AARES National Conference

2010

Paper Title: Productivity tradeoffs and synergies for grazing lands in central Queensland to generate carbon offsets

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Abstract:

This paper reports research seeking to understand the economic implications for central Queensland graziers of participating in a carbon trading scheme and to measure the likely participation of graziers in an emissions trading scheme under various market design scenarios.

An initial desktop study was undertaken to compare an enterprise which produced only cattle to one which produced cattle and sequestered carbon. The findings from this analysis were used to inform the design of an experimental auction to test alternative carbon trading scenarios.

An experimental workshop was conducted at seven locations across central Queensland with a range of beef producers, extension officers and consultants. Participants were presented with a scenario in which they had the choice of maintaining current management practices against altering management practices to reduce beef production and enter into a carbon sequestration contract (CSC). They were asked at what price they would enter into a CSC and how that price and likelihood of participating would change under a range of alternative contract conditions.

The results of the experimental auctions found significantly higher than breakeven prices for carbon would be required before landholders would offer land as a carbon offset. Participation rates were influenced by price and also the carbon contract rules. Five rule changes were trialled and all were found to have a significant impact on reducing participation and increasing required payment levels.

Introduction

In September 2008 the Australian Government announced plans to introduce an emissions trading scheme to be known as the Carbon Pollution Reduction Scheme (CPRS) (Department of Climate Change 2008a). The stated aim of the proposed scheme is to reduce carbon emissions and will initially cover the stationary energy, transport, fugitive emissions, industrial processes, waste, and forestry sectors. Initial policy papers proposed that agriculture will initially be exempt from the scheme and a final decision on inclusion will be made in 2013 for implementation in 2015 (Australian Government 2008). This position was revised and the policy at time of publication is that agriculture will be permanently excluded from the CPRS. However, the Australian Government has also indicated that agriculture will need to demonstrate reductions in emissions to meet world best practice standards (Department of Climate Change 2009).

The Fitzroy Basin in Central Queensland is the second largest externally draining catchment in Australia (after the Murray-Darling), and is representative of a number of regions in Australia with a range of resource intensive industries. Almost eighty per cent of the Fitzroy Basin is currently grazing land and as such the region has the potential to be both negatively impacted by any emissions trading scheme but also to contribute to emissions reduction through vegetation sequestration. This paper examines the economic tradeoffs for graziers of trading carbon offsets from regrowth vegetation in a voluntary carbon trading scheme and estimates likely participation under a range of market design and reporting frameworks.

Carbon Emissions Accounting and Trading

The proposed Australian Carbon Pollution Reduction Scheme will begin operation in 2011 and cover most major greenhouse gas emitting sectors; however at this stage agriculture is excluded. The Australian Government has indicated that a system for sequestration credits will be developed to allow offsets from agricultural sources including direct emissions from livestock, manure management, fertiliser use, savanna burning and avoided deforestation (Department of Climate Change 2009).

In addition to these requirements agriculture is likely to experience increases in the costs of inputs including fuel, electricity and fertilizer as major emitters pass on the costs of abatement (Keogh 2007).

Several emissions trading schemes are already operating internationally. These include the European Emissions Trading Scheme which covers the energy and industrial sectors in 27 countries across the European Union. The New Zealand Emissions Trading Scheme began in 2008 with the forestry sector. New Zealand is the only national emissions trading scheme other than Australia which is proposing to include agricultural emissions in a mandatory reporting program (New Zealand Government 2009). Japan has a Voluntary Emissions Trading Scheme which also began in 2005 to trial emissions trading, initially between 31 businesses.

The voluntary carbon emissions market in Australia consists of a range of programs such as 'Greenhouse Friendly' which provide accreditation to companies which follow certain practices to reduce their carbon emissions (Department of Climate Change 2008b) and several companies which are offering landholders payments in return for changed land management practices such as reducing land clearing.

Impact of greenhouse gas emissions policy on Agriculture

Since the release of the CPRS Green and White papers a profusion of modelling has appeared from various sources on the potential impact of an emissions trading scheme on agriculture. Modelling from the Commonwealth Treasury found that the impact on economic growth would be minimal (real GNP per capital growth of 1.1 per cent compared to 1.2 per cent without CPRS) and that agriculture would maintain its comparative advantage in global markets (Treasury 2008). In comparison, modelling which considered specifically the impacts on agriculture at the sector and farm level, found significant decreases in profit and production under almost all CPRS scenarios across most industries (CIE 2009; Ford *et al.* 2009; Keogh 2009; Tulloh 2009).

