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Greenhouse Gas Emissions in Top End Horticulture

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WHAT ARE GREENHOUSE GASES?

A greenhouse gas (GHG) is an atmospheric gas that absorbs and emits the sun's energy, keeping the atmosphere warm. This is known as the greenhouse effect. For each greenhouse gas, a Global Warming Potential (GWP) is calculated to reflect how long it remains in the atmosphere and how strongly it absorbs energy. Gases with a higher GWP absorb more energy than gases with a lower GWP and thus contribute more to warming the Earth. This global warming is slowly altering sea levels and weather patterns. To combat this, Australia has agreed to reduce future GHG emissions.

There are three important GHGs related to horticulture. These are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). These gases are exchanged naturally between horticultural cropping systems (plants and soils) and the atmosphere. The exchange can be in both directions, that is, the soil may emit gases (i.e. a source to the atmosphere), or may sequester gases (i.e. a sink or store from the atmosphere). The direction and magnitude of GHG exchange changes with season and land use.

CO_2 is the most prevalent GHG exchanged through agricultural activities but has the lowest GWP. All other gases are measured against it by calculating their CO_2 equivalency – or CO_2-e.

In Top End soils, CH_4 emissions are typically low; in fact most soils in the Top End are a sink for CH_4. CH_4 is more efficient at trapping radiation than CO_2 and has a GWP 25 times greater than CO_2.

N_2O accounts for a small amount of total GHG emissions but is 296 times more potent as a GHG than CO_2 and is therefore the most important GHG in horticultural systems. It attracts the most interest and is the focus of most scientific research.

THE NT CONTRIBUTION

The Northern Territory (NT) contributes just 1% to Australia's GHG emissions arising from agricultural soils (Figure 1). So we might ask why this research is relevant. Within the NT's overall contribution to the national GHG accounts (from all sources, such as mining, industry, urban areas, transport, etc.), agriculture is responsible for approximately 45%. This is a much higher proportion than the national average of 15% (State Greenhouse gas Inventory). Our research is benchmarking the soil GHG emissions from NT farm soils, so we can prepare the industries to reduce emissions through improved nitrogen (N) management. The Australian Government is firmly committed to reducing Australia's overall greenhouse gas emissions to 5% below 2000 levels by 2020.

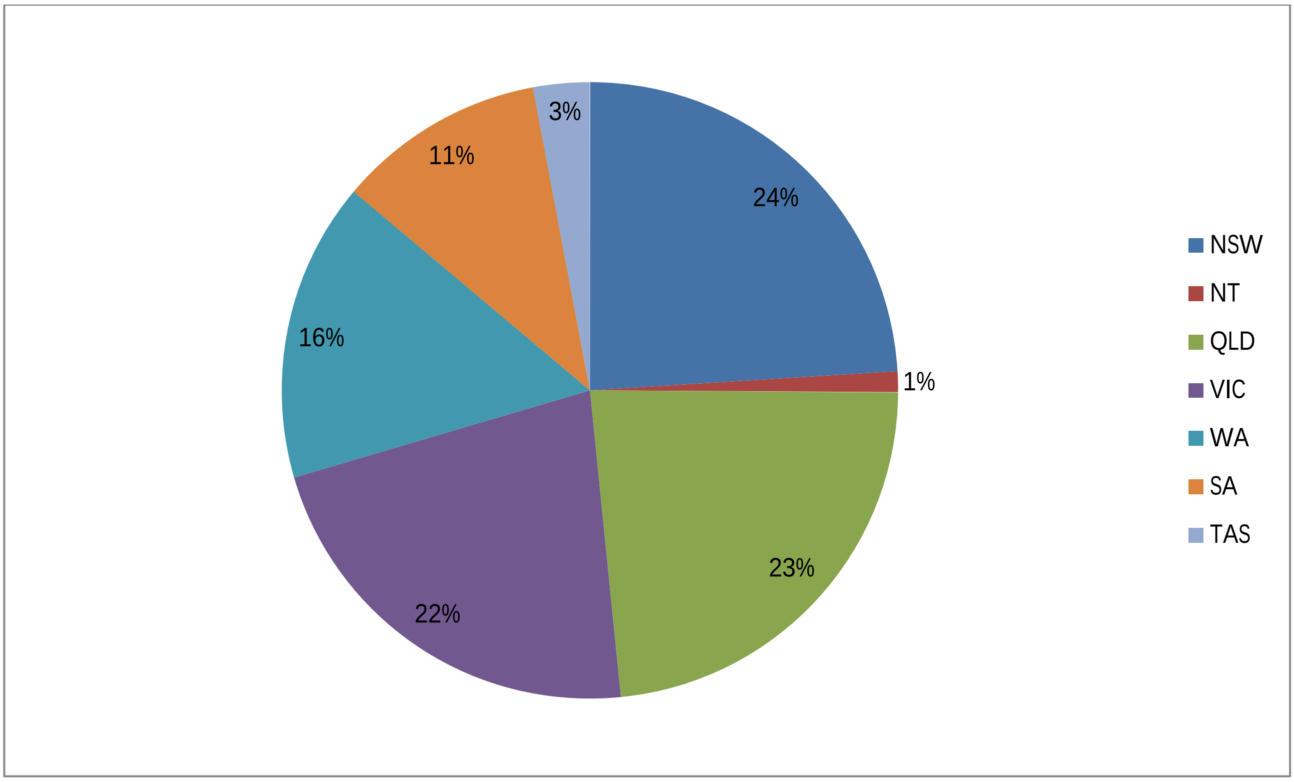

Figure 1. Carbon dioxide equivalent (CO2-e) emissions from agricultural soils, 2013

