

# A community investigation into the use of cover crops to improve soil health and decrease the leaching of nitrates to groundwater

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## Abstract

Intensive land use systems such as market gardening have long been recognised for their often deleterious effects on soil and water. In an area of North Otago a community land care group, known as the North Otago Volcanic Soils Environmental Group (NOVsEG), is concerned about the impacts that past and present management practices have had on the Waiareka soil. A previous study, initiated by the Otago Regional Council, which looked at the environmental impacts of intensive horticultural land use in this area, highlighted that soil organic matter levels were decreasing and that nitrate levels in the groundwater were increasing. To address these issues, NOVSEg set up a trial to investigate the benefits of cover crops as opposed to the current fallow ground practices. The trial compared five different cover crops and resulted in the identification of best management practices for incorporating cover crops into a crop rotation. Through the group's initiatives, information collected on the advantages and disadvantages of each cover crop will now provide the market gardeners with practical options for maintaining soil organic matter and decreasing nitrate leaching into groundwater.

**Keywords:** community investigation, cover crops, leaching, market gardening, nitrate, North Otago Volcanic Soils Environmental Group (NOVsEG), soil health

## Introduction

In North Otago, around the settlements of Kakanui and Totara, there is an area of a highly productive volcanic soil called the Waiareka soil. The Waiareka soil comprises an area of approximately 4000 ha and is considered to be among the most productive soils in the South Island of New Zealand. The predominant land use on this soil is market gardening. The advantages for horticulture are a high pH (6.5–8.1), high natural soil fertility, excellent water storage and resilience of the soil to long-term cultivation (McIntosh

1992). A large proportion of this soil has been intensely cultivated for almost 100 years, some properties having been continuously cultivated for 60 years. This soil is still being intensely cultivated – a testament to its extreme resilience.

This paper looks at a community's approach to address concerns over the health and productivity of the Waiareka soil and increasing nitrate levels in the groundwater. Through the formation of a community action group landholder awareness of these issues was greatly increased, setting in place a means of promoting and implementing appropriate sustainable land management practices.

## North Otago Volcanic Soils Environmental Group

In February 1995 a number of influential vegetable growers from the Kakanui/Totara area and representatives from the Otago Regional Council held a meeting to look at ways the community could get involved in identifying and addressing environmental concerns within the area. The community, well aware of the uniqueness of the Waiareka soil, was keen to ensure the soil's productive capacity was maintained. Similarly, the Otago Regional Council was interested in determining the impact that decades of intensive cultivation has had on the soil and groundwater resource in the area. From this meeting the North Otago Volcanic Soils Environmental Group (NOVsEG) was formed.

NOVsEG recognised a need to determine what land management practices were currently being used on the Waiareka soil and the present state of the environment for this area. A survey about management practices was sent to growers and farmers in the area. In addition to this survey, soil and groundwater samples from representative sites were collected and analysed.

Results from this investigation identified a number of land sustainability issues within the Waiareka soil area that needed to be addressed. To address these issues the NOVSEg committee, with input from scientists and the Otago Regional Council, produced guidelines that provided practical information on the most appropriate ways to sustainably manage the Waiareka soils.

## Cover crop trial

Results from the soil and groundwater investigation highlighted a serious decline in soil organic carbon contents in areas that had been intensely cultivated. High nitrate levels, ranging from 14 to 27 g/m<sup>3</sup>, were measured in groundwater from a number of bores, indicating that nitrate leaching is occurring. These results have been attributed to the use of long fallow periods, intensive cultivation and the inefficient use of fertilisers. The survey conducted by the growers indicated that 76% included a fallow period within their crop rotation, the length of these fallow periods ranging from 2 months to 24 months. The significance of these results prompted NOVSEg to investigate the use of cover crops as a way of increasing soil organic matter contents, improving the soil's structure and decreasing the loss of nutrients from the soil, in particular, the leaching of nitrates into groundwater.

The ideal cover crop practice is to sow the ground in long-term ryegrass. However, this is not practical under a market gardening situation where land area is often limited. As no data existed on which species of cover crop was best suited to growing conditions on the Waiareka soil, and in particular, which species best fitted into the growers' crop rotations, five different crops were investigated.

