Ashley Petersen in a crop of the soybeans that he grows in rotation with sugarcane on his Hervey Bay property to reduce nitrogen fertiliser inputs.

Soybeans deliver win-win for profitability and the environment

Farmers are using a sophisticated mix of new agronomy and farm practices that are improving the agricultural economy and providing an answer to the environmental risk of nitrogen fertiliser escaping into the atmosphere.

For more than 20 years, north Queensland sugarcane farmer Simon Mattsson has seen the benefits that the soybeans he grows in-fallow between sugarcane plantings have brought to his paddocks.

As a natural nitrogen-fixing legume, soybeans provide a low-cost, alternative nitrogen supply for the following sugarcane crop, reducing and sometimes even eliminating the need for expensive nitrogen fertiliser inputs (legumes, such as soybeans and pulse crops take nitrogen from the atmosphere and fix it in the soil).

Any reduction in the use of manufactured nitrogen fertilisers also decreases environmental impacts, in particular nitrogen-rich water run-off into surrounding catchments and emissions of nitrous oxide (N_2O), a greenhouse gas about 300 times more potent than carbon dioxide.

During the past few years, however, Mr Mattsson has taken his nitrogen-efficient practice a step further by intercropping soybeans and sunflowers with his sugarcane crop in a bid to further improve soil biology and the overall health of his farmland.

The Marian-based farmer says nitrogen use efficiency (NUE) is a hot topic for sugarcane farmers because their proximity to the Great Barrier Reef requires them to take care with nutrient use.

"And for me, it revolves around soil biology. If we have an 'alive' soil we can better fix nitrogen naturally from the atmosphere."

His 'whole farm' approach to soil biology is echoed by fellow sugarcane farmer Ashley Petersen, who farms 600 hectares of sugarcane, 50ha of pineapples and runs cattle on 1000ha at Hervey Bay in south-east Queensland.

Like Mr Mattsson, Mr Petersen's approach to soil health includes a legume rotation, controlled-traffic farming (restricting machinery to set wheel tracks to help avoid soil compaction on the rest of his land) and no-till practices.

It is a system that has reduced fertiliser use and tractor hours, allowing for the planting of other crops, and an increase in NUE and crop yield.

For this fifth-generation farmer, the journey towards more efficient nitrogen input use began about 20 years ago. Soybeans were chosen when a break crop was needed to deal with ratoon stunting disease.

That decision saw the Petersen family rethink other on-farm practices and over the next decade, they converted to controlled-traffic farming, followed by no-till practices.

"For 10 years, we have direct drilled the sugarcane into soybean residue," Mr Petersen says. "It's a big waste to plough it because the soybean residue on top is so beneficial to the soil. It also saves us about $200/ha in paddock preparation costs."

The continual goal to improve soil biology now also includes more crop diversity – with mungbeans and pineapples part of their sugarcane rotation. Mr Petersen also adds about 50 tonnes/ha of mill mud to his soils.

This has allowed him to reduce his nitrogen fertiliser applications by about 100 kilograms/ha.

"We used to put down 140kg/ha on the plant cane (the first crop after a soybean fallow). Now it's a total of 40kg/ha in a split application. A liquid application of 10kg/ha is put down at planting and is topped up in the season with fertiliser granules," Mr Petersen says.

"Crop yield has also increased due to this whole package of farm management practices."

Mr Mattsson says growing soybeans has also reduced his overall urea requirements from 150kg/ha to 80 to 120kg/ha. "And on the plant cane crop, we use no urea at all. We rely on the soybeans to provide the nitrogen."

In work funded by the National Agricultural Nitrous Oxide Research Program (NANORP), researcher Dr Weijin Wang tested the approach now practiced by these sugarcane farmers.

The goal, says the Queensland Department of Science, Information Technology and Innovation (DSITI) principal scientist, was to assess the influence of in-fallow soybean rotations and subsequent residue management practices on N_2O emissions, productivity and crop nitrogen uptake.

In an experiment at Bundaberg, Queensland, a soybean crop was harvested and then different residue management options – including tillage, no tillage, using a nitrification inhibitor spray before tillage, and sowing a cereal (triticale) – with varying fertiliser regimes were tested.

The research echoed what farmers have found: in-fallow soybean rotations can reduce the need for applied nitrogen fertiliser.

Dr Wang found nitrogen fertiliser applications could be reduced by 120kg of nitrogen (N)/ha. He also found that N_2O emissions dropped by 55 percent, compared with tests where conventional fertiliser was applied to bare fallow.

The research is important given those nitrogen losses from leaching deep in the soil, lateral run-off and denitrification (where nitrate is converted into gas) remain problematic.

According to Dr Wang, between 40 and 60 percent of applied nitrogen is lost from the system, with N_2O a good indicator of much larger gaseous losses of dinitrogen from denitrification.

Dr Wang's research found that growing soybeans in fallow also had other benefits in terms of improved soil biology and NUE.

For example, mineralisation of the organic nitrogen in soybean crop residues was generally much slower than the rate at which nitrogen is released from fertiliser, such as urea.

Dr Wang says this is significant. "This slow-release should increase the opportunity for plant uptake of the mineralised nitrogen and minimise the accumulation of large amounts of mineral nitrogen in the soil, particularly in the wet season when denitrification can be prolific."

N_2O emissions following a soybean rotation were further reduced by adopting no-till, growing a nitrogen catch-crop, such as triticale, following soybean harvest and spraying soybean residues with the nitrification inhibitor 3,4-dimethylpyrazole phosphate (DMPP) before tillage.

Although the different fallow, fertiliser and soybean residue management practices did not significantly affect sugarcane productivity, Dr Wang says profit from the additional soybean was $400 to $590/ha compared with a bare fallow regime.

Mr Mattsson is also testing a nitrogen catch-crop, daikon radish, as part of a multi-species trial with the University of Queensland.

Now in its third year, the trial is looking at intercropping raddish, turnip, chickpeas, soybean, vetch, sunflower, oats and cereal rye with sugarcane. And last year, using controlled-traffic farming on two-metre centres, he planted and harvested sunflowers among his sugarcane rows. The sunflowers were harvested over the top of the growing sugarcane.

Although the alternative crops provide another income stream, Mr Mattsson says the intercropping is primarily about improving soil health and more efficient use of nitrogen inputs, leading to increased profitability and better outcomes for the Great Barrier Reef and the wider environment.

For more information

Simon Mattsson on 0417 862 979
or email mattsson@mcs.net.au

Ashley Petersen on 0418 787 032
or email ashlone@bigpond.com

Dr Weijin Wang (Queensland DSITI)
on 07 3170 5768 or email
weijin.wang@dsiti.qld.gov.au

** Dr Weijin Wang's work was completed as part of NANORP, which is funded by the Grains Research and Development Corporation, through the Australian Department of Agriculture and Water Resources.*