The results published by ABARE (Ford *et al.* 2009; Tulloh 2009) were the most positive for agriculture, predicting a three per cent increase in grain profitability and a minimal 1.6 per cent fall in livestock productivity by 2020 (assuming that agriculture becomes a covered sector from 2015). Importantly, ABARE assumed that similar policies including agriculture would be implemented in major international markets within a similar timeframe. However, currently the only other major agricultural producer considering the inclusion of agriculture in an emissions trading scheme is New Zealand. Therefore significant impacts on export market competiveness are likely.

The modelling conducted by ABARE does recognise the fact that the agricultural processing sector will be covered from 2011. This sector is highly trade exposed and therefore unlikely to be able to pass on the full rate of cost increases to the consumer.

Thus, along with increased prices for inputs including fuel, electricity and fertilizer, agricultural producers will potentially face lower prices for their outputs (Tulloh 2009). Early modelling conducted by the Australian Farm Institute (AFI) based on representative farm financial models found that the beef and sheep industries would experience large declines in returns as measured by the difference in farm cash margins (-6% to -20%). Further modelling conducted by the Centre for International Economics (CIE) for the AFI predicted a 9 per cent fall in gross value of production (GVP) for beef by 2020 and a fall of almost 30 per cent by 2030 (CIE 2009). GVP was also predicted to fall across other major sectors of the agricultural industry with the worst affected being wool (-27.48% by 2030) and sheepmeat (-21.02% by 2030). This modelling was based on an assumption of 100% free allocation of permits in 2015, reducing to zero over a period of ten years.

As noted by AFI in a second report released in September 2009 the results produced by all models are dependent on the assumptions of policy design and carbon price made by each institution (Keogh 2009). While each has striven to make these assumptions based on current government policy and price expectations, significant uncertainty exists to reduce confidence in any estimate at this stage. As a result ongoing research is required to ensure accurate measurement and monitoring protocols are in place prior to the commencement of any emissions reduction scheme.

Various attempts have been made to estimate the potential supply of carbon credits from agriculture (for example Antle et al. 2007; Lawson et al. 2008). Antle (2007) used county level data agricultural census data from the United States to construct profit functions which were then used to derive soil carbon supply curves based on marginal opportunity costs of carbon sequestration versus current cropping practices. This method found that to accurately model carbon sequestration would require a comprehensive model of land use choices with capacity to account for spatial variation in opportunity costs.

Lawson et al (2008) estimated that at a carbon price of \$29.10 CO_2^{-e} approximately 25 million hectares of land in Australia would become economically suitable for afforestration, 40 per cent of which would be in Queensland. Lawson et al (2008) estimated that this area of land would sequester approximately 623 million tonnes of CO_2^{-e} over the period 2007-2050.

These estimates are largely based on biophysical potential and to a lesser degree on economic viability; they do not take into consideration the range of other factors such as social dynamics or biodiversity considerations which may also influence land use decisions. A review of biosequestration options for Queensland found that although there was biophysical potential for up to 225 million tonnes of CO_2^{-e} to be sequestered on rural land annually, the actual potential was likely to be only 10 to 15 per cent of this figure (CSIRO 2009). Figures estimated in CSIRO (2009) also differ significantly from those calculated by the Garnaut Climate Change Review (Garnaut 2008). For example, Garnaut estimated that approximately 286 million tonnes of CO_2^{-e} per year would be available from rangelands. Estimates contained in the CSIRO report are for only 75 million tonnes per year from rangeland sources, a third of which would be in Queensland. Of this it is estimated that only 6.3 million tonnes would actually be offered as carbon offsets. The magnitude of the differences between these estimates highlights again the need for further research to understand not only the biophysical potential for carbon offsets but also the economic and social potential.

In addition, many of the options for biosequestration proposed by Garnaut (Garnaut 2008, Table 22.2, page 543) are not currently available under the conditions of the Kyoto agreement as signed by Australia. The biggest source Garnaut identified was the rehabilitation of rangelands and mulga country degraded by overgrazing. Australia elected not to sign Article 3.4 of the Kyoto protocol which covers grazing management in the 2008-2012 reporting period (Department of Climate Change 2008c). The reason for not including Article 3.4 was concern over the risks of emissions from natural disturbances such as wildfires and droughts having to be included in the National Greenhouse Gas Inventory (Department of Climate Change 2008c).

Designing Policy Solutions

While it appears that agriculture will be permanently exempt from a compulsory emissions trading scheme, indications are that some form of emissions management will be implemented for the sector. Difficulties such as achieving acceptable levels of measurement accuracy, reporting and transactional costs make the inclusion of agriculture under a similar format to the CPRS problematic. This is particularly so for the extensive grazing sector.

There are approximately 60,000 beef producing entities in Australia compared to only 1000 entities required to report under the first stage of the CPRS. These 1000 entities represent those businesses which emit greater than 25 000 tonnes of CO_2^{-e} per year. Applying the same assumptions to agriculture would mean that less than one per cent of Australian agricultural entities would be required to directly report. The farms covered under this threshold represent only two per cent of agricultural emissions (Ford *et al.* 2009; Tulloh 2009).

