Measuring greenhouse gas emissions from cotton crops

By Traci Griffin, CRC for Greenhouse Accounting

When the words "global warming" are mentioned, the conversation quickly shifts to climate change and greenhouse gas emissions. Over the past few decades Australia has been experiencing warmer temperatures and variability in rainfall. Ice core research shows cyclical warming events within the earth system occur about every 100,000 years. These events track closely with increases in atmospheric levels of carbon dioxide.

Where the current global warming event differs is that the levels of carbon dioxide and other greenhouse gases in the atmosphere have risen well beyond normal concentrations, leading to what has been termed the greenhouse effect. While there is much debate about climate change one fact agreed is that the global-average surface temperature has increased by about 0.6°C over the past 100 years, with climate models predicting further increases of up to 2°C by 2030.

The principal greenhouse gases of concern are carbon dioxide, methane and nitrous oxide. While methane and nitrous oxide are emitted in smaller quantities than the more widely recognised carbon dioxide, they are much more powerful greenhouse gases with global warming potential 310 and 21 times that of carbon dioxide.

But what relevance does Australian agriculture and more specifically the cotton industry have to the emission of these greenhouse gases? Agriculture is not a high emitter of carbon dioxide, but 80 per cent of Australia's total emissions of nitrous oxide and 60 per cent of methane come from agriculture.

Agriculture and greenhouse gasses

Nitrous oxide and methane are produced naturally when living and dead biomass is consumed, decays or is burnt. Agricultural activities like cultivation, addition of fertiliser, controlled burning, flooding and increased numbers of ruminant animals modify and increase these emissions.

These on-farm biological processes account for 19.2 per cent of Australia's total greenhouse gas emissions (Figure 1).

So where does the cotton industry factor into these emissions? What role might it have to play in global warming other than prepare itself for potentially higher temperatures, changes to rainfall patterns and potential evaporation rates — and develop ways to adapt to climate change.

In a normal season, the Australian cotton industry uses up to 100,000 tonnes of nitrogen fertiliser. Research indicates that up to one-half of this fertiliser is potentially lost to the atmosphere.

The cost of this loss alone may be as much as $6000 for every 100 hectares of cotton — a significant economic liability. One possible pathway to this loss is denitrification, which normally occurs when soils become waterlogged, a common occurrence on the heavy textured vertosols found in our cotton growing regions.

The more nitrogen that is applied in excess of crop demand, the greater the potential loss of nitrogen to the atmosphere if waterlogging occurs. A proportion of the nitrogen lost to the atmosphere is also the potent greenhouse gas nitrous oxide, but no benchmarking data exists for these processes in Australian cotton systems.

A project being led by Peter Grace from Queensland University of Technology is conducting research to address this lack of information about nitrous oxide emissions from cotton farming systems. The project is a partnership between the CRC for Greenhouse Accounting, Australian Cotton CRC, Cotton Research and Development Corporation, and the Australian Greenhouse Office.

Field studies were first conducted at Australian Cotton Research Institute in Narrabri in 2002–03 to determine nitrous oxide emissions from cotton crops in continuous cotton, wheat-vetch-cotton and

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Project leader Peter Grace and Senior Policy Officer – Australian Greenhouse Office, Bill Salletry in a 2004 research crop. Measurement chambers are in the background.

OVERVIEW

Judicious use of water and nitrogen, in combination with reduced tillage, use of cover crops and shortened fallows all promote economic and environmental sustainability for the cotton industry.

Additionally soil carbon is increased, which improves soil structure — leading to reduced potential for waterlogging events and subsequent emissions of nitrogen and the very potent greenhouse gas, nitrous oxide, into the atmosphere. Metered nitrogen fertiliser applications or the use of green manures as a form of slow-release nitrogen will potentially minimise any loss of mineral nitrogen stocks and nitrous oxide to the atmosphere.

These are some of the themes being investigated over the coming seasons to reduce greenhouse gas emissions and ensure greenhouse gas and nitrogen emissions are minimised for maximum financial and productivity returns from Australian cotton growing systems.

FIGURE 1: Greenhouse emissions in Australia by sector

FIGURE 2: Greenhouse gas emissions

wheat-cotton rotation systems. The largest emissions (reported as a proportion of nitrogen applied in Figure 2) were measured from the cotton crop in the wheat-vetch-cotton rotation.

This is not surprising, with the incorporation of the green manure crop providing ample nitrogen for the cotton crop. The subsequent addition of fertiliser to the vetch system resulted in a surplus of nitrogen, which was prone to loss to the atmosphere when waterlogging occurred.

In the 2003–04 season, state-of-the-art continuous monitoring equipment was used to measure all greenhouse gases — carbon dioxide, nitrous oxide and methane — throughout the season. Preliminary data confirms earlier observations that the magnitude of nitrous oxide emissions is highly dependent on the source of available nitrogen. Early season emissions from a non-fertilised cotton crop, which had been preceded by vetch, are approximately one-third the magnitude of emissions from a cotton crop that had received 140 kg nitrogen per hectare.

Over the coming seasons, the research will focus on providing data which accurately accounts for the nitrous oxide emissions from Australian cotton farming systems. Improved understanding of nitrous oxide emissions may also provide an easy-to-measure indicator of total nitrogen loss to the atmosphere. Management of nitrous oxide emissions will be promoted through Best Management Practices that focus on improved efficiencies within the system, including water and nitrogen use efficiency, which create a win-win situation for the cotton industry in terms of achieving both economic and environmental health outcomes.

For more information, contact: Peter Grace, Queensland University of Technology, phone 07 38 64 261 or Traci Griffin, CRC for Greenhouse Accounting, phone 02 67 30 4500.

Continuous monitoring of greenhouse gas emissions in a cotton crop.