Green manure a viable alternative to artificial nitrogen

Effects of green manure crops on captured nitrogen and potato yields

Why: To quantify how much atmospheric nitrogen (N) spring green crops capture, how much biomass they produce, and the effect on potatoes grown in the lightly crop cultivated residue.

Where: Ferretti Growers, Brightwater, Nelson.

Who: Dominic Ferretti (Ferretti Growers) and Sjef Lamers (Sustainable Nutrition).

What:

- Using N fertiliser for vegetable production is subject to increasing costs and regulation, as well as contributing to environmental pollution.
- N fertiliser costs have doubled between 2020 and 2022 in New Zealand and are expected to keep increasing since they are derived from fossil fuels.
- Green crops can capture N in their biomass so offer an alternative N source. Biologically fixed N is renewable and less influenced by increasing production costs.
- Both legume only and mixed green crops were effective at capturing high amounts of N and subsequently improving yields in potato crops.
- Farmers can quickly build the required management experience from on-site green crop trials to maximise economic and environmental benefits.

More:

ourlandandwater.nz/outputs/green-crops-video

Green manure crops provided enough nitrogen to grow a bumper crop of top-quality potatoes, as well as improving the soil structure, in a trial designed to put some data around traditional horticulture practice.

Using green crops to provide the nitrogen (N) his organic vegetable crops need has been a huge success for Nelson market gardener Dominic Ferretti. A scientific trial just finished on his property has showed the practice will work well for any grower, organic or otherwise.

The research project by former scientist Ferretti and consultant Sjef Lamers showed green crops are an effective way to reduce N fertiliser bills while maintaining a high yield of quality potatoes.

Harvesting the N-fixing power of legumes is a traditional farming practice, but green crops have been replaced on some farms by nitrogen fertiliser such as urea. With the price of fertiliser now increasing sharply, green crops might prove more attractive for many farmers.

Ferretti turned to green crops to replace the mountains of compost he'd been making to replace N fertilisers.

"We were making compost on a big scale using sawdust and chicken manure, which does make great compost for growing vegetables, but there's a lot of labour and a lot of machinery and costs. I was getting really tired of it. Soil tests were showing we were getting too high in phosphorus, coming from the chicken manure, so we thought this imbalance isn't going to work long term."

His consultant, Lamers, talked him into trying green crops instead, sending him mountains of papers and articles from overseas to help convince him.

Market gardeners Dom Ferretti and wife Jeanette Ida in front of green crops they use to improve soil fertility for vegetable production

"We started using them and they seemed to work pretty well. After not too long, I thought, 'I'm going to give up making this compost and use green crops instead'. It didn't take too long to be quite impressed by the benefits," Ferretti says.

But while green crops were clearly working for him, Ferretti couldn't find any significant published New Zealand-based research about the traditional horticulture practice. He then realised his former occupation as a scientist made him the right person to do it.

"The papers that Sjef was sending me were all for Europe and North America. There was a whole lot of data, but it was hard to relate it to New Zealand. Some of the varieties they grow are different or the same thing with a different name, it's all in pounds per acre instead of kilos per hectare, and it's for growing corn and soya beans in America. It doesn't really make sense to the average Kiwi farmer."

Putting green crops to the test

Ferretti and Lamers designed a simple trial on the Brightwater property where two green crops were grown and a third plot was left bare as a control. The first crop was legume only (tic beans, *Vicia faba*) and the second a legume/grain mix (50:50 tic beans and black oats, *Avena strigosa*).

Each treatment was assigned a plot (48 m x 2.5 m) and replicated five times with a randomised arrangement.

"The legumes fix nitrogen out of the atmosphere. The oats, a grain, don't fix nitrogen but they're really good at mopping it up out of the soil, and they add more carbon but take longer to break down," says Ferretti.

After two months the captured biomass from the legume and mixed green crops were 9.7 t/ha and 9.9 t/ha, respectively. This input of about 10 tonnes of dry matter/ha is the equivalent of adding about 17 tonnes of compost/ha.

Captured N was 289 kg/ha for the legume green crop and 198 kg/ha for the mixed green crop. As the research findings note, measurements for the total captured N from the green crops are sufficiently high for the viability of many vegetable crops.

The crops were terminated at the onset of tic bean flowering. The start of flowering is the point when biomass is maximised before excessive conversion to carbon material. To speed decomposition, the biomass was reduced into smaller pieces by two passes with a slasher mower, then incorporated into the top 4 cm of soil with a rotary hoe cultivator.

A week later Agria potatoes were planted – a total of 185 kg of seed potatoes in 15 plots – and harvested 112 days later.

Table 1: Green crop dry matter (DM) biomass and captured N content (%N) for above ground (AG), below ground (BG) and totals. Differences between Legume and Mix are indicated by * for significance at the p<0.05 level and ** for significance at p<0.01. NS indicates differences are not significant

		DM (%)	DM (kg/ha)	%N	N (kg N/ha)	Total DM, AG+BG (kg/ha)	Total N, AG+BG (kg N/ha)
Legume	AG	11.2**	8,345, NS	3.2**	264**	9,673, NS	289*
	BG	13.3**	1,327*	1.9**	25**		
Mix	AG	13.1**	7,230, NS	2.3**	163**	9,904, NS	198*
	BG	20.4**	2,674*	1.4**	35**		

Potato yields were 33.5, 30.6 and 30 tonnes/ha from the legume, mixed and control treatments, respectively.

Potatoes were graded for quality. The legume treatment had the highest weight and number of marketable potatoes, as well as the largest mean tuber weight compared to the mixed and control treatments.

Throughout the nine-month trial soil tests were conducted, including the levels of the different forms of mineral N, as well as Olsen P, K, Ca, Mg, Na, total carbon and other elements.

The biomass of both the green crops and the potatoes was measured (see **Table 1**). "We had to cut the plants at ground level, weigh that material and then pull out the roots. We sent it all to Hill Laboratories where they carefully washed the roots, and analysed them and the tops for nitrogen content," says Ferretti.

"The overall results are enough to raise eyebrows," he says. "It was what we expected – the trial went well and we were very pleased."

Benefits for all farm systems

Ferretti says that it's not just organic vegetable growers who could benefit from the research. Any producer wanting to reduce their N fertiliser use should also take notice.

N fertiliser costs have doubled between 2020 and 2022 in New Zealand and are expected to keep increasing since they are derived from fossil fuels. Regulations for N use are increasing globally and freshwater farm plans will be required here by 2025 with associated implementation costs.

"We just wanted to get people talking and maybe get them to think, 'I might just try that down in the back paddock', or something. That's all we want people to do at this stage, because as soon as you try it you'll see the results and they'll speak for themselves – and it's a no-brainer from there."

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As well as effectively replacing artificial N, the research findings showed that the green crops observably improved soil structure. They can provide extensive benefits to soil and ecosystem health that can assist vegetable production, as well as vineyards and orchards.

Ferretti and Lamers have secured additional funding to produce a best practice guide for other growers, building on the knowledge gained in the trial.

"We actually found that we didn't need to do that much incorporating into the soil, mixing it in with a rotary hoe. It's actually best left on the surface as residues, a mulch, so that's even less fuel cost.

"I think Kiwi farmers are feeling the pressure. We've got heaps of regulations coming and I believe if we can just get the information to them to try this, even if just using a bit less synthetic nitrogen to begin with, that would be a huge success."

Tony Benny for the Our Land and Water National Science Challenge