The framework used to calculate the current National Greenhouse Gas Inventory (AGO 2006) calculates methane emissions from tropical pastures based on factors developed by Kurihara (1999) and Kurihara *et al* (2006). The calculations are based on standard estimates of liveweight, liveweight gain and dry matter intake for broad classes of cattle. Whilst this method provides a sufficiently accurate estimate for national emissions accounting and Kyoto reporting, it does not take into account the large variation in seasonal conditions, grazing management and breed which occur in northern Australia. An emissions trading or carbon offset scheme for agriculture, in whatever form it takes, will essentially be a case of creating a market for a product which was previously a public good. The use of market based instruments to resolve market failures in the area of environmental and natural resource management is a relatively new but not untested system. Previous experience both within Australia and internationally has shown that the specific design details of the scheme will have significant impact on how successful the scheme is.

Auctions for carbon offsets

Auction mechanisms[1] have previously proven successful in procuring the supply of environmental services in Australia (Rolfe *et al.* 2008; Stoneham *et al.* 2003; Windle & Rolfe 2008) and overseas (Cason & Gangadharan 2007). To be successful auctions need to have high numbers of participants who have access to good information regarding the value of the goods to be offered.

Participants in agricultural carbon contracts are likely to be small producers who are less than perfectly informed, have difficulty estimating true opportunity costs and face resource constraints in increasing knowledge and ability to calculate true values. There are potentially many eligible bidders, however insufficient knowledge of the process, long term consequences and distrust of governments are likely to be barriers to entry. The large number of potential bidders supplying relatively small amounts of carbon also results in high transaction costs. To mitigate perceived risks in this environment landholders are likely to overstate costs and offset values which may result in their bids being rejected. Therefore, the efficiency of the final outcome will be dependent on the auction design and how the price discovery process is managed.

A review of auction literature finds that ascending auctions tend to favour advantaged bidders, deter weaker bidders and are often subject to issues of collusion (Klemperer 2002). Alternatively, sealed bid auctions are more likely to attract greater numbers of bidders as ‘weaker’ firms have a greater chance of winning (Klemperer 2002). However, sealed bid auctions require bidders to have good information about the distribution of their rivals’ values to bid intelligently (Klemperer 2002). Given that in the market for agricultural carbon offsets bidders may not have good information on their own values, there is little chance that they will have good information on rivals’ values. This may lead to high levels of over-bidding to compensate for lack of information and to avoid risks of the ‘winner’s curse’ (Rolfe *et al.* 2009)

[1] A process by which private suppliers of a good or service (in this case environmental services) bid for incentives to supply environmental services such as improved water quality. The incentives are awarded to the bids which represent the greatest outcome per dollar invested.

Methodology

The focus of the research reported in this paper is to explore how landholders in the Fitzroy basin in central Queensland might potentially be involved in a carbon offset market. Research was conducted to explore the level of economic incentives required and the likely participation levels in carbon offset markets under different operating rules. The key management strategy of interest was for landholders to allow vegetation regrowth to occur, with subsequent impacts on beef cattle stocking rates and profitability.

The analysis was conducted on the assumption that agriculture would be involved in an emissions trading scheme. While it appears that this may not happen directly, there is still an expectation for agriculture to be involved in emissions reductions in some form.

The economic tradeoffs of cattle production versus carbon sequestration were initially calculated using a desk-top benefit cost analysis. The case study considered an 1100 hectare property in central Queensland which currently produces cattle for the trade market. The property is a mix of poplar box, Brigalow, bauhinia and silver leaf ironbark landtypes and current runs approximately one adult equivalent (AE[2]) to 7.3 hectares. The estimated returns from the current cattle enterprise were calculated using representative, regionally accurate gross margins (Best 2007). The results of this analysis were then compared to a purely carbon enterprise in which all cattle were removed and vegetation thickening was allowed to occur. Carbon income was calculated based on a carbon price of $10 per tonne CO_2^{-e} and the assumption that a total of 71 tonnes per hectare of CO_2^{-e} would be sequestered and sold over 30 years. The third scenario considered a mixed enterprise in which cattle numbers would be reduced by to 40% of original levels thus allowing the sale of some cattle plus the trading of carbon credits through sequestration in vegetation. The three scenarios were analysed using a discounted cash flow to compare relative returns over the long term. The key assumptions used for this analysis are listed in Table 1.

[2] An Adult Equivalent (AE) refers to a method of comparison between animals of different feed requirements with a recognised standard of a single adult animal feed ration. The international standard being a single non-pregnant, non lactating animal of 455 kilograms live weight EQUALS 1 AE.