This figure includes both direct emissions from organic and inorganic fertiliser application, crop residue, dung and urine deposited by grazing animals, indirect soil emissions, including atmospheric deposition, nitrogen leaching and runoff (State Greenhouse gas Inventory).

SOURCES/HOW ARE THEY PRODUCED?

Soils have the capacity to generate (source) or store (sink) GHG, depending on how they are managed. In horticulture, these GHGs arise from the breakdown of organic matter and from the application of fertilisers. GHG outputs from the soil are dynamic and are driven by seasonality and farming practices, including application of irrigation (moisture) and tillage (soil disturbance). Fertilisers are a direct source of emissions, especially N_2O. Any emissions of this gas indicate a loss of applied fertiliser through a process called denitrification whereby emissions of N_2O equate to losses of available N from the soil.

MEASURING SOIL GREENHOUSE GASES

Soil GHGs are measured from chambers in the soil, which trap and capture the gases being emitted. Over a period of three years, scientists from the Department of Primary Industry and Fisheries (DPIF) have used both manual and automatic chambers to quantify soil GHG emissions from key NT crops, including:

- Irrigated dry season vegetable and melon crops - (cucumbers, tomatoes, taro, pumpkins, watermelons and rockmelons).
- Wet season rain-fed hay – (sabi grass pasture and Jarra grass pasture).
- Wet season rain-fed cover crops – (sweet jumbo forage sorghum hybrid, Fumig8tor™ forage sorghum and the legume Lablab (*Lablab purpureus*).

Figure 2. Manual chambers made of PVC are inserted into the soil and are manually closed; during this time gas samples are taken from the chambers and stored in vials for analysis in a laboratory

Figure 3. Automated chambers automatically open, close and take samples of gas, which are then analysed on site by electronic sensing devices

EMISSIONS FROM NT HORTICULTURAL SOILS

The extremes of soil moisture conditions in the Top End's wet and dry seasons make gas exchange dynamic. We have measured soil gas exchange to understand and manage these emissions, particularly N_2O, from soil in the Darwin and Katherine regions. Our results show rainfall, which drives soil moisture, is a major driver of GHG emissions. It has the greatest influence on CO_2 and CH_4 emissions.

Trials showed that soil GHG emissions in the dry season irrigated row crops differed by crop and were generally high during these short cropping cycles compared with background natural soil emissions. High emissions were generally driven by high rates of irrigation and/or high rates of fertiliser application. Soil disturbance through ploughing and tilling also results in high emissions, up to 100 times the background level.

Our research identified that the time between crop cycles poses the highest risk of soil emissions. This is early in the wet season before newly-sown cover crops have had a chance to grow and access the high levels of residual fertiliser left over from the dry season cropping period. This phase coincides with heavy rains and it is a time of potential high loss of GHG from soils and N leaching deep in the soil profile. Our cover crops research is targeting ways to mitigate this loss.

MANAGING SOIL GREENHOUSE GASES

Cover crops grown in temperate climates have been reported to help lessen emissions of GHG. To test if the same is true of Top End soils, a number of trials were conducted in the Darwin region. We measured the effectiveness of wet season-grown cover crops in mopping up excess N left over from the irrigated cropping cycle and thereby mitigating N_2O emissions and/or reducing N leaching below the plant root profile. Results suggest cover crops may be less effective in mitigating soil GHG emissions in the Top End than in cooler regions. The challenges of intensive rains and limited plant N uptake at this period were highlighted by high emissions correlated with high soil moisture at the start of the crop cycle. However, cover crops remain a useful means of reducing soil erosion, supressing weeds and improving the efficiency of soil N use by drawing N up from deeper in the soil profile.

Using nitrification inhibitors in agricultural fertilisers to enhance N efficiency and reduced soil emissions of N_2O have been successful in other regions. These fertilisers suppress the bacteria that convert N in the urea to N_2O and reduce leaching losses. We have tested these products under NT conditions. Hay trials in Katherine demonstrate that these enhanced fertilisers are effective in tropical conditions with up to a 60% decrease in N_2O emissions compared with fertiliser without inhibitors. No loss in production and quality was observed with enhanced fertiliser use.

Practices to reduce residual N in the soil and smarter timing of N application based on crop demand and nutrient release can reduce emissions and save growers the cost of lost or wasted N.

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