SRDC Workshop

Climate Change Coordination Workshop

Identifying research needs to better equip the Sugar Industry

June 2009, Brisbane

Workshop Notes

INTRODUCTION

This document provides a brief summary of key points arising from a climate change workshop held in Brisbane on June 19, 2009.

The workshop was facilitated by Mr. Russel Pattinson of Miracle Dog Pty Ltd, who also delivered a report to SRDC on the outcomes from the workshop.

The SRDC led workshop was developed jointly with CCRSPI, using financial support provided by DAFF, in order to support coordination and communication of climate change research needs within the Sugar sector, and to bring together policy makers, industry representatives, and researchers to discuss key impacts on sugar farmers and producers.

This report has been agreed between CCRSPI and SRDC, for submission to the Australian Government DAFF as per the terms of the Funding Agreement for CCRSPI.

PURPOSE

The purpose of the workshop was clearly articulated by Frikkie Botha (Executive Director, SRDC):

- The sugar industry has been active in the climate change area. SRDC produced its "Climate change and the Australian Sugarcane Industry – Impacts, Adaptation and R & D Opportunities" publication in 2007.
- Since that time, there have been many developments, especially in relation to policy regarding climate change and more recently emissions trading.
- It is opportune for the industry to hear about the latest research findings and to use these to further review this issue with the help of industry and researchers.

- The purpose of the workshop was to identify real gaps in knowledge so that these could be considered by SRDC and industry, subsequently prioritised and then acted on. This would then better equip the industry to meet future challenges and harness opportunities.

SETTING THE SCENE

The opening presentation set the scene for the day, describing how different policy and business drivers were emphasising the need for targeted research to help the sugar industry best meet the productivity challenges associated with climate change. Key points arising were:

- Dr Owen Cameron, of CCRSPI, presented an overview of the current policy frameworks that were shaping the research response to climate change and potential impacts on business:
    - Carbon Pollution Reduction Scheme (CPRS);
    - National Greenhouse & Energy Reporting System (NGERS);
    - Australia's Farming Future (coordinated climate change research);
    - Mandatory Renewable Energy Target;
    - National Adaptation Research Plan ;
    - Primary Industry Standing Committee (PISC) (sectoral RDE strategies)
    - National Water Initiative (NWI) & Council Australian Governments (COAG); and
    - Accounting and offset frameworks under the Kyoto Convention.
- He then discussed the opportunities available when farmers and producers viewed sustainability as a business issue and communicated their key needs to government.
- This was followed by verbal presentations from Dr. Rohan Nelson of DCC and Mr. Mark Gibbs of DAFF, who outlined the rationale for and opportunities associated with current Government policy and consultation initiatives.
- Dr Nelson emphasised the opportunity for industry to be involved in an ongoing Australian Government initiative to identify actions that could complement or be alternatives to the mechanisms of the Carbon Pollution Reduction Scheme (through reducing emissions, supporting best practise on farm, and maintaining and enhancing productivity).
- Mr Gibbs described the Australian Government's investment in a comprehensive suite of research initiatives under Australia's Farming future. Further detail on this investment program was given in a presentation by Professor Peter Grace.
- As far as the CPRS (ETS) is concerned for agriculture, it was noted that no policy decisions have been taken as yet, though Government is strongly inclined to have agriculture included under the scheme. Such decisions will be taken in 2013

with a view to implementation in 2015. If it transpires that agriculture is not a 'covered' industry under the CPRS, the Government's intention is that the sector will have the cost of carbon recognised in some way. This may involve complimentary measures.

- The Australian Government DCC, working closely with DAFF, has formed a structure for examining the various options of how agriculture may be included. This includes the formation of the Technical Options Development Group (TODG). Ian O'Hara is a member of this Group and is one conduit to carry forward sugar industry views to Government.

- Agriculture will be impacted directly when the CPRS commences in 2011 through higher fuel and electricity costs etc.

- The Industry perspective on climate policy and research was then shared through two invaluable presentations from Mr. Bernie Milford (Canegrowers) and Ms. Sharon Denny (ASMC). Workshop participants were given a comprehensive overview of the concerns and needs as expressed by the members of these two industry bodies, and of some of the areas where industry felt further information was required.

