore, other ranking techniques such as paired comparisons can be inadequate when the respondent is indifferent between the options or dislikes both options (Bateman et al., 2002).

Applications of BWS have been in food policy, food quality, health policy, transport and agricultural contexts (e.g., Coltman et al., 2010; Cross et al., 2012; Erdem et al., 2012; Glenk et al., 2014; Jones et al., 2013; Lee et al., 2007; Marti, 2012). The BWS technique has been used twice previously in agricultural GHG emissions mitigation studies. Jones et al. (2013) used BWS to elicit expert and farmer opinion on the relative effectiveness and practicality of practices to reduce GHG emissions from sheep farms in Wales. Glenk et al. (2014) used a BWS survey to rank 20 different greenhouse gas mitigation strategies for Scottish dairy farms to determine how current levels of adoption affected the perceived impacts of mitigation practices on farm performance. The authors found that current adoption rates significantly affected farmers' evaluation of potential carbon farming practices (Glenk et al., 2014). Our study is the first to use BWS to understand farmers' preferences to adopt carbon farming practices at the same time as a policy (the CFI) is in operation to incentive the adoption of a sub-set of the practices.

3. Survey design

In this study, we used a 'Case 1' BWS to identify what carbon farming practices farmers in the case study region would be 'most likely' and 'least likely' to adopt (Finn and Louviere, 1992; Flynn and Marley, 2012).[3] The survey was designed to gather information

[1] See www.environment.gov.au/climate-change/emissions-reduction-fund/methods for a list of all approved methods under the ERF.

[2] Sometimes also referred to as 'objects' or 'items'. In this paper we use the term 'element' to indicate the nine carbon farming practices available to respondents. We use the term 'option' to indicate the choice alternatives in one choice set.

[3] Flynn and Marley (2012) describe three types of BWS including Case 1 (the object case). The interested reader is referred to Flynn and Marley (2012) for further information about Case 1 BWS and other BWS approaches.