What are the barriers to adopting carbon farming practices?

Marit Kragt[a,b,*], Louise Blackmore[a], Tim Capon[c], Cathy J. Robinson[d], Nooshin Torabi[e] and Kerrie A. Wilson[f]

[a] Centre of Environmental Economics and Policy, School of Agricultural and Resource Economics, University of Western Australia, Crawley WA 6009
[b] CSIRO Agriculture Flagship, Floreat WA 6014
[c] CSIRO Land and Water, Black Mountain ACT 2601
[d] CSIRO Land and Water, Dutton Park QLD 4102
[e] Interdisciplinary Conservation Science Research Group, School of Global, Urban and Social Studies, RMIT University, Melbourne VIC 3000
[f] School of Biological Sciences, The University of Queensland, St Lucia, 4065, Brisbane, Australia.

*E-mail address: marit.kragt@uwa.edu.au

Example: 21 December 2014
Working Paper 1407
School of Agricultural and Resource Economics
http://www.are.uwa.edu.au

THE UNIVERSITY OF WESTERN AUSTRALIA

Citation: Kragt, M.E., Blackmore, L., Capon, T., Robinson, C.J., Torabi, N. and Wilson, K.A. (2014) *What are the barriers to adopting carbon farming practices?*, Working Paper 1407, School of Agricultural and Resource Economics, University of Western Australia, Crawley, Australia.

What are the barriers to adopting carbon farming practices?

Abstract

In many environmental and conservation policy contexts, gaps are observed between policy objectives and implementation outcomes. Carbon farming policies are designed to mitigate greenhouse gas emissions, but policy success depends on the participation of land managers and their adoption of alternative land management practices. We surveyed Western Australian farmers to gauge their knowledge of carbon farming, their current adoption of carbon farming practices, and identified the drivers and barriers to adoption. Drivers for adoption included knowledge and perception of co-benefits (for yield, productivity, and the environment); beliefs and attitudes about climate change and its causes. Key barriers to the adopting carbon farming practices included policy and political uncertainty, and on-farm characteristics. We conclude that, to increase participation, the productivity benefits of carbon farming practices must be actively promoted and practices must be easy to integrate into existing farming systems.

Keywords

Land management; Policy adoption; Climate change mitigation; Farmer surveys

JEL codes

Q16, Q18, Q58

What are the barriers to adopting carbon farming practices?

Introduction

A policy-implementation gap is the difference between the anticipated outcomes of a policy, and the results observed on-the-ground (Hinds, 2003; Ran, 2013). The development and implementation of 'carbon farming' policies in agri-environmental settings have not been immune to such discrepancies. Carbon farming programs aim to mitigate greenhouse gas emissions through encouraging the adoption by land managers of carbon sequestration or emissions reduction practices. The success of such programs depends on both the participation of land managers and on the level of adoption of alternative land management practices.

Carbon sequestration on farms is an important aspect of climate change mitigation policy and in Australia has received bi-partisan political support. The Australian Federal Government introduced the Carbon Farming Initiative (CFI) in 2011 to help Australia meet its long-term emission reduction targets (Jotzo, 2012). This program allows farmers and land managers to earn carbon credits by storing carbon or reducing greenhouse gas emissions on the land (Department of Environment, 2014). These credits can then be sold on the voluntary carbon offset market (DCCEE, 2012; Clean Energy Regulator, 2014a).

'Carbon farming' is a term to describe agricultural practices that reduce greenhouse gas emissions or sequester carbon in agricultural landscapes (DCCEE, 2012). Carbon farming practices can include no-till cropping, stubble retention, grazing management, composting or manure management (Kragt et al., 2012). Farmers who undertake carbon farming practices that are approved as eligible methodologies can participate in the CFI and earn carbon credits (Clean Energy Regulator, 2014a). As of 1st September 2014, only 158 CFI projects had been approved by the government. These are primarily emissions avoidance projects such as capturing and combusting methane gas from landfill or early dry season savanna burning. Most project proponents are commercial carbon abatement providers, energy companies or local councils rather than individual farmers (Clean Energy Regulator, 2014b).

The CFI reflects the broader push for agri-environmental schemes that apply financial payments to incentivise farmers to adopt best management farming practices. Gaining farmer participation in these programs is often problematic due to the complexity of scheme design and implementation, program rules or conflicting goals of policymakers and farmers. This study investigates what gap exists between the carbon farming policy and uptake of carbon farming practices by landholders.

Understanding the policy-implementation gap can potentially be informed by literature pertaining to the adoption of agricultural innovations and land managers' participation in

natural resource management schemes (Wynne-Jones, 2013). Many factors have been found to affect adoption of new land management practices including landholders' personal characteristics (e.g. Morrison et al., 2011a; Raymond and Brown, 2011; Moon et al., 2012), farm characteristics (e.g. Wilson, 1997; Zbinden and Lee, 2005; Raymond and Brown, 2011), characteristics of the new technology or practice (Feder et al., 1985; Pannell et al., 2006), and social context (e.g. Measham et al., 2011; Morrison et al., 2011b).

Political uncertainty is also likely to have substantial negative effects on the uptake of programs and practices given the widely-acknowledged importance of continuous, trusting relationships between landholders and implementing agencies (Pannell et al., 2006; Cocklin et al., 2007; Mendham et al., 2007; Morrison et al., 2008; Blackmore and Doole, 2013). Uncertainty about environmental policies can seriously undermine their uptake, and can be exacerbated by limited awareness or understanding of the program or practice in question (e.g. Vanclay and Lawrence, 1994; Kabii and Horwitz, 2006; Pannell et al., 2006; Mendham et al., 2007).

In this paper, we aim to identify the social, institutional and biophysical factors that may lead to a policy-implementation gap in the implementation of carbon farming practices in Australia (hereafter 'carbon farming'). Our evaluation follows a 'bottom-up' approach, which explicitly recognises the importance of stakeholders in shaping policy implementation. Through surveys of farmers we identify the drivers of carbon farming adoption and the barriers to carbon farming implementation. Important implications for the design and implementation of carbon farming policies are identified.

Methods

Survey design

The data for this study comes from two farmer surveys about carbon farming, the results of which are jointly presented in this paper. Both surveys were designed based on information from the literature and on interviews with experts with experience in carbon farming practices, farm management and the economics of broad-acre systems across Australia. The surveys gauged farmers' knowledge of carbon farming, their current adoption of carbon farming, and drivers and barriers to adopting carbon farming practices. Farmers were asked whether they thought that encouraging carbon farming was an appropriate policy measure for climate change mitigation, and whether they knew any colleagues who had adopted carbon farming practices.

The first survey ('Survey 1') investigated attitudes to climate change mitigation and adaptation options on farms. Respondents were asked to indicate their agreement with potential challenges to adopting mitigation and adaptation practices on a 5-point Likert

scale. We present the data pertaining to farmers' attitudes about mitigating practices, i.e. 'carbon farming'.

The second survey ('Survey 2') focussed specifically on the carbon storage activities that can be undertaken by farmers, and respondents' attitudes towards the Australian Carbon Farming Initiative. We asked respondents to identify what factors would limit their involvement in the Carbon Farming Initiative.

Survey administration

Both surveys were programmed in online survey software Qualtrics, and distributed randomly to farmers in the Wheatbelt of Western Australia with the help of local Natural Resource Management (NRM) organisations. Survey 1 was conducted in December 2012 and January 2013, and yielded 107 completed. Survey 2 was sent to a different sample of farmers in the Northern Wheatbelt of Western Australia (Figure 1). A total of 43 responses to survey 2 were collected in August-September 2013.

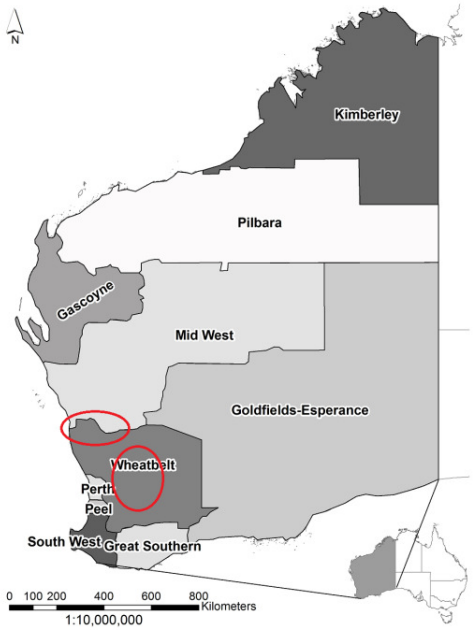

Figure 1. Western Australia - Case-study regions

Results

Socio-demographic characteristics of survey respondents

150 farmer responses were collected in the WA Wheatbelt (Table S1). Most respondents were male (79%). Overall average farm size was 7,820 ha (median 3,130 ha, range: 60 ha – 217,000 ha). Farms were either mixed crop-livestock or cropping-only. The main crops

grown by respondents were wheat, canola, lupins and barley. The majority of respondents (61% and 78% from survey 1 and 2 respectively) also reared sheep on their property. About half of the respondents (47% from across both surveys) know someone currently participating in carbon farming practices (Table S1).

Respondents were asked their opinions on the causes of climate change in a multiple choice question (following Leviston et al., 2011). Some respondents (27% and 37%) believe climate change is a result of natural fluctuations in the Earth's temperature, while most (54% and 70%) believe humans are either causing or contributing to climate change (Table 1).

Table 1. Respondent's beliefs about the existence and causes of climate change

Opinions about climate change	Survey 1 (%)	Survey 2 (%)
I don't think that climate change is happening	1.9	2.3
I have no idea whether climate change is happening or not	1.9	7.0
I think that climate change is happening, but it is a natural fluctuation in Earth temperatures	27.1	37.2
I think that climate change is happening, and that human actions are contributing to the change	47.7	46.5
I think that climate change is happening, and that human actions are causing it	21.5	7.0

Drivers of carbon farming adoption

Respondents who self-identified as already undertaking carbon farming (henceforth called 'adopters') were asked about their key drivers. Productivity benefits were identified as a key driver: 67% of the adopters in survey 1 and 73% of adopters in survey 2 mentioned "increased yield and productivity of the land" as drivers for undertaking carbon farming practices (Tables S2 and S3). Environmental co-benefits were another key driver. These co-benefits included: improved soil conditions (survey 1, 87%; survey 2, 82%), environmental condition (survey 1, 81%; survey 2, 46%), and vegetation condition (survey 1, 80%). The responses show that the opportunity to earn carbon credits was the least important reason for undertaking carbon farming in both surveys. In survey 2, respondents were asked whether incentive programs encouraged their uptake of carbon farming. A distinction was made between incentive programs from government, from local NRM or grower groups, and from environmental NGOs. Less than 20% of adopters named government incentives as a driver of carbon farming uptake.

Logit regression modelling was used to assess which variables can explain adoption. These models were estimated on survey 1 data in the NLOGIT software (Econometric Software, 2012). The results are presented in Table 2. The constant is negative and significant. This

indicates an average overall tendency of farmers to not adopt carbon farming practices that could not be explained by any of the other variables in the model. The logit model does, however, identify some of the key variables that can explain the uptake of carbon farming practices. Knowing another farmer who has adopted carbon farming practices has a positive and significant influence on the probability that a farmer will adopt carbon farming. Furthermore, the logit model results reveal that the more someone believed in human-induced climate change (on a 1 to 5 scale), the more likely it is that they adopt carbon farming practices. Other socio-demographic variables such as being a member of a grower group, believing that farming changes are an appropriate way to mitigate climate change, whether the farm is a core source of income, gender, age or overall income were not significant in explaining the adoption of carbon farming practices (Table 2).

Table 2. Logit Model estimates for having adopted carbon farming practices (yes/no data from survey 1)

Variable	Coefficient	St.Error	p-value
Constant	-3.692***	1.369	0.007
Member of grower group (yes = 1)	0.392	0.525	0.456
Farming changes are an appropriate mitigation policy (yes = 1)	0.454	0.281	0.106
Know someone who has adopted carbon farming (yes = 1)	1.465***	0.466	0.002
Attitude towards climate change (1 – 5)	0.624**	0.307	0.412
Farming as core business activity (yes = 1)	0.408	0.557	0.464
Gender (male = 1)	0.560	0.565	0.322
Age (in years)	0.002	0.005	0.733
Gross on-farm income ('000 $/in 2011/12)	-0.0003	0.0003	0.401
Model statistics			
Log Likelihood	-60.101		
McFadden Pseudo R-squared	0.190		
Percentage correctly predicted	60.75%		

Note: ***, ** = Significance at 1% and 5% level. Number of observation n= 107. Dependent variable = having adopted carbon farming practices (0 = no; 1 = yes).

Barriers to implementing carbon farming

The responses of 'adopters' were compared to farmers who said they had not adopted carbon farming practices ('non-adopters') to gain insights into the challenges associated with carbon farming implementation. The results from surveys 1 and 2 revealed two main barriers to implementing carbon farming in Western Australia: policy/political uncertainties and on-farm characteristics. Uncertainties surrounding carbon markets and climate change

policies were identified as significant barriers by both adopters and non-adopters (Figure 2). Key uncertainties that were named in the surveys included:

- Uncertainty about political developments in carbon policies;
- Uncertainty about the market price for carbon;
- Uncertainty about buyers in the voluntary carbon market;

Both adopters and non-adopters agreed that they had insufficient information about possible carbon farming options. Other important barriers were a lack of methodologies approved under the CFI, high administrative costs, and complexity of obtaining certification as an accredited carbon offset provider.

On-farm characteristics were also identified as a barrier to implementing carbon farming practices – particularly for non-adopters. Characteristics that were mentioned as barriers included the capital investment costs needed to change farming practices, incompatibility of carbon farming with current farm management strategies, and potential impacts on the farmers' ability to obtain finance from banks and other lenders (Figure 2).

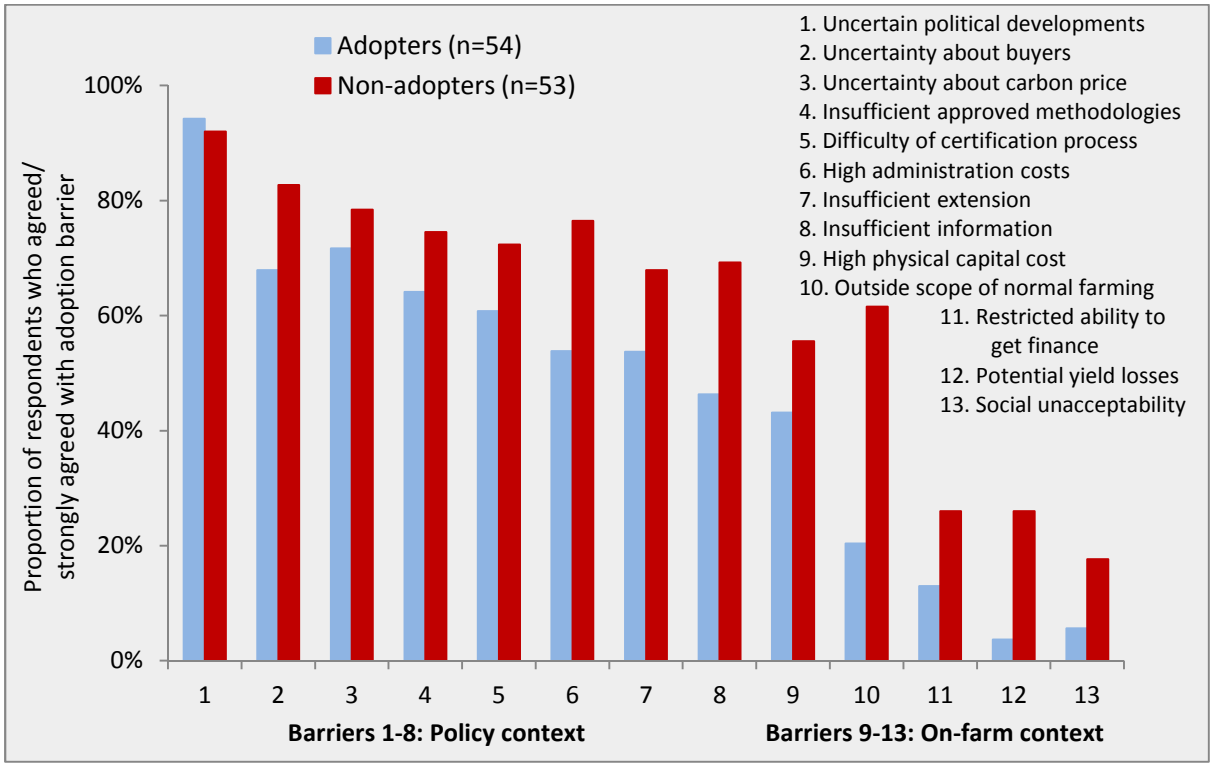

Figure 2. Barriers to carbon farming adoption (results from Survey 1 for current adopters vs non-adopters of climate change mitigation practices)

In survey 2, respondents were asked specifically about the Australian Carbon Farming Initiative Program (CFI) and the barriers they face to participating. Respondents agreed that "policy uncertainty due to changes in government and policy priorities" was the single

largest barrier to participating in the CFI (indicated by 82% and 81% of adopters and non-adopters respectively – Figure 3). Other important barriers were: uncertainty about carbon prices; uncertainty about the production benefits of carbon farming; insufficient approved carbon farming methodologies; and measurement and monitoring being too difficult or expensive. Of the barriers that were mentioned, the only on-farm barrier is "uncertain yield benefits". All other barriers are related to the policy context of carbon farming. From Figure 3, it is clear that farmers who have not yet adopted carbon storage activities indicate more barriers than those who are already undertaking carbon farming activities.

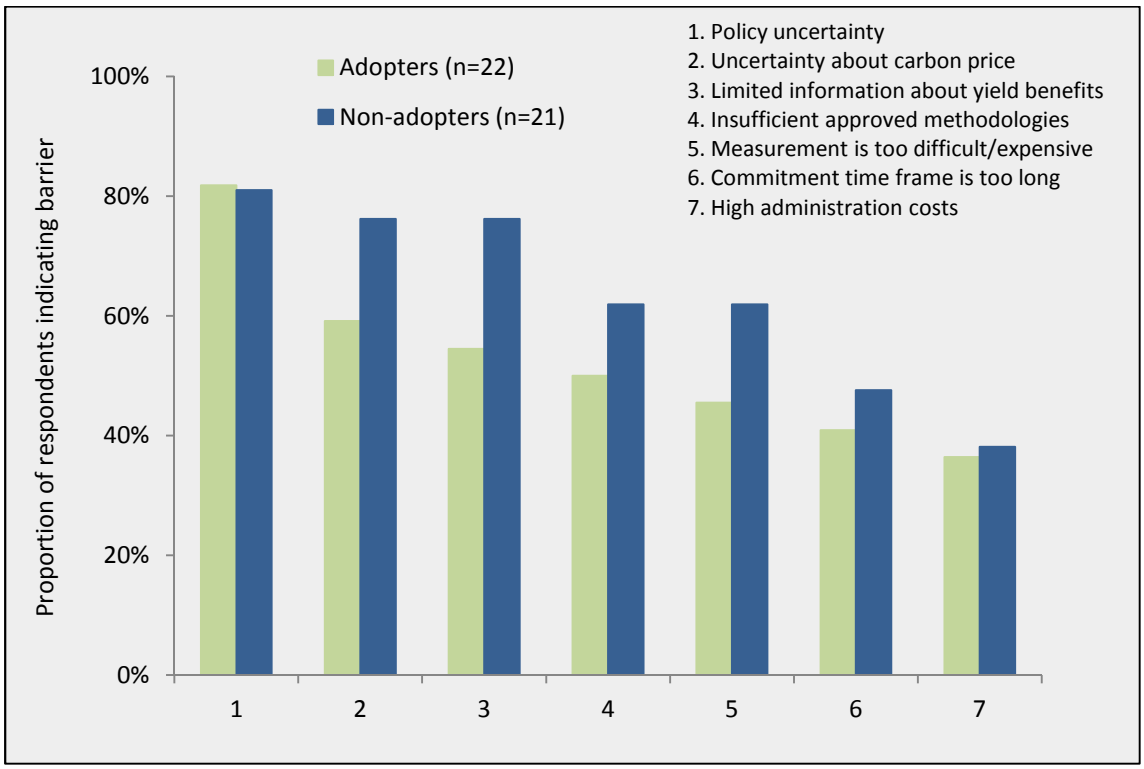

Figure 3. Potential barriers to participating in the Carbon Farming Initiative (results from Survey 2 for current adopters vs non-adopters of climate change mitigation practices)

Discussion

The uptake of environmental policies and programs often fall short of expectations. In such cases, a gap exists between what is envisioned by policymakers when they design the policy, and implementation of the policy on-the-ground. Through a case study of the adoption of carbon farming practices in Western Australia, we identified several key considerations for closing the policy–implementation gap. Landholder socio-demographics and the ability to sell carbon credits were found not to be drivers of carbon farming uptake in this study. Conversely, knowledge and perception of co-benefits (for yield, productivity, and the environment); opinions about climate change and its causes; and whether the individual

knew other adopters were all identified as significant drivers. Key barriers to carbon farming uptake included policy and political uncertainty, and on-farm characteristics.

Previous studies identify some of the key factors that drive the uptake of environmental practices in agriculture. These include landholder socio-demographics and incentive payments (Kabii and Horwitz, 2006; Moon et al., 2012; Comerford, 2014)(Pannell et al., 2006; Mendham et al., 2007; Morrison et al., 2008). Interestingly, neither of these factors were identified as drivers of the uptake of carbon farming practices in our study. Although Australia's CFI and other government programs offer significant financial incentives to encourage carbon farming practices (Department of Environment, 2014), our study reveals that these have not been important drivers of adoption. In particular, government incentives were less popular among farmers than incentives distributed at a regional level or though locally-based grower groups.

Productivity and environmental benefits have been identified as important drivers for revegetation activities on farms (Ahnström et al., 2008; Jellinek et al., 2013). Our study has identified yield and productivity benefits as a driver of the adoption of carbon farming practices. This echoes Pannell et al. (2006), who found that the relative financial advantage of a conservation practice (including effects on agricultural yield) are of key importance to its uptake. One respondent to our survey commented that "*the co-benefits of management changes (to increase soil carbon) will probably be of more financial benefit to the farmer without participating in the credits and trading market*". Non-market environmental co-benefits (e.g. improving soil health, enhancing the condition of the environment and vegetation) also explained carbon farming adoption in our study. Such co-benefits have previously been identified as a significant factor to take up conservation practices (e.g. Mendham et al., 2007; Moon and Cocklin, 2011). Communicating the potential to obtain both yield and environmental co-benefits through carbon farming practices could reflect a key strategy to increase adoption in the future.

We reveal that knowledge of farmer's opinions about climate change, and explicit acknowledgment that individuals rarely make choices in isolation, could enhance adoption of carbon farming practices. This strongly aligns with previous work exploring attitudinal (Kabii and Horwitz, 2006; Morrison et al., 2008; Moon et al., 2012) and social networks (Pannell et al., 2006; Moon et al., 2012) as drivers of environmentally-beneficial land management. Specifically, we find that if a farmer perceives climate change to be a human-induced phenomenon then they are more likely to undertake climate change mitigation activities. If a farmer knows others who have adopted carbon farming practices then they are more likely to also adopt such practices. This concurs with other literature showing that a farmer's connection with a network of neighbours who have or are willing to adopt new land management practices impacts their participation in such activities (Lynch and Lovell, 2003). It also indicates that early adopters of new practices are a valuable source of information for their peers who may be interested in participation.

The most frequently-cited barrier to implementing carbon farming practices in our study was uncertainty, including political and policy dimensions. The Australian government has also identified difficulties associated with the delivery of information to landholders as a key barrier to implementation of carbon farming (Australian Government, 2012), despite significant efforts directed toward extension and outreach by NRM bodies, grower groups and government initiatives (Department of Agriculture, 2014a). Political and policy uncertainty were identified as key barriers despite financial incentives to encourage uptake of practices. One farmer in our survey noted that "*it seems too risky and complex to earn carbon credits*" and another noted that there are "*too many questions left unanswered*".

On-farm characteristics – including both yield and operational considerations – emerged as a second key group of barriers to carbon farming implementation. Practices that are likely to generate productivity losses will face stronger resistance by landholders, particularly where agricultural production is their core business focus and where operational or opportunity costs to modify practices are high (Moon and Cocklin, 2011). In contrast, practices that are easily integrated into the existing farm operation and align well with existing management priorities are generally well-received by landholders (Robinson et al., 2009; Marshall et al., 2012).

Improving landholder awareness and understanding of overarching climate change policy could generate enhanced uptake. This could be achieved through a more involved strategy for communicating with landholders, involving face-to-face contact and leveraging existing trusting relationships with local implementing agencies. Pannell et al. (2006) identified a history of respectful and trusting relationships as well as membership of social networks and local organizations as factors that can be positively related to adoption. Greater emphasis on the role of social networks is also likely to be beneficial in closing the policy-implementation gap, recognising that landholders function as an important source of information to one another. Thus, identifying key members of social networks in target areas to facilitate the diffusion of information is likely to be valuable (Reed, 2008). The same networks and trusted agents could also be used to deliver education about climate change and its causes, as changing attitudes towards climate issues and science could improve uptake, provided that this information is delivered in an accessible manner.

Uptake of carbon farming practices (and environmental land management practices in general) can be explained by a plethora of factors. Understanding these factors is an important research goal in itself, but the full value of such work is realised by its application to identifying solutions to bridge policy-implementation gaps. By systematically assessing the gap for carbon farming activities, we identified several key leverage points for improved uptake of practices. Our work clearly indicates a need to specifically target the promotion of practices with productivity benefits. Ideally, such practices would be compatible with existing farm operations. It is likely that soil carbon management and agroforestry/silvopastoralism practices will be well-suited to this task, as they are relatively

easily integrated into farming systems. Where such practices are also associated with productivity and environmental co-benefits (e.g. improved biodiversity through agroforestry), their uptake is likely to be higher still. Ongoing research efforts (e.g. through the Filling the Research Gap program – Department of Agriculture, 2014b) into the development of climate change mitigation practices that can readily be integrated in existing farming systems will be vital to close the gap between policies and implementation.

Acknowledgements

Support for the farmers' surveys was provided by a University of Western Australia - Research Development Award.

This research was conducted with funding support from the Australian Government's National Environmental Research Program and the Australian Research Council Centre of Excellence for Environmental Decisions. Kerrie Wilson was supported by an Australian Research Council Future Fellowship. Catherine Robinson was supported by the CSIRO Sustainable Agriculture Flagship.

References

Ahnström J., Höckert J., Bergeå H.L., Francis C.a., Skelton P., Hallgren L., 2008. Farmers and nature conservation: What is known about attitudes, context factors and actions affecting conservation? Renewable Agriculture and Food Systems 24 38.

Australian Government, 2012. Summary Report CFI Workshop Series for Agricultural Advisors, May-June 2012. Available at www.daff.gov.au/climatechange/cfi.

Blackmore L., Doole G.J., 2013. Drivers of landholder participation in tender programs for Australian biodiversity conservation. Environmental Science & Policy 33 143-153.

Clean Energy Regulator, 2014a. Carbon Farming Initiative. Australian Government: Canberra; http://www.cleanenergyregulator.gov.au/Carbon-Farming-Initiative, viewed 1 May 2014.

Clean Energy Regulator, 2014b. Register of Offsets Projects. 1 September 2014. Australian Government: Canberra.

Cocklin C., Mautner N., Dibden J., 2007. Public policy, private landholders: Perspectives on policy mechanisms for sustainable land management. Journal of Environmental Management 85 (4), 986-998.

Comerford E., 2014. Understanding why landholders choose to participate or withdraw from conservation programs: A case study from a Queensland conservation auction. Journal of Environmental Management 141 169-176.

DCCEE, 2012. Carbon Farming Initiative Handbook. Department of Climate Change and Energy Efficiency: Canberra.

Department of Agriculture, 2014a. Extension and Outreach. Australian Government: Canberra; http://www.daff.gov.au/climatechange/carbonfarmingfutures/extensionandoutreach, viewed 1 May 2014.

Department of Agriculture, 2014b. Filling the Research Gap. Australian Government: Canberra; http://www.daff.gov.au/climatechange/carbonfarmingfutures/ftrg, viewed 1 May 2014.

Department of Environment, 2014. The Carbon Farming Initiative. Australian Government: Canberra; http://www.climatechange.gov.au/reducing-carbon/carbon-farming-initiative/carbon-farming-initiative-handbook/carbon-farming. Viewed 1 May 2014.

Econometric Software, 2012. Nlogit5. Econometric Software Inc.: Castle Hill.

Feder G., Just R.E., Zilberman D., 1985. Adoption of Agricultural Innovations in Developing Countries: A Survey. Economic Development and Cultural Change 33 (2), 255-298.

Hinds L., 2003. Oceans governance and the implementation gap. Marine Policy 27 (4), 349-356.

Jellinek S., Parris K.M., Driscoll D.a., Dwyer P.D., 2013. Are incentive programs working? Landowner attitudes to ecological restoration of agricultural landscapes. Journal of Environmental Management 127 69-76.

Jotzo F., 2012. Australia's carbon price. Nature Clim. Change 2 (7), 475-476.

Kabii T., Horwitz P., 2006. A review of landholder motivations and determinants for participation in conservation covenanting programmes. Environmental Conservation 33 (1), 11-20.

Kragt M.E., Pannell D.J., Robertson M.J., Thamo T., 2012. Assessing costs of soil carbon sequestration by crop-livestock farmers in Western Australia. Agricultural Systems 112 (October), 27-37.

Leviston Z., Leitch A., Greenhill M., Leonard R., Walker I., 2011. Australians' views of climate change. CSIRO Report: Canberra.

Lynch L., Lovell S.J., 2003. Combining Spatial and Survey Data to Explain Participation in Agricultural Land Preservation Programs. Land Economics 79 (2), 259-276.

Marshall N.A., Park S.E., Adger W.N., Brown K., Howden S.M., 2012. Transformational capacity and the influence of place and identity. Environmental Research Letters 7 (3), 034022.

Measham T.G., Brake L., Robinson C.J., Larson S., Richards C., Smith T.F., 2011. NRM engagement between remote dryland communities and government agencies: Success factors from Australia. Journal of Arid Environments 75 (10), 968-973.

Mendham E., Millar J., Curtis A., 2007. Landholder participation in native vegetation management in irrigation areas. Ecological Management & Restoration 8 (1), 42-48.

Moon K., Cocklin C., 2011. Participation in biodiversity conservation: Motivations and barriers of Australian landholders. Journal of Rural Studies 27 (3), 331-342.

Moon K., Marshall N., Cocklin C., 2012. Personal circumstances and social characteristics as determinants of landholder participation in biodiversity conservation programs. Journal of Environmental Management 113 292-300.

Morrison M., Durante J., Greig J., Ward J., 2008. Encouraging Participation in Market Based Instruments and Incentive Programs. Land and Water Australia.

Morrison M., Durante J., Greig J., Ward J., Oczkowski E., 2011a. Segmenting landholders for improving the targeting of natural resource management expenditures. Journal of Environmental Planning and Management 55 (1), 17-37.

