

Climate in Primary Industries

– Winter 2011

INTRODUCTION

The Climate in Primary Industries Unit has implemented a number of key research initiatives that deliver on priority actions for climate change for NSW primary industries. These include developing models to downscale global climate projections for specific industries and regions in NSW; plant and animal breeding programs, decision support tools and production systems to cope with a changing and more variable climate; developing low cost accounting and lifecycle assessment techniques for quantifying emissions at farm and forest scale; developing technologies to reduce emissions, (such as methane and nitrous oxide from agriculture and forestry), sequestering carbon in soil and forests; and developing energy from biomass. The key questions that this Unit considers are:

- » What are the impacts of a changing climate on primary industries and associated rural communities?
- » How can primary industries and communities adapt to these changes?
- » What are the options available to primary producers to reduce their emissions and sequester carbon?
- » What research is required to inform the development of policies designed to address a changing climate?

RESEARCH CAPABILITIES

- » A dedicated unit of 52 of the Department's top research staff are directly involved in climate impact and mitigation research. A number of other staff embedded within other units are also involved in involved in adaptation research.
- » A network of 14 research institutes and 13 supporting stations across the state.
- » Plant and animal scientists ranked in the top 1% of the world.

CONTACT US

For more information on our full portfolio please contact Dr Georgina Kelly (02) 9872 0151 or georgina.kelly@industry.nsw.gov.au

- » Effective integration with extension staff ensures adoption while strong links with policy staff ensures policy is underpinned by sound science.

RESEARCH PRIORITIES

- » Climate impacts and adaptation.
- » Methane from livestock.
- » Soils for climate mitigation.
- » Forests for climate mitigation.
- » Biomass and bioenergy.

CLIMATE IMPACTS & ADAPTATION

Research is undertaken to assess the impact of climate change and develop strategies to cope with those changes in order to maintain future food security and productivity.

IMPACT OF CLIMATE CHANGE ON NSW WHEAT DEVELOPMENT (2010–2012)

INTRODUCTION: Temperature is one of the main drivers of the wheat developmental processes. We downscaled Global Climate Models for 509 sites across the NSW wheat belt and investigated the impacts of climate change on wheat development.

FINDINGS: Days to flowering (DTF) of spring wheat will be shorter in the NSW wheat belt; frosts risks will be lower while heat stress at flowering time and during grain fill will vary depending on wheat type, time of sowing and geographical location. Managing sowing dates, changing varieties, or limiting the sowing of winter varieties can help mitigate the impacts of climate change on wheat. This research will guide the development of future cereal breeding and crop management programs in NSW.

CONTACT: Dr De Li Liu (02) 6938 1922

PARTNERS: Primary Industries Innovation Centre, alliance between UNE and NSW

THE EFFECT OF CLIMATE CHANGE ON AUSTRALIAN TREES AND FORESTS (2009-2012)

INTRODUCTION: CO₂ levels in the atmosphere are expected to continue to rise in the foreseeable future due to fossil fuel use. This will have an impact on the way plants grow. The Hawkesbury Forest Experiment in Sydney has investigated the effects of elevated CO₂ on young trees growing in large environmentally-controlled chambers.

FINDINGS: Results show that under elevated atmospheric CO₂, trees used less water to fix the same amount of carbon. While they fix slightly more carbon per unit leaf area, the main benefit is their capacity to continue production during periods of water stress, grow faster and/or reach maturity sooner. Research is continuing on combined impacts of high temperatures and elevated CO₂, and the partitioning of carbon above and below ground. This research underpins the development of models of forest growth, carbon sequestration and water use in forested catchments.

CONTACT: Dr Craig Barton (02) 9872 0199

PARTNERS: OEH, UWS, DAFF, DECCE, UTS, Mac Uni, USyd, UNSW, Swedish University of Agric.Sci

METHANE FROM LIVESTOCK

Agriculture contributes 16% of Australia's greenhouse emissions. Around 67% of these emissions are methane from ruminant livestock. Methane has a global warming capacity 23 times that of CO₂, so it is important to find ways to reduce livestock methane emissions. Our livestock methane research focuses on developing technologies to measure and monitor methane emissions; genetics to breed low emission sheep and cattle; rumen modification; and testing methane inhibitors in feed.

BREEDING CATTLE AND SHEEP FOR LOWER GREENHOUSE GAS EMISSIONS (2009-2012)

INTRODUCTION: Cattle and sheep emit methane, a potent greenhouse gas, as part of the fermentation process in their stomach. If lower methane production were an inherited trait then farmers could use superior bulls and rams to breed future generations of animals with lower methane production.

FINDINGS: Preliminary results show that low methane bulls produce less than half the methane per unit of feed eaten or kilogram of animal product than high emitting bulls. Some of this variation appears to be heritable. This opens the possibility that farmers may be able to use animal breeding to reduce methane emissions from their herds and flocks while maintaining or enhancing productivity.



CONTACT: Dr Robert Herd, Armidale, (02) 6770 1808

PARTNERS: DAFF, MLA, UNE

SOILS FOR CLIMATE MITIGATION

Soils have the potential to sequester enough carbon to completely offset all emissions from Australian agriculture. This research aims to reduce nitrous oxide emissions from soil, which accounts for 19% of Australia's agricultural emissions, and sequester carbon. It covers; the agricultural and silvicultural benefits of biochar; its characteristics and capacity to sequester carbon and reduce emissions of nitrous oxide and methane; and the impact of land management on soil carbon accumulation.

BIOCHAR IN SOIL FOR LONG-TERM CARBON SEQUESTRATION (2007-2010)

INTRODUCTION: There is growing interest in the use of biochar as a soil amendment, with potential to increase the long-term soil carbon (C) pool, reduce greenhouse gas (GHG) emissions, and enhance agricultural productivity. The rate of turnover (decomposition) of biochar C is the major determinant of its value for long-term C sequestration in soil.

FINDINGS: A long-term laboratory experiment has revealed that the stability of biochar in soil varies depending on how the biochar was produced and what it was made from. Our data suggests that a large proportion of the C in biochars, especially those made from wood or made at temperatures exceeding 550 °C, will remain in soil for more than 100 years (commonly required for acceptance under emissions trading and carbon offset schemes).



CONTACT: Dr Bhupinder Pal Singh (BP) (02) 9872 0148

PARTNERS: NSW OEH, University of Sydney

BIOCHAR: THE ANSWER FOR REDUCING GREENHOUSE GAS EMISSIONS FROM SOIL? (2007-2012, SEVERAL STUDIES)

INTRODUCTION: Application of biochar as a soil amendment also has the potential to reduce emissions of nitrous oxide (N₂O). Given that N₂O has 300 times the global warming potential of CO₂, it is important to develop strategies and technologies that can mitigate N₂O emissions from agricultural soils.

FINDINGS: Automated chambers in field trials which continually monitor emissions of greenhouse gases have demonstrated that biochar can reduce emissions of N₂O from soil by up to 94%.

CONTACT: Dr Lukas Van Zwieten 02 6626 1126 and Dr Bhupinder Pal Singh (BP) 02 9872 0148

PARTNERS: OEH, USyd, DAFF, CSIRO, UNE, Richmond Landcare

THE POTENTIAL OF LAND MANAGEMENT FOR SOIL CARBON SEQUESTRATION? (2009–2012)

INTRODUCTION: Land management can influence soil organic carbon (SOC), but there is a high degree of variability reported for similar management practices. Our research is investigating the land management options and physical constraints that combine to determine SOC levels on individual paddocks across central NSW.

FINDINGS: Climate and soil properties have a major impact on SOC levels. SOC levels are higher in areas with more rainfall and biomass production. Research is continuing to determine the magnitude of difference between land management options in different environments.



CONTACT: Dr Warwick Badgery
(02) 6391 3814

PARTNERS: OEH, UNE, CSIRO, DAFF

NITROUS OXIDE EMISSIONS FROM DRYLAND CROPPING SOIL (2009–2012)

INTRODUCTION: Nitrous oxide (N_2O) is a potent greenhouse gas with 300 times the warming effect of carbon dioxide. While it is produced by natural soil processes, significant amounts of N_2O comes from fertilisers used in modern farming. We are measuring N_2O emissions from several commonly-practiced cropping rotations and comparing nitrogen sourced from fertiliser with that fixed from the atmosphere by rhizobia in legumes.

FINDINGS: In dryland cropping systems N_2O emissions are activated by rainfall with little emitted from dry soil. The greatest emissions occurred after heavy rain on soil that had newly-applied fertiliser or freshly decomposed crop residues. Growing more legumes in crop rotations should reduce greenhouse gas emissions from the broadacre grains industry, and reduce the need for emission intensive fertiliser manufacturer.