- Discussion around these presentations highlighted the need for the industry not to just focus on the direct costs of any emissions trading scheme (ETS), but also to consider how indirect costs and financial uncertainty could impact on their businesses. Issues raised included the implications on the scale and timing of capital investment, management of risk through the supply chain, and how best to estimate likely changes in input costs.

- The biggest concern for industry at the moment is what will be the direct and indirect impact of climate change and ETS on farmers? How will emissions be estimated or "modelled" and what will be the cost of compliance?

- The importance of considering, and researching, social impacts (especially at a regional scale) was also highlighted, though there was not a consensus on who should be funding such work.

- Although here has been a considerable effort put into best practices, there is a perceived lack of data on emissions for the various industry practices.

- Sugar mills are already reporting on energy use and climate change emissions via the NGERS.

- It was also emphasised that, while challenges do exist, the industry can also focus on potential opportunities (e.g. the introduction of biofuels, seeking grants for water and energy efficiency measures, new labelling and branding opportunities).

PRESENTATIONS ON CURRENT RESEARCH

Research is being conducted on a range of issues including the source of emissions (especially nitrous oxide), soil biology and soil carbon, reducing mill emissions and green power opportunities, cane physiology, biofuels and Life Cycle Assessments.

Presentations were made on a number of important current research initiatives, by the following speakers:

DAFF research framework **Peter Grace, QUT**

Emissions

- Sugar industry emissions - models **Peter Thorburn, CSIRO**
- Emissions – nitrous oxide **Weijijn Wang, DNRW**
- Emissions – nitrous oxide **Ben Macdonald, ANU**
- Emissions – soil biology **Jirko Holst, UQ**
- Emissions at the mill **Anthony Mann, QUT**

Adaptation

- Growing Sugarcane in elevated CO2 environments. **Geoff Inmam-Bamber, CSIRO**

Life Cycle Assessment

- Sugar industry findings **Marguerite Renouf, UQ**
- Practical issues **Simon Winter, RIRDC**

A brief summary of these presentations is attached as an Appendix.

COMMENTS AND OBSERVATIONS ON THE PRESENTATIONS

The workshop discussed some initial observations, reflecting on the presentations provided beforehand, and identified a number of outstanding questions. These included:

- How will emissions be measured and at what scale (farm, region)?
- Will proxies be used instead of direct emission measurements? What is the cost effectiveness of direct on farm and on-site measurement versus the use of proxies and compliance costs? (It appears that modelling using programs such as Agricultural Production Systems Simulator (APSIM) may be useful in this area).
- What emissions result from the different farm management practices that may be employed and what effect do those practices have on yield and profit (a carbon cost curve)?
- Can we design resilient farm management systems?
- What will be the economic and social costs from climate change and ETS?
- What mitigation options exist for industry?
- What sequestration options exist for industry?
- The industry should recognize that policy decisions in the climate change / ETS space are often impacted by other policy issues (they are not mutually exclusive e.g. Climate Change and the Great Barrier Reef).
- How will ETS be applied (or not) to the agriculture sector in other countries?

- Recognize that farm emissions may increase under an ETS – it will depend on what is the highest value use of carbon!
- Communication is critical – to industry at all levels and to Government

Copies of all the PowerPoint presentations can be obtained from SRDC.

SUGAR INDUSTRY NEEDS – WORKSHOP OUTCOMES

Workshop participants were asked to consider what was needed (information, data, tools, research etc) to equip the industry to operate within a changing climate and emissions trading Framework Various "needs" were identified and are listed below. T

Subsequent to the workshop, these "needs" were grouped according to an "investment theme". The number of "needs" identified within each investment theme reflects the conversation and the workshop, and is not meant to be interpreted as being indicative of research priority.

A recurring priority across all the identified themes was the need to harvest existing data and determine what work has / is already being done for both adaptation and mitigation.

Availability of measurement data and / or proxies of sugar industry emissions.

