How farmers' observations may assist in scientific research

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Abstract
Accepted modern farming practises with observed outcomes such as steadily increasing animal numbers, high utilisation of pastures, and heavier use of fertiliser nitrogen often appear at odds with farmers' notions of a healthy farming enterprise. An increasing number of farmers are not only questioning the accepted outcomes, but also implementing practises that are aligned to biological farming principles. The farmers observe the direct link between soil, plant, animal, and human health, and believe that soil health is the basis of high quality food production. Following the implementation of alternative soil fertility programmes these farmers have observed many benefits and significant changes e.g. increase in clover number and decrease in soil compaction, within the first year. However, scientist input is essential to ensure that these changes are not short term and at the expense of long-term production. Understanding of the reasons for these beneficial changes is also important to remove confusion and encourage rapid implementation of practises that help achieve the goal of sustainable farming. Typically these farmers are experienced owner operators highly skilled in observing and recording changes. They are by nature inquisitive and often good communicators keen to share their experiences. By forging a close link with these experienced farmers and scientists, the interchange of knowledge and observed changes in practical farming situations can be enhanced.

Key Words
Biological farming, grazed pastures, nitrogen fertiliser, water quality, soil health.

Introduction

In recent years, water quantity and quality have become important issues in many countries including New Zealand. The increased use of synthetic fertilisers, such as urea, has not only been expensive to farming systems, but also been considered as one of the causes of water quality degradation (Magesan *et al*. 1996; Monaghan *et al*. 2007). In the Central North Island (CNI), New Zealand, nutrient leaching is one of the risks to the continuation of farming. New Zealand farming needs solutions to nutrient leaching that are simple to implement and simple to monitor.

The Rotorua Lakes and Land Trust (RLLT) – a joint venture between Te Arawa Federation of Maori Authorities and Rotorua/Taupo Province of Federated Farmers – has been looking at various solutions to farm nutrient loss. One of the options is to modify soil biology by using the Eco-logic method to increase soil biota and root depth to capture nutrients, particularly N. This method is currently used by some mainstream farmers on a number of CNI farms. Instead of applying fertiliser nitrogen, a mix of dolomite (Ca & Mg) or lime (Ca), humate and soft carbon inoculated with specifically selