FACILITATION OF EFFECTIVE REDUCTION OF GREENHOUSE GAS EMISSIONS FROM AGRICULTURAL SECTOR

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ABSTRACT

Greenhouse effect is a very significant issue for the Australian agricultural and land management sector. At present, the greenhouse gas emissions from the Australian agriculture represent approximately 16% of Australia's total national emissions. This paper discusses and reviews the research and key issues that need to be addressed to facilitate effective greenhouse action in Australian agriculture. It is found that all the current emission estimation tools contain no economic or mitigation components. Little is also known about the costs of best management practices to reduce agricultural emissions or enhance greenhouse sinks. Some initial research to address this gap is outlined.

Keywords: greenhouse gas emissions, agriculture, tools

INTRODUCTION

Greenhouse gas emission is a very significant issue for the Australian agricultural sector. At present, the greenhouse gas emissions from the agriculture sector (excluding land-clearing) represents approximately 16 % of Australia's total national emissions (Australian Greenhouse Office, 2007a). There are now growing pressures from the community and general public to significantly improve the management practices of agriculture and reduce the greenhouse gas emissions from this sector.

On the other hand, Australian agriculture is also very vulnerable to the potential impacts of climate change. For example, the gradual warming of the planet and associated climate change may lead to severely reduced rainfall and more frequent and intense droughts, with direct implications for agricultural production, and the natural ecosystems. Indirect impacts are also likely through changes resulting from greenhouse-induced adjustments in demand and in production, both locally and globally. A recent report (Stern, 2006) highlighted the potential cost of inaction on the issue of climate change.

While agriculture has not been proposed to be directly included in any emission trading scheme developed so far, agriculture has demonstrated that it has considerable potential to help the mitigation of greenhouse gas emissions. In fact, it is argued that Australian greenhouse gas emissions are only 'on track' to meet Kyoto targets as a result of farmers planting trees (storage of additional carbon) and halting land clearing (reduction of emissions at source). In the same time, emissions from the other sectors such as electricity generating industry is predicted to increase by as much as 60% from 1990 to 2010 (MRET Review Panel, 2004).

Despite the above impressive achievements, it is realised that neither the absolute quantities of emissions, nor the potential for mitigation of greenhouse gases from the agriculture have been fully accomplished and understood.

CURRENT RESEARCH AND ISSUES

Overall, the Australian farmers and landholders are highlighted as generally not showing great interest in the current greenhouse management programs. Some of the reasons identified include:

lack of conclusive research, education, extension and suitable tools, economic issues, diversity of farming systems, and uncertainty of policy and market framework. This is further complicated by the fact that many production landholders are increasingly economically marginalised, with little resources or capabilities to invest in sustainable practices or diversified markets.

Research

Significant effort has been spent to research and understand the mechanisms of greenhouse by both the modelling and monitoring methods. A number of studies have employed the analytical methods to model carbon and other greenhouse flows (Australian Greenhouse Office, 2007b). These studies have generally improved our understanding and knowledge of the impact of greenhouse emissions and sinks. However, because agriculture has a number of unique features, including the widely distributed nature of agriculture, the difficulty of measuring small changes in annual fluxes over large areas, permanence, it is recognised that overall, greenhouse science for agriculture is still incomplete and in early stage of development at present.

At the regional and national levels, a number of studies have attempted to assess the vulnerability, adaptation strategy, and risk management of large systems of water resources, coasts, major infrastructure, and ecosystems to climate change (Jones, 2001). In these studies, systems modelling approaches are often adopted, so that the assessment can integrate several dimensions and the consideration of multiple issues and stakeholders.

There also have been considerable government and community initiatives under way in Australia (Slattery, 2004). Examples of these include the development of various models and database for Australia's national greenhouse account, Greenhouse Challenge industry program, and other sector and community-based initiatives. These schemes greatly promote the public awareness of the issue of greenhouse and climate change.

Emission estimation and decision-support tools

Despite the importance of managing greenhouse and climate change for agriculture, unless suitable extension and decision-support tools are available, it is unlikely that abatement opportunities will be widely adopted. There also have to be clear price signals or other productivity and economic benefits, or practical incentives for wide implementations.

For this purpose, a number of greenhouse auditing and decision-support tools have been developed to estimate emissions from agricultural systems and to understand key processes of carbon emissions and sinks (http://www.greenhouse.crc.org.au/tools/). GreenGauge model has also been developed by QMDC (Stephenson, 2003) to estimate net emissions of the greenhouse gases from land-based activities that align broadly with both the Agriculture and Land Use Change and Forestry sectors identified under National Greenhouse Gas Inventory (NGGI) methodologies.

Sector-specific calculators such as Grains, Cotton and Sugar Greenhouse Gas Calculators are now also available (http://www.greenhouse.crc.org.au/tools/; http://www.isr.qut.edu.au/tools; Lisson, et al 2001). These calculators allow individual growers to roughly estimate their greenhouse footprint and compare the relative contributions from fuel, soils and nitrogen for their operation.