Note: the key date for when the determination of measurements and / or proxies is needed is 2013. However, DCC indicated that the design of options for a voluntary reporting trial is required in 2011.

1. Collate existing information on emissions & farm practices – to help identify gaps and assist in the examination of measurement proxies (straw men-options). Included in this should be how reliable is existing data?

2. Understand the variability of emissions from different regions, soil conditions, farming practices and soil biology (e.g. soil bacteria, archea).

3. Accuracy of measurement and proxies (what's really needed and what's the tradeoff between accuracy, equity and compliance costs).

4. Examine the availability of commercial / proprietary software for monitoring / managing emissions data – is there any value for the sugar industry and can it be transferred to help meet future reporting requirements.

5. Develop analytical frameworks to allow for the calculation of transaction costs for individual businesses.

6. Develop a framework for consistent and agreed LCA application in the industry (and across agricultural sectors).

Farming practices to adapt to climate change

7. Identify R&D opportunities for climate change adaptations that may decrease the cost of production and / or improve soils and moisture retention.

8. Improved cane varieties for adaptation to new environments.

9. Need to understand the impact of climate change on the whole farming system, not just the cane component.

10. Be open to considering innovation and new technologies developed in overseas markets.

Farming practices to reduce emissions

11. Develop a hierarchy of farm management practices – structured on their impacts on emissions and productivity.

12. Identify opportunities, via measurement or proxies, of quantifiable change in emissions that may be eligible as offsets for farmers.

13. Opportunities from GM for the sugar industry – and their impact on both emissions and production.

14. How to decrease N fertilizer use, reduce emissions but increase output and thus productivity and profitability (improve soil response, N use efficiency etc).

15. Better understanding of the plant / soil micro environments and how these may be better harnessed to reduce emissions and increase production.

16. Alternatives to N fertilizers (e.g. legume rotations)

17. Nitrous oxide inhibitors and fertilizer coatings – identify what's available from other sectors and what impact this may have in tropical environments.

Opportunities for diversification in the "sugar" industry

18. Research the possible farming and processing systems for energy crops. This would need to include an analysis of the whole biomass nutrient cycle and sustainability in the short term and long term (i.e. including trash removal – impacts, relationships, nutrient returns etc).

19. Mill mud – options and opportunities for its further use.

20. Co-generation technology – opportunities to accelerate adoption of new technologies. Would a greater level of assistance (via partnerships) from government support this process?

21. Examine opportunities for reducing the cost of capital to support infrastructure for diversification options and attract international innovators to support development of new technologies e.g. visibility of demonstration plants.

Sequestration opportunities for the industry

22. Examine sequestration at the mill e.g. algae to sequester CO2, greater use of bagasse.

23. Managing waste water better (at the mill and crop level) and integrate this into processing and production systems.

24. Biochar – what are the characteristics of sugar industry produced biochar and how may they impact on production and the environment. Is it as miraculous in this environment as people hope?

Economic and social impacts

25. Prepare a range of carbon cost curves (both technical and economic) using different scenarios (e.g. carbon prices) in order to examine the tradeoff between various carbon uses e.g. C trading, cane production, biofuels etc.

26. Identify the potential economic and social impacts of a range of policy options on a defined region (i.e. consider all factors including social acceptability, infrastructure etc) and then expand to other regions.

27. Skill base of farmers operating in a business environment where carbon is valued – are they sufficient?

28. Keeping the land base we have available for the industry – analyze alternative land use options and clarify impacts.

29. Understand, and where appropriate, come to terms with other policies (such as the Great Barrier Reef, water policy, wild northern rivers) that will have related impacts on industry.

Engaging with Industry and Government (Communication)

30. Provide comprehensive information about the expected environmental changes associated with climate change at a regional level.

31. Manage the expectations of businesses and individuals – processors, farmers and service providers

32. Develop stronger links between policy (Government) and research (industry) so that there is better targeting of research and analysis – i.e. understand what Government needs and what industry needs – and then identify gaps.

33. Review the latest social science to identify how to improve engagement with farmers.

34. Improve partnerships / collaboration across agricultural sectors so as to better utilize research findings, not reinvent wheels and increase opportunities to leverage government funding e.g. big opportunities between beef and sugar.