Morrison M., Oczkowski E., Greig J., 2011b. The primacy of human capital and social capital in influencing landholders' participation in programmes designed to improve environmental outcomes*. Australian Journal of Agricultural and Resource Economics 55 (4), 560-578.

Pannell D.J., Marshall G.R., Barr N., Curtis A., Vanclay F., Wilkinson R., 2006. Understanding and promoting adoption of conservation practices by rural landholders. Australian Journal of Experimental Agriculture 46 (11), 1407-1424.

Ran R., 2013. Perverse Incentive Structure and Policy Implementation Gap in China's Local Environmental Politics. Journal of Environmental Policy & Planning 15 (1), 17-39.

Raymond C.M., Brown G., 2011. Assessing conservation opportunity on private land: Socio-economic, behavioral, and spatial dimensions. Journal of Environmental Management 92 (10), 2513-2523.

Reed M.S., 2008. Stakeholder participation for environmental management: A literature review. Biological Conservation 141 (10), 2417-2431.

Robinson C.J., Taylor B.M., Pearson L., O'Donohue M., Harman B., 2009. A SMART assessment of water quality partnership needs in Great Barrier Reef catchments. Australasian Journal of Environmental Management 16 (2), 84-93.

Vanclay F., Lawrence G., 1994. Farmer rationality and the adoption of environmentally sound practices; A critique of the assumptions of traditional agricultural extension. European Journal of Agricultural Education and Extension 1 (1), 59-90.

Wilson G.A., 1997. Factors Influencing Farmer Participation in the Environmentally Sensitive Areas Scheme. Journal of Environmental Management 50 (1), 67-93.

Wynne-Jones S., 2013. Carbon blinkers and policy blindness: The difficulties of 'Growing Our Woodland in Wales'. Land Use Policy 32 (0), 250-260.

Zbinden S., Lee D.R., 2005. Paying for Environmental Services: An Analysis of Participation in Costa Rica's PSA Program. World Development 33 (2), 255-272.

SUPPLEMENTARY MATERIAL

Table S1. Demographic characteristics of respondent samples

Socio-demographic characteristics of survey samples	Survey 1 (n=107)		Survey 2 (n=43)	
Gender	# of resp	%	# of resp	%
Male	81	75.7	37	86.0
Female	26	24.3	6	14.0
Age group (years)				
18-34	7	6.5	13	30.2
35-44	13	12.2	9	20.9
45-54	28	26.2	7	16.3
55-64	34	31.8	12	27.9
65 +	24	22.4	2	4.7
Farming as Core business?				
Farm is main source of income	38	35.5	34	79.1
Income is supplemented by off-farm income	37	34.6	8	18.6
Farming is not core business	32	29.9	1	2.3
Know anyone who undertakes carbon farming practices?				
Yes	47	43.9	24	55.8
No	60	56.1	19	44.2

Table S2. Drivers of carbon farming adoption – survey 1 adopters (n = 54)

Possible drivers of adoption	Strongly Disagree or Disagree	Neither Agree or Disagree	Agree or Strongly Agree
Improve soil conditions on my land	5.6%	5.6%	87.0%
Improve other environmental conditions on my land	3.7%	13.0%	81.5%
Improve natural vegetation conditions on my land	9.3%	9.3%	79.6%
Increase the productivity of my land	7.4%	24.1%	66.7%
Contribute to global reductions in climate change risk	13.0%	18.5%	64.8%
Lifestyle benefits of carbon farming	20.4%	37.0%	37.0%
Social benefits of carbon farming	24.1%	38.9%	33.3%
Increase my income by selling carbon credits	25.9%	33.3%	31.5%

Note: Farmers were asked to rate the statements on a 1-5 Likert scale where 1 = Strongly disagree with statement being a reason for adoption, and 5 = Strongly agree with statement being a reason for adoption.

Table S3. Drivers of carbon farming adoption – survey 2 adopters (n = 22)

Possible drivers of adoption	# of times named as driver	%
Carbon farming will improve soil health	18	81.8%
Carbon farming will increase my yield and productivity	16	72.7%
Carbon farming will have ecological benefits such as greater biodiversity on my farm	10	45.5%
I can diversify the source of farm income by selling carbon credits	5	22.7%
Incentives and policies from my local NRM or grower groups	5	22.7%
Carbon farming will help increase my farm's resilience against climate change impacts	4	18.2%
Government incentives and policies for carbon farming	4	18.2%
I can increase farm income by selling carbon credits	2	9.1%
Incentives and policies from an environmental organisation	1	4.5%
Other	1	4.5%

Note: Farmers were asked to tick the three most important reasons for adopting carbon farming.