Despite their usefulness, it is also recognised that these tools suffer several limitations. First, all these tools are merely an emissions-estimation tool with no capabilities to assess mitigation options (Stephenson. 2003). Second, they are also intended to be estimations only. Essentially, all these calculators are derived from the static simple algorithms (Table 1) based on the AGO's Factors and Methods Workbook (http://www.greenhouse.gov.au/workbook/index.html) contained in National Greenhouse Gas Inventory (NGGI). These values will therefore not necessarily represent the true local emissions which will change with time and locations.

Nevertheless, the numbers and types of emission estimation tools are continually expanding. The method and calculation algorithms are also being improved and refined (Malhi, et al 2006).

Table 1: An example of the method for calculating N_20 emissions from agricultural (cultivated) soils

Column #	**2**	**3**	**4**	**5**	**6**
System	Area (ha) *(A)*	Emission factor (kgN/ha/yr) *(EF)*	Conversion factor *(CF)*	N_20 emissions (GgN_20/yr)	$C0_2$ equivalent (Gg $C0_2$-e) *($C0_2$-e)*
Crop		0.25	1.57		
Pasture		0.25	1.57		
Total					
Algorithm: (*A* x *EF* x *CF*) x 10^{-6} x 310 (GWP) Total emission in gigagrams of C02-e from Soil Disturbance = $\sum C0_2$-e					

Economic and natural resource management issues

As found previously, there is currently only limited understanding of the relationships between agricultural management practices, and the sources and rates of greenhouse emissions. In addition, there is a particular difficulty of the lack of well-developed farm-level economics tools to guide identification of priorities for action and implementation. As a result, trade-off of alternative farming practices have not been systematically studied and compared. This information is particularly important because the agriculture industry in Australia relies heavily in being internationally competitive. Low-cost abatement methods should be actively encouraged.

To implement responses to the impacts of climate change, and to facilitate effective industry and stakeholder engagement, it is also important that the model should integrate greenhouse management with other economic, productivity or natural resource management considerations so that it can not only identify opportunities for reducing greenhouse gas emissions and enhancing greenhouse sinks, but also identify potential opportunities to contribute to the production and management and conservation of natural resources such as reducing soil erosion and improving biodiversity. It has been found that many of these practices are not only beneficial to agricultural production but might also offer potential for carbon benefits. For example, minimum tillage could reduce the soil disturbance, top soil loss and moisture loss, and result in reduced fuel use and hence lower direct emissions of greenhouse gases, although it may require more uses of pesticides. Several US studies have also showed that no-till conservation farming method could typically sequestrate more than 300 kg of carbon per hectare per year over conventional tillage method (http://www.greenhouse.crc.org.au/greenhouse_in_agriculture/grains.cfm). There may also be opportunities for reducing fertiliser emissions by reducing the volume of fertiliser used. This approach could be a “win-win” strategy, in that fertiliser costs are reduced but (to a point) productivity does not decline (Eckard, 2006). Planting trees as carbon sinks can also deliver multiple benefits including ameliorating land degradation, salinity and biodiversity loss and economic returns from harvesting timber.

Diversity of farming systems

The diversity of land systems and management practices adopted by landholders has made monitoring and estimating greenhouse gas emissions from agriculture difficult.

1. Agriculture in Australia comprises more than 120,000 enterprises, with a variety of production systems, and spread into different locations and large areas.
2. Production systems link in complex ways and can include both emissions and sinks in one system. These emissions are also from both diffuse and point sources, are highly variable in time and space, and difficult and expensive to measure.

3. Methane from livestock and nitrous oxide from fertilisers and soil carbon rundown in pastures and land clearing dominate the emissions profile of agriculture, with carbon dioxide a more limited component than in other sectors.

Government policy and carbon trading

In addition to the imposition of regulatory standards, a price signal of the cost of carbon is also needed to promote effective mitigation. It is believed that emission trading is a powerful way to promote cost-effective reductions in emissions. The prices achieved for carbon credits in other countries so far have indicated that their value could be sufficient to drive substantial changes in land use and natural resource management in Australia.

However, at this stage of development, there is still much uncertainty as to the details of how the carbon market will operate in Australia (Land & Water Australia, 2007).

For agriculture, establishment of accurate and verifiable accounting systems is also a significant challenge (Wilson, 2002; Land & Water Australia, 2007).

PROPOSED RESEARCH

Cost model development

From the above discussion, it can be seen that all current emission estimation tools contain no economic or mitigation components. This has seriously hampered the progress and implementation of best management practices. In light of this situation, it is therefore essential that a research project is initiated and implemented, to develop a cost evaluation tool to highlight the above issue, and to promote practical and cultural changes, and to strengthen our understanding and adaptation capacity.