INVESTMENT OPPORTUNITIES – A BRIEF SUMMARY

A number of consistent messages emerged from the workshop, and are captured below. In summary:

1. Sugar industry decisions should be taken with the awareness that decisions on emissions trading and agriculture will be made in the immediate future, with a voluntary reporting trial scheduled to commence in 2011 and a decision about agriculture's inclusion in carbon trading to be made in 2013.

2. While there is an obvious need for more data on sugar industry emissions, it should be recognized that "there will never be enough" (i.e. it is financially impossible to get data to cover emissions for every region by soil type by management practice by climatic condition etc.).

3. The industry should consider a comprehensive review of existing emissions data so as to better identify key gaps. This review should not be limited just to Sugar industry developed information. This data should be used to build industry understanding of the impact of climate change by generating models that could help determine consequences of changes and gaps in knowledge.

4. Where research to obtain additional data is undertaken, longer term timeframes and comparability over a range of farming practices and locations should be considered. Farmers need systems to reduce emissions using cost effective management practices. It is also important to ensure that any directed / requested changes to farming systems result in a meaningful level of reduction of emissions.

5. Consideration needs to be given to the potential role of proxies for measurement in future systems – what are they, what are the compliance cost issues, what degree of accuracy is required, how would they be applied?

6. To assist decisions about sugar (and agriculture's) role in carbon trading economic models should be developed so as to "test" the impacts (both direct and indirect) of different options. Such models do not need to be comprehensive initially, but can be developed over time. They could also play an important role in identifying gaps in knowledge. However, models should not be seen as a 'silver bullet' that answers all questions.

7. While the focus of much current discussion may be on the direct economic impact of carbon trading, consideration should also be given to other factors such as the potential impact on society and social structures, infrastructure, and the need for future investment.

8. The industry needs to work closely with other parties (e.g. Government, other sectors) so as to maximise the efficiency of collaborative research investments and communication strategies.

9. In communication strategies, information on economic imperatives need to be considered and need to be relevant and linked to what it means for

farmers and millers. Effective communications must recognise that a variety of views exists on the accuracy and impacts of climate change.

End of report.

Appendix

Summaries of Background Papers

1. Understanding the sources and management of emissions

Dr Peter Thorburn, Leader: Tropical Production Systems Group. CSIRO Sustainable Ecosystems

Climate change poses the dual challenge of adapting to the change, while mitigating greenhouse gasses responsible for the change. Within the policy settings being developed by the Federal Government, CSIRO is aiming to deliver research and analysis to support greenhouse mitigation and increase carbon sequestration in land use systems. We intend to do this by helping better understanding the sources and management of emissions, exploring new opportunities for carbon sinks, and investigating the environmental, economic and social co-benefits and trade-offs associated with emissions reductions. The sugar industry has some characteristics that set it aside from other agricultural production systems, potentially giving it some diverse opportunities for helping Australia mitigate greenhouse emissions, and these will be discussed.

2. Emissions from Sugarcane production

Dr Weijin Wang, Senior Scientist, Department of Environment & Resource Management, Qld Email: weijin.wang@nrw.qld.gov.au

Greenhouse gas emissions from sugarcane soils under different N fertilizer management practices were investigated using manual chamber sampling techniques. In situ measurements were carried out on a subtropical sugarcane farm near Murwillumbah, NSW from October 2005 to September 2006 and on a tropical sugarcane farm near Mackay from November 2006 to October 2007. The annual cumulative nitrous oxide (N_2O) emissions under the farmers' fertilizer application rates (160 and 150 kg N/ha, respectively) amounted to 28 kg N_2O-N/ha from the Murwillumbah site and 3.6 kg N_2O-N/ha from the Mackay site. The emission factor (% fertilizer N emitted as N_2O) was about 10% at Murwillumbah and 1.3% at Mackay. Application of fertilizer at 80 kg N/ha reduced N_2O emissions by on average 18% and 28% at each site respectively. Polymer coated urea reduced N_2O emission by 30% on the Murwillumbah site but increased emission by 50% on the Mackay site. Removal of stubble decreased net emissions of N_2O by about 24-30%. Methane fluxes were insignificant at both sites. A life cycle analysis suggested that the production of one tonne of raw sugar emit 210-1066 kg CO_2-e greenhouse gases, depending on the site and management practices. N-related emissions are the major sources, demonstrating the importance of tightening the N cycling in mitigation management strategies. For irrigated cropping systems, minimizing electricity consumption for irrigation may be another effective management option to reduce pre-farm emissions.