This analysis assumed that the only costs to a grazier of participating in a voluntary carbon trading scheme were the opportunity costs of foregone cattle production and the only benefits would be payments for carbon offsets. For this analysis there was no attempt made to incorporate the affects of on-property emissions, transaction costs associated with a carbon reporting framework or perceived risk on the part of landholders.

Table 1 Desk-top study assumptions

Desktop Study	Assumptions
Landtype	Poplar box/Brigalow
Enterprise description	Trade steers for domestic market
Gross margin	$168.61/AE
Analysis period	30 years
Discount factor	8%
Carbon price	$10/tonne CO2-e
Carbon sequestration	2.4 tonnes per hectare per year for the first 7 years, 0.35tonnes per hectare per year thereafter.

In the second stage of the research, landholders' willingness to accept payments for carbon offsets was tested using an experimental auction. The auction used a sealed bid format which included a general information session on carbon trading policy, risks and opportunities. The aim of this was to provide all participants with the same level of information and improve their chances of providing bids which reflected their true costs. Participants were drawn from Queensland Primary Industries and Fisheries (QPIF) extension networks, AgForce contacts and Fitzroy basin Association (FBA) sub-regional group contact lists. Workshop locations and participant numbers are shown in

Table 2. A copy of the auction rules and bid cards is included in Appendix A.

Table 2 Workshop Locations and Participant Numbers

Location	**No. Completed Bids**
Biloela	51
Rockhampton	18
Emerald	47

Springsure	7
Nebo	3
TOTAL	126

The format of the experimental auction workshop was as follows; participants were given an information session on carbon trading policy, risks and opportunities then the rules of the ‘mock’ carbon auction were explained. Participants were asked to imagine that the CPRS had been introduced and that offsets from agriculture were being sought. The auctions were conducted in two stages. The first asked participants to consider four scenarios which included a photo standard, details on land-type, pasture, carrying capacity and condition. Participants were asked to imagine that they owned the paddock as described and to answer questions regarding; how they would treat vegetation regrowth in that paddock under current grazing strategies, the payment they would require to implement the rules of the carbon trading scheme and the likelihood that they would participate in the scheme given the rules as stated. Four scenarios were developed based on different land types with different levels of grazing productivity. The four scenarios were:

- Brigalow High Density (Tree Basal Area: 8m^2/hectare)
- Brigalow Low Density (Tree Basal Area: 3m^2/hectare)
- Silver-leaf Ironbark High Density (Tree Basal Area: 5.3m^2/hectare)
- Silver-leaf Ironbark Low Density (Tree Basal Area: 2.7m^2/hectare)

The bid cards and mock auction rules as given to the participants, including the details of each of the above scenarios, are included in Appendix A.

The second stage of the workshop involved asking producers to describe an area on their own property which they would include in a carbon trading scheme. They were asked to list the land-type, pasture and soil types, current grazing enterprise and stocking rate. They were then asked to state the payment they would require to include that area in a carbon trading scheme and the likelihood that they would participate. Participants were then asked to consider a list of alternative trading rules and how the changed rules would affect both their required payment level and the likelihood that they would participate. The list of trading rules under the original scenario and the alternative rules are shown in Table 3. Each of the rule changes was to be considered independently. A copy of the worksheet outlining the alternative rules is included in Appendix B.

Table 3 Carbon contract trading rules

Original Rule	Alternative Rule
1 page annual report	5 page annual report
Independent audit every 5 years	Annual independent audit
Annual payments	Payments made every five years at completion of audit
No requirement to account for methane emissions	Can only sell net carbon after methane emissions accounted for
Contract length 20 years	Contract length 50 years

The experimental auction rules allowed graziers to voluntarily undertake grazing strategies which would sequester additional carbon in return for a specified payment. Under the rules of the auction, areas which were to be used for carbon sequestration could no longer be cleared or treated for regrowth control. Cattle could continue to graze those areas but as woodland thickening occurred it was expected that carrying capacity would be reduced. The rules also stated that participants would need to implement a weed, fire and pest management plan and ensure that the land remained at or above the current land condition score. The most important assumption to note is that there was no requirement for landholders to account for their on farm emissions (including methane and land clearing). This assumption reflects the current policy for most voluntary trading schemes and the difficulty in accurately measuring on-farm emissions.

Results

Desk-top Study

Table 4 shows the difference in net present value[3] (NPV) between the current cattle enterprise and two carbon sequestration options on a per hectare basis. In the first option all cattle are removed and vegetative thickening for sequestration occurs, while in the second only 60 per cent of the cattle are removed to allow for some cattle production and vegetation thickening. Both scenarios return negative results compared to the cattle only enterprise at $10 per tonne CO_2^{-e} but positive results at $25 per tonne CO_2^{-e}.