It is expected that the first step of this research would be to extend the existing model to include a cost model (Sekhesa, 2006). Further analysis of the benefits and costs of the system will then be carried out, including detailed consideration of costing and practical issues for specific cases. It is anticipated that costs of "carbon tax" will be included in the model in anticipation of possible introduction of carbon credits trading in the future (Petersen, Schilizzi, and Bennett, 2003).

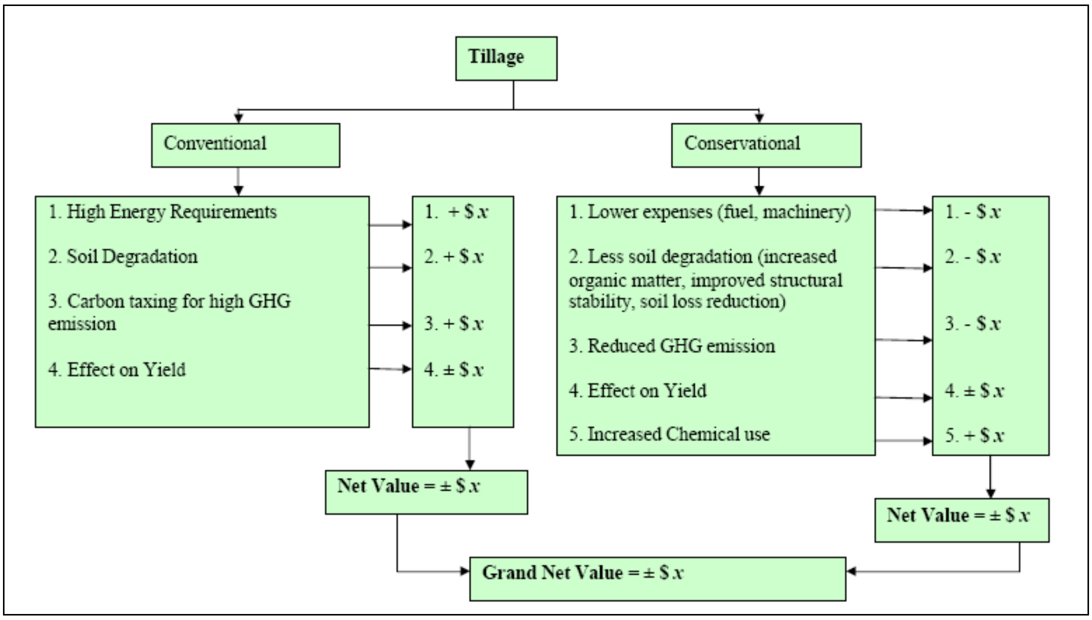

Fig.1 The example of a framework for comparing the relative costs of conventional and conservation farming tillage systems. The environmental impact has been factored in the cost model.

It is also anticipated that the model will be designed as a simple cost model, with the '+' sign on the cost columns (Fig.1) indicating expenditure (e.g. purchase costs and penalties etc). The model may also be broken down into three components: incomes, production expenditures, and environmental penalties, with

Final Profit = Incomes - Production Expenditures – Environmental Damage Costs

Cost model applications

It is anticipated that the cost model will be a useful tool to identify the specific costs and implementation opportunities in Australia. The initial case studies may focus on comparing different farming systems, especially the intensive farming systems with conventional farming systems or conservation farming systems, because it is argued that a potentially effective way of reducing agricultural emission might be intensive farming, where emissions can also be more accurately measured and monitored over time (Land & Water Australia, 2007).

After collecting sufficient data, the economics and emission estimation tool may be further developed into a benchmarking and star-rating tool in the future, to encourage best practice and to provide market recognition and a competitive advantage for low greenhouse emitters. Similar schemes have found great success in the building and electrical appliances industries http://www.abgr.com.au/.

CONCLUSION

Greenhouse is a very significant issue for the Australian agricultural sector. The sector is a major emitter of greenhouse gases, and has real potential to achieve emissions reductions. Australian agriculture is also particularly vulnerable to the potential impacts of climate change.

The research has highlighted the need for the development of an effective tool to encourage best practices. It has been found that although a number of decision-support tools have been developed, their direct uses are still rare. Economic issue has also not been appropriately addressed, together with the research into the socio-economic implications of climate change and mitigation actions. Consequently, little is known about the best management practices to reduce agricultural emissions, the costs of such practices, or the extent of their impact. There are also significant uncertainties and methodological issues with current tools. In particular, the current gaps and uncertainties in measurement and experimental data will need to be addressed.

A coordinated approach, consistent with the principles of agricultural production and natural resources best-practice management and adaptation is required to promote practical and cost-effective abatement, and to win the support of the industry. On-going commitment to research and monitoring will also provide the basis for community acceptance and support. It is proposed that not only the greenhouse and economics calculators, but a further step in star-rating and accredited auditing tool be developed. With careful management, it is possible that productivity is increased or costs are reduced as emissions are reduced. An initial cost model has also been outlined.

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