3. Agricultural Emissions of Carbon, Methane and Nitrogen Gases.

Ben Macdonald, ANU, ben.macdonald@anu.edu.au

- Results of Australian Greenhouse Gas funded project which involved Australian National University (White & Macdonald), CSIRO (Denmead), Queensland Department of Natural Resources and Water (Wang and Moody), University of Wollongong (Griffith, Naylor, Kettlewell, Wilson) and BSES (Salter)
- Measurements were made at Murwillumbah (acid sulfate soil) and Mackay (sandy loam chromosol)

Gas	Source of Emission	Emission rate kg/ha/d		Net emission to atmosphere CO_2 equivalents, t/ha	
		Murwillumbah	Mackay	Murwillumbah	Mackay
CO_2	Soil	82	35		
	Crop	-150	-186	-51.5	-55.8
N_2O-N	Unfertilised soil	0.039	0.0015		
	Fertilised Soil	0.134	0.016	22.4	2.3
NOx-N	Fertilised Soil	0.102*	0.004	0.2	0.006
NH_3-N	Fertilised Soil	NA	0.002		0.003
CH_4	Fertilised Soil	.154	0	1.1	0

*Only 4weeks of measurements

- Our measurements and calculations suggests that N_2O production from Australian sugarcane soils might be much smaller than the previous estimate by Weier (1998), perhaps only one-half, or around 7% of national emissions from agricultural soils (Dalal *et al.*, 2003). Further, it indicates that although ASS constitute only about 5% of Australia's sugarcane soils, they could contribute about 25% of the national N_2O emissions from sugarcane.

4. Harnessing soil biology to improve the productivity of the new sugarcane farming system

Jirko Holst[1], Richard Brackin[1], Regina Sintrajaya[1], Peer Schenk[1], Prakash Lakshmanan[2] and Susanne Schmidt[1]

[1] University of Queensland

[2] Bureau of Sugarcane Experimental Stations (BSES)

Our research group at the University of Queensland currently investigates the effects of different sugarcane management on soil microorganisms and microbe-mediated processes in soil at field sites near Bundaberg, with a strong focus on nitrogen cycling. We determine microbial gross N turnover rates and follow the pathway of the applied fertiliser-N into and through different pools (soil, microbial biomass, crop biomass, atmosphere, groundwater) over the temporal course of the sugarcane crop cycle. Two agricultural sites are investigated: 1.) a conventionally managed sugarcane site with trash burning, flood irrigation, high N fertilisation rate and a fallow period between cane cycles, and 2.) a site managed using the "new farming system". The latter includes legume breakcrops, trash retention, controlled traffic, overhead irrigation and a reduced N fertiliser application. An adjacent forest serves as a control site. Since microorganisms are the main driver of nutrient cycling in soil, we furthermore investigate the soil microbial community composition and microbial gene expression at the three sites. Management-related effects on soil microorganisms and their activity may also affect soil carbon cycling, thus soil carbon stocks and the quantity and quality of different soil organic matter fractions are examined.

With respect to climate change, we will – based on preliminary results of our investigations – point out relevant aspects of the sugarcane cultivation and applied management practices for the production and consumption of greenhouse gases (nitrous oxide, methane) and other climate change related issues.

5. The way of the future for the sugar industry – reduced emissions and increased production of green power

A P Mann, Queensland University of Technology

The sugar industry is ideally placed to make a significantly greater contribution to the generation of green power in Australia. It is also under increasing pressure to reduce

factory emissions. This presentation summarises previous research directed at reducing factory emission levels and increasing electricity export from the sugar industry. Challenges facing the industry and areas requiring further study are identified.