It is currently proposed that the price of carbon in the first year of the CPRS will be set at $10 per tonne CO_2^{-e} after which it will be allowed to move with market forces and is expected to reach $25 per tonne fairly quickly. Based on this analysis the beef producer would therefore be better remaining a beef only producer in the first years of the CPRS. The initial desk-top calculation on the mixed Brigalow/poplar box landtype showed the breakeven price of carbon to be $19.60 per tonne CO_2^{-e}. This means that at a carbon price of $20 per tonne CO_2^{-e} beef producers would be better off switching to producing carbon rather than cattle (assuming no risk, and no requirement to account for emissions).

Table 4 Net Present Value Differences per hectare compared to Cattle only

Carbon Price ($/tCO2-e)	Discount rate	No Cattle	40% cattle
$25			
	6%	$ 82	$ 30
	8%	$ 66	$ 17
	10%	$ 93	$ 39
$10			
	6%	-$ 180	-$ 131
	8%	-$ 121	-$ 90
	10%	-$ 147	-$ 108

Experimental Auctions

In the experimental auction stage, seven workshops were held in central Queensland for a total of 126 fully completed bid cards. Bid card sets which were incomplete

[3] Net Present Value is the difference between the costs and benefits of a project discounted to present values terms.

were not included in the data analysis. Eleven completed bids were also removed from the data set because they contained extreme values. A summary of results from the mock carbon auctions is shown in Table 5.

The average bid price per hectare across the 115 included bids was \$163.61 (\$56.79/tCO_2^{-e}). This means that on average, landholders in central Queensland would be willing to participate in a carbon offsets scheme once the carbon price had reached \$56 per tonne CO_2^{-e}. As expected, the bid price per hectare was higher for the brigalow land type, reflecting the higher opportunity cost of beef production.

Table 5 Mock Carbon Auction results

	No. Observations	**Average Bid (\$) (500ha)**	**Average Participation**	**Average \$/ha**	**Average \$/tonne**
Brigalow	72	\$64,545.05	48%	\$182.74	\$63.43
Ironbark	52	\$52,949.42	63%	\$144.48	\$50.15

For Brigalow landtypes 26 per cent of producers would enter the scheme at the breakeven carbon price of \$20 per tonne. Despite lower opportunity costs on Ironbark landtypes only 15% of landholders would enter the scheme at \$20 per tonne in these areas. The average participation rate for Brigalow and Ironbark areas was well below 100 per cent (48 and 63 per cent respectively). This indicates that there are still a significant number of landholders who would not participate, regardless of price offered.

The results were also analysed using multiple regression analysis to examine any relationships between bid prices and participant characteristics. The regression analysis showed that level of education and brigalow areas were positively and significantly related to bid level. This means that as education levels increase, so do bid levels. It was also found that the larger the area supplied, the higher the bid per hectare demanded.

Participation rate rose with participants' education level but fell for Brigalow areas and areas with a higher stocking rate. There was no significant relationship between bid level and stated participation rate which indicates that some landholders would not participate regardless of the level of payment offered.

The difference in bid price received for Brigalow and Ironbark landtypes was significant at the 5% level using an independent samples t-test. This is indicative of the difference in cattle production opportunity cost between the two landtypes. There was no significant difference between bid price for high carrying capacity Brigalow and low carrying capacity Brigalow which indicates that the difference in opportunity costs of production was not considered. The same result was found for different carrying capacities of Ironbark.

A multiple regression model was constructed to examine the demographic factors which affect bid prices and participation. Table 6 shows the results of the multiple regression for factors affecting bid price. The number of hectares offered (Ha), education level (Education) and Brigalow landtypes (Brigcard) were found to be significant explanatory variables for bid price

Table 6 multiple regression for bid price

Coefficients[a]

	Unstandardised Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	-19606.6	11604.1		-1.7	0.94
Ha	100.3	20.8	0.4	4.8	0.0
Education	7568.2	3642.9	0.2	2.1	0.00
Brigcard	11837	6078.5	0.2	1.9	0.054

a. Dependent Variable: bid $R^2 = 0.23$

As shown in Table 7, number of hectares offered (Ha), Brigalow landtypes (Brigcard) and stocking rate (Highstock) were found to be significant explanatory variables for participation rate.

Both models were found to be significant but with low explanatory power. The R-squared values were 0.23 and 0.197 for the bid price and participation models respectively.

Table 7 Multiple regression for participation

Coefficients[a]

	Unstandardised Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	0.402	0.125		3.209	0.002
Ha	0.000	0.000	0.195	2.020	0.046
Education	0.071	0.038	0.168	1.891	0.061
Brigcard	-0.145	0.063	-0.206	-2.322	0.022
Highstock	-0.197	0.061	-0.282	-3.224	0.002
bid	-2.595E-7	0.000	-0.027	-0.267	0.790

a. Dependent Variable: Participation $R^2 = 0.02$

The second part of the experimental auction workshops involved exploring the impact of alternative carbon conditions on bids and participation rates. Figure 1 shows the percentage increase in the level of payment which would be required under alternative contract conditions. Results indicate that if contracts were for 50 years there would be a fifty per cent increase in required payment levels compared to original bids based on a 20 year contract. Increases in administration requirements (5 page report, yearly independent audit; compared to 1 page annual report, independent audit every 5 years) would require a corresponding thirty per cent increase in yearly payments. The increase in administration (measurement and monitoring) costs associated with accounting for methane emissions is reflected in the forty per cent increase in required payment levels under this scenario.

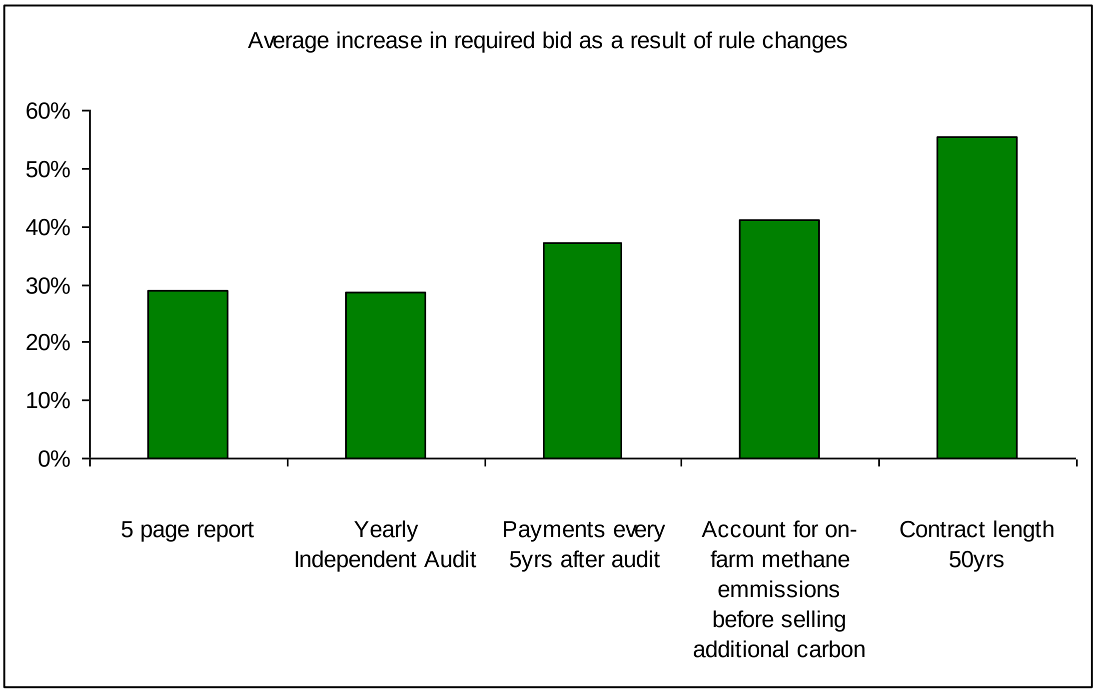

Figure 1 Percentage bid change under alternative rules

Under all alternative contract conditions tested the rates of participation fell significantly compared to the original conditions. Table 8 shows the percentage of participants with a less than 50 per cent likelihood of participating under each alternative condition. It is significant to note that the inclusion of methane emissions in accounting had the greatest impact on participation; however increasing contract length had the greatest impact on bid levels.

Table 8 Percentage of participants with a less than 50% likelihood of participating

	Original	5 page report	Yearly Independent Audit	Payments every 5yrs after audit	Account for on-farm methane emissions	Contract length 50yrs
Brigalow	38%	63%	61%	68%	83%	75%
Ironbark	23%	73%	75%	77%	94%	85%

Discussion

The results of the desktop study of the economics of carbon sequestration on grazing lands indicated that even at low carbon prices, landholders would benefit from introducing a carbon enterprise into their business, assuming that they don't need to account for on-farm emissions. This would involve some modest reductions in stocking rates to allow more vegetation regrowth, and hence carbon accumulation. However this does not consider the risks in participating in a carbon offsets scheme nor include a penalty for on-farm emissions or emissions from land-clearing. The requirement to account for on-farm emissions, including those from land-clearing would change these results significantly.