CONTACT: Dr Graeme Schwenke, Tamworth (02) 6763 1137

PARTNERS: NCRGGR, GRDC, QUT

FORESTS FOR CLIMATE MITIGATION

NSW DPI has undertaken detailed research over a number of years to quantify carbon stored above and below ground in different forest systems. Much of this research is complete and has been built into the national carbon accounting framework. Current research is focused on: species selection and plantation management for dryland areas; carbon sequestration in mixed plantings on farmland; carbon in forests and in timber products; biomass for bioenergy; and soil carbon in forestry.

CARBON IN PAPER AND COMPOSITE WOOD PRODUCTS IN LANDFILLS (2010-ONGOING)

INTRODUCTION: Landfills have long been the main disposal option for paper and composite wood products in Australia. This project will determine the extent of decomposition and long-term carbon storage in panel and paper products through landfill excavations and laboratory-scale landfill simulations.

FINDINGS: We are currently determining the extent of decomposition and long-term carbon storage in paper and composite products recovered from a range of landfill types. As a conservative benchmark for decay, products are also being assessed in anaerobic reactors under optimal conditions in the laboratory. The actual decay of paper and composite products in landfills will then be correlated with that determined in the laboratory under optimal conditions. This research will underpin the inclusion of harvested timber products in future carbon trading schemes.

CONTACT: Fabiano Ximenes
(02) 9872 0143

PARTNERS: DAFF



PINE AFFORESTATION'S IMPACT ON SOIL CARBON SEQUESTRATION (2007-2011)

INTRODUCTION: Afforestation with pine is likely to expand across Australia in response to the growing opportunities for forests to earn "carbon credits" under emissions trading. Assessment of the impact of agricultural land use and pine plantations on soil carbon is required to determine the net greenhouse gas mitigation potential of pine plantations.

FINDINGS: Soil C stocks were higher in a mature pine plantation (by ~15%) than in the adjacent pasture in the central tablelands of NSW. This finding does not support the common assumption of a 15% decline in soil C where pasture is converted to pine. Further research is underway to examine the influence of this land use change on soil C and N stocks.

CONTACT: Dr Bhupinder Pal Singh (BP) (02) 9872 0148

PARTNERS: 2007-2010 (DECCW) 2010-2011 (DAFF), University of Sydney, NCRGGR



BIOMASS AND BIOENERGY

Research into locally available renewable resources from forestry and agriculture for bioenergy and biofuel production underpins the development of a next generation biofuel industry for NSW. Research covers: conversion of the waste components of agricultural and forestry residues (straw, forest thinnings, green waste) to liquid biofuel; quantifying biomass availability for bioenergy; and the use of biomass to produce bioenergy and biochar through the pyrolysis process.

CONVERSION OF EUCALYPT FORESTRY WASTE RESIDUES TO BIOFUELS (2010-2011)

INTRODUCTION: Eucalypt wood residues from subtropical plantations could produce about 10 M tonnes of feedstock over the next 15 years in the Grafton catchment. This represents a unique opportunity to develop a biofuels industry whilst mitigating greenhouse gas (GHG) emissions. The aim of this project is to assess biochemical pretreatment options for the production of next generation biofuels from forestry harvest residues.

FINDINGS: Eucalypt residues treated with dilute acid at high temperatures (175-195°C) for short periods, yielded liquors suitable for enzyme digestion (resulting in high glucose release). All available sugars must be fermented to make the ethanol production economically viable. The main sugar (glucose) derived from eucalypts was fermented by yeast to produce ethanol. The other sugar, xylose, was only fermented by recombinant bacteria.

CONTACT: Dr Tony Vancov, (02) 6626 1359

PARTNERS: DAFF, NCRGGR



ESTIMATING RESIDUAL BIOMASS FROM PLANTED FORESTS (2010-2012)

INTRODUCTION: Significant volumes of plantation biomass must currently be managed or removed to reduce fire risk, allow for plantation re-establishment and improve forest health. This project aims to quantify the biomass currently left on site following harvest operations in Radiata pine plantations around Oberon and Bathurst (NSW).

KEY EXPECTED OUTCOMES:

- » Quantification of available resources for biomass harvesting in Radiata pine with a focus on underutilised material.
- » Cost benefit analysis of a range of biomass yields against various price scenarios.
- » Quantification of nutrient removal levels due to extraction of residues and greenhouse gas implications of the removal.
- » Development of inventory techniques targeting the incorporation of recoverable harvest residues.

CONTACT: Fabiano Ximenes (02) 9872 0143

PARTNERS: DAFF