6. Sugarcane physiology and CO_2 abatements and impacts

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SRDC is, or will be funding two projects dealing with climate change and sugarcane physiology. Climate change will affect sugarcane production directly through biophysical processes and indirectly through socio-economic processes as governments start implementing energy and environmental policies to deal with climate change and compliance with Kyoto Protocol commitments, urban air pollution, and energy security (Jolly, 2007). Some countries have already started selecting for 'energy canes' (Leal, 2007) and it likely that the first response in breeding programs to climate change will be to exploit the opportunity to use sugarcane as a feedstock for the energy market rather than to prepare for changes in climate per se. Brazil is of course the leader in substitution of fossil fuel with biofuel (mostly sugarcane) which supplies about 32% (2008) of their energy needs. By replacing fossil fuel, sugarcane in Brazil abates about 3.3 t carbon/ha after all carbon emissions have been deducted compared to 1.8 t C/ha for planted forests used for charcoal production (Moreira and Goldemberg, 1999). The amount of C abated is only about 1/6 of the total C captured during the growth of the average Brazilian crop (85 t/ha).

Although sugarcane is one of the most efficient plants in nature for fixing CO_2 through photosynthesis it can only manage to utilise a maximum of 3% of the radiant energy. Unfortunately most of the remaining energy is used for evapotranspiration but there is good news in climate change scenarios for reductions in water use. Recent research indicates that water use efficiency (WUE) could increase by 50% or more as CO_2 levels rise to predicted levels. A new SRDC project is to study sugarcane physiology at about 720 ppm CO_2 and will look for variation in the genepool for responses in WUE to elevated CO_2.

Another project is testing the hypothesis that sugarcane clones that accumulate fibre in preference to sucrose will produce more biomass and therefore be more suited to a biofuel market than 'sucrose' clones. Broadening of the genetic base for selection of germplasm for improved sucrose and biomass production, started in the West Indies in 1960 (Rao and Kennedy, 2007). Clones of the wild relative of Sugarcane (*Saccharum spontaneum*) have fresh stalks with up to 56% fibre. Jackson et al (2007) evaluated progeny from 43 bi-parental crosses between sugarcane and *S. spontaneum* clones, against several commercial 'sucrose' cultivars and reported a doubling of stalk biomass in clones with dry matter content as high as 41% and fibre up to 29%. It is possible that high fibre genotypes can produce higher biomass yields than high sucrose types because sucrose may feedback on photosynthesis either through end-product

suppression or through sucrose signalling compounds such as Trehalose-6-phoshate (McCormick et all, 2009). Sucrose feedback inhibition was thought to be involved in higher rates of photosynthesis when sugarcane plants were modified to produce isomaltulose as well as sucrose (Wu and Birch, 2007). Irvine (1975) measured higher rates of photosynthesis in *S. spontaneum* with low sucrose contents than commercial hybrids (*Saccharum* spp.) with high sucrose contents, possibly because of feedback inhibition. Botha (2009) compared three strategies for improving the value of sugarcane for both food and fuel markets based simply on the heat of combustion of sucrose and fibre. More energy would be derived by improving fibre than sucrose content even without the benefits of increased photosynthesis and new technologies for ligno-cellulosic fermentation. The new project is looking at photosynthesis and biomass accumulation in a range of high sucrose and high fibre clones. Photosynthesis normally declines as the crop matures regardless of how much water or nutrients are applied and if this is because of feedback inhibition then fibre types will maintain higher levels of photosynthesis for longer than will be the case in the sucrose types.

7. Opportunities for using life cycle assessment (LCA) to guide climate change mitigation

Marguerite Renouf, Lecturer (Environmental Management)

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A comprehensive LCA of Queensland sugarcane production has been undertaken, which provides baseline information on the carbon footprint of the industry. A summary of this work will be presented. The presentation will then give suggestions for how LCA could be used as a tool by the industry to 1) generate data for external accounting and reporting purposes, and 2) model alternative sugarcane systems to optimise greenhouse gas mitigation measures.