These findings were tested in a workshop setting with current producers. When the option of including a carbon enterprise into a cattle business was tested with producers in central Queensland several trends emerged. The first is that producers generally had a very low level of understanding of most concepts regarding climate change and emissions trading schemes. As a result many participants found it very difficult to complete the bid sheets. The biggest challenge to producers was to calculate the capital value implications of signing up to long term carbon sequestration contracts. Factors outside basic bid price including education, land type, location and area offered were found to have an impact on participation and bid price itself was influenced by more than simply the opportunity cost of a carbon enterprise.

Returns from biosequestration on grazing land are highly sensitive to the carbon price. Initial desktop studies used a base carbon price of $10 per tonne CO_2^{-e} and conducted sensitivity analyses at $25 per tonne CO_2^{-e}. Results of the experimental auctions showed that less than 20% of producers indicated that they would enter a voluntary trading scheme at a carbon price of $10 per tonne CO_2^{-e}. Of those producers who would enter the scheme at this price the average likelihood of participation was less than 50 per cent. These results and the results of testing the sensitivity of producers to alternative conditions suggest that at low carbon prices very few beef producers would be willing to voluntarily change their practices to sequester carbon. This is particularly true given the high degree of uncertainty regarding CPRS rules and implementation at the time of data collection.

A limited number of carbon prices have been tested in these scenarios based on the price which is set for the first year of the proposed CPRS and possible prices in subsequent years. However, there is a great deal of uncertainty regarding the level carbon prices may reach and in what time frame. In addition to uncertainty regarding payments for carbon credits, producers in the experimental auctions expressed significant concerns regarding the ability of current protocols to accurately measure emissions and sequestration, the cost of doing so, liability in the case of fire and the impact of participating in the CPRS on the capital value of their property.

The supply (i.e landholder participation) of carbon offsets from grazing lands in central Queensland is dependent on factors other than simply the price offered. Characteristics including the area and type of land considered, current stocking rates, education level of the landholder and geographic location impact significantly on the level of payment required by landholders and the likelihood that they will participate in a voluntary carbon offsets scheme. Any market design for carbon offsets from grazing land should consider these factors. Also to be considered is the difference between average bid price received in experimental auctions and the breakeven cost of providing carbon which demonstrates the level of risk premium graziers are incorporating in their bids as a result of uncertainty regarding carbon scheme rules and the likelihood that rules may change in the future. The magnitude of this risk premium is likely to fall if and when emissions trading is introduced in Australia and the rules of the carbon emissions framework (including verification and reporting requirements) applicable to agriculture are understood by industry.

Conclusions

The economic analysis reported here suggests there is an opportunity to diversify income from grazing businesses depending on the final rules of an emissions trading scheme (ETS). However, participation is likely to remain low in a voluntary system until clarity is received on trading rules and contract frameworks.

At the same time, the results of this study highlight a lack of knowledge amongst landholders regarding carbon offsets, the impact of a carbon emission trading scheme on their business and what the long term implications might be. This lack of knowledge is reflected in the diversity of bid prices received and the difference between these bid prices and the breakeven price of carbon calculated in the desktop studies. This risk premium is largely influenced by uncertainty over rules for carbon trading and the concern that rules may change after contracts are signed.

This analysis assumed that graziers would not be required to account for emissions from livestock or routine clearing. However, if they were required to account for these emissions, most graziers would be net emitters and therefore worse off under an ETS. Under these conditions it is expected that regrowth clearing in central Queensland would largely cease, woodlands would thicken and livestock numbers would decrease as graziers adjust stocking rates to match declining carrying capacities.

Acknowledgements

The research reported in this paper was fully funded by the Fitzroy Basin Association. The authors gratefully acknowledge the contributions and support from FBA staff and board members.

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Appendix A

Bid Card Number 1 – Brigalow High Density

Tree basal area: $8m^2$haCurrent stocking rate: 1AE: 8ha (20ac)

Paddock size: 500ha (total property area: 5,000ha)

Pasture: buffel

Water points: 1 trough

Fences: Good condition

Location: NOT in a priority area

Answer the following questions.

What action you would normally take in a paddock of this condition to continue grazing? (e.g. blade-plough now, blade-plough in five years, no action)

How many hectares of this paddock would you include in the CSC?

How much would you wish to be paid to enter into a Carbon Sequestration Contract (CSC)? (under the stated rules) $ /yr

How likely is it that you would participate given the stated rules of a CSC? (ie 100% - would definitely participate, 0% definitely would **not** participate) %

The stocking rate you would expect after 20 years (if under a CSC):

Bid Card Number 2 – Brigalow Low Density

Tree basal area: $3m^2$ha

Current stocking rate: 1AE: 4ha (10ac)

Paddock size: 500ha (total property area: 5,000ha)

Pasture: buffel

Water points: 1 trough

Fences: Good condition

Location: NOT in a priority area

Answer the following questions.