The cover crops used were: massif oats; black oats and vetches mix; bitter blue lupins; Italian ryegrass and red clover mix; and *Phacelia*. The trial was set up on the property of Mr J. Kong. The block, approximately 2.5 ha, was broken up into five plots. A strip running alongside the plots was used as the control. The control was left as fallow ground to which normal practices would be applied, such as cultivating when necessary to discourage weeds.

## Results

The crops were sown in mid October 1996 and incorporated into the soil after 12 weeks of growth. To determine the benefit of each crop, a vegetation sample

was collected from a representative 1 m<sup>2</sup> area before rotary hoeing and analysed for dry matter production and nutrient content (Table 1).

The roots of each cover crop were also assessed. Both the massif oats and black oats and vetches mix had many fine roots down to a depth of 17 cm. However, these roots were not dense and made no notable difference to the soil's structure. The lupins and *Phacelia* had comparable root systems. They both had a main tap-root with long lateral roots growing to a depth of 25 cm. These roots were not dense but did manage to break up the compacted cultivation pan. The Italian ryegrass and red clover mix had the most notable effect on the soil's structure. A mass of fine roots down to a depth of 18 cm, with smaller amounts growing down to 23 cm depth, were starting to produce some nutty structure in the top 10 cm of the soil.

Since an economic crop is normally grown immediately following the cover crop, it is desirable that the cover crop residues decompose rapidly and release their nitrogen to the next crop. Seven weeks after the crops were incorporated into the soil a field-day was held at the trial site. Comparisons were made on the breakdown rates of each trial cover crop by growers who attended the field-day. Their observations were based on the amount of plant residue left in the soil and the workability of the soil to produce a fine seed-bed.

The massif oats, black oats and vetches, and ryegrass and clover crops, owing to the amount of dry matter they produced, still had a large quantity of crop residue left to decompose. Regrowth was also occurring at these sites. The lupin crop had decomposed readily leaving only small amounts of woody residues in the soil; however, the *Phacelia* crop was the fastest to break down, leaving the soil available sooner for planting the next crop.

Along with the comparisons the growers made on the breakdown rates of the individual crops, advantages, disadvantages and best management practices were identified for each cover crop. This information will be passed on to the community as an addition to the Waiareka Soils Guidelines.

**Table 1** Dry matter production and nutrient contents of the cover crops after 12 weeks of growth.

| Cover crop                      | Dry matter production<br>(t/ha) | Nitrogen content<br>(kg/ha) | Phosphorus content<br>(kg/ha) | Potassium content<br>(kg/ha) | Sulphur content<br>(kg/ha) |
|---------------------------------|---------------------------------|-----------------------------|-------------------------------|------------------------------|----------------------------|
| Massif oats                     | 10.7                            | 140                         | 41                            | 398                          | 19                         |
| Black oats and vetches          | 11.4                            | 182                         | 45                            | 466                          | 28                         |
| Bitter blue lupins              | 6.9                             | 138                         | 22                            | 187                          | 10.5                       |
| Italian ryegrass and red clover | 7.5                             | 98                          | 27                            | 263                          | 14                         |
| <i>Phacelia</i>                 | 8.8                             | 114                         | 35                            | 342                          | 19                         |

## Conclusion

Simple community based initiatives (which do not have to be rigorous) can go a long way towards changing behaviour. NOVsEG's objective of the cover crop investigation was to provide as much information as possible to market gardeners in the Kakanui–Totara area on the practical options available to them for increasing and maintaining organic matter levels in the soil and decreasing the leaching of nitrates into groundwater. Already a number of market gardeners in this area have started to include cover crops into their crop rotations as a result of this community investigation.

The tremendous positive outcome of this investigation was owing to the community taking ownership of future obligations to achieve and adhere to sustainable land management practices. Allan Robins, North Otago farmer and Chairperson of NOVsEG, stated:

“Maintaining a healthy soil will leave a resource for future generations and help ensure market access for our products.”

With support from the Otago Regional Council and scientists, a strong partnership has been developed that has proved beneficial to all parties. This partnership has provided a path for information transfer which is helping market gardeners and farmers to become more sure of themselves and where they stand in relation to sustainability issues.

## REFERENCES

McIntosh, P.D. 1992: Soils for Horticulture in North Otago – Landuser Guide Number 4. Landcare Research New Zealand Ltd, Lincoln, in association with Ravensdown Fertiliser Co-operative Ltd, Dunedin