What action you would normally take in a paddock of this condition to continue grazing? (e.g. blade-plough now, blade-plough in five years, no action)

How many hectares of this paddock would you include in the CSC?

How much would you wish to be paid to enter into a Carbon Sequestration Contract (CSC)? (under the stated rules) $ /yr

How likely is it that you would participate given the stated rules of a CSC? (ie 100% - would definitely participate, 0% definitely would **not** participate)

%

The stocking rate you would expect after 20 years (if under a CSC):

---------------------------- Ha/head

Bid Card Number 3 –Silver-leaf Ironbark High Density

Tree basal area: 5.3m^{2}ha

Current stocking rate: 1AE: 8ha (20ac)

Paddock size: 500ha (total property area: 5,000ha)

Water points: 1 trough

Fences: Good condition

Location: NOT in a priority area

Answer the following questions.

What action you would normally take in a paddock of this condition to continue grazing? (e.g. blade-plough now, blade-plough in five years, no action)

How many hectares of this paddock would you include in the CSC?

How much would you wish to be paid to enter into a Carbon Sequestration Contract (CSC)? (under the stated rules)

$ ----------------------------- /yr

How likely is it that you would participate given the stated rules of a CSC? (ie 100% - would definitely participate, 0% definitely would **not** participate)

-----------------------------%

The stocking rate you would expect after 20 years (if under a CSC):

----------------------------- Ha/head

Bid Card Number 4 –Silver-leaf Ironbark Low Density

Tree basal area: 2.7m^2ha

Current stocking rate:

1AE: 8ha (20ac)

Paddock size: 500ha (total property area: 5,000ha)

Water points: 1 trough

Fences: Good condition

Location: NOT in a priority area

Answer the following questions.

What action you would normally take in a paddock of this condition to continue grazing? (e.g. blade-plough now, blade-plough in five years, no action)

How many hectares of this paddock would you include in the CSC?

How much would you wish to be paid to enter into a Carbon Sequestration Contract (CSC)? (under the stated rules) $ /yr

How likely is it that you would participate given the stated rules of a CSC? (ie 100% - would definitely participate, 0% definitely would **not** participate)

%

The stocking rate you would expect after 20 years (if under a CSC):

Auction 2 – Individual Bid Card

Nominate an area on your property, or a property you are familiar with, which you think would be suitable for a Carbon Sequestration Contract. (At least 50 hectares)

Describe the area – it should be a paddock which has the potential for regrowth to occur

Area/Paddock size		ha
Vegetation	Brigalow	%
	Ironbark	%
Last regrowth control	Pulled	Year
	Blade-ploughed	Year
	Graslan (or similar)	Year
		Year
Soil type		%
		%
		%
		%
Pasture	Buffel	%
	Speargrass	%
		%
		%
Condition	A	%
	B	%
	C	%
	D	%

Current enterprise (e.g. steers, breeders)	
Current stocking rate	
Expected future stocking rate under a CSC	

How much would you wish to be paid for this Carbon Sequestration Contract?

$-------------------------/yr

How likely is that you would participate given the stated rules of a CSC (100% - would definitely participate, 0% definitely would **not** participate)

-------------------------- %

How much would your bid and likelihood of participation change if the following rules were implemented?

(Assume all other rules remain the same, each possible rule change is independent)

Rule	Bid change (+/- %)	New Participation Rate
Example	*double*	*20%*
Yearly report 5 pages		
Yearly independent audit required		
Payments made every five years at completion of independent audit		
Landholders can only sell additional carbon after on-farm methane emissions accounted for.		
Contract length is 50 years		

Please list any other comments you have regarding the potential design of a carbon trading scheme for agriculture.

Appendix B

Mock Auction Carbon Sequestration Rules

Policy terms

- Landholders are not required to account for on-farm emissions, but may sell carbon sequestered on their land.

Under the terms of the Carbon Sequestration Contract the following management actions would be prohibited:

- mechanical clearing e.g. blade-ploughing, pulling, thinning
- chemical clearing e.g. Graslan etc
- stocking rates above current levels

Landholders would also be required to:

- implement a fire prevention plan (including firebreaks, control burning etc)
- implement a weed and pest control plan
- maintain land condition at or above current condition (ABCD framework)
- submit an annual 1-page report on progress/condition of sequestered land (including photo standard)

Contract terms:

- Carbon sequestration contracts will last for 20 years
- At the end of the 20 years the option will be available to renew the contract
- If property is sold the purchaser has the option to continue the contract. If the contract is terminated, the purchaser is responsible for any emissions released as a result of a change in management.

Payment schedule:

- Payments will be made annually at the completion of progress/condition report
- Independent audits will be carried out every five (5) years to ensure contract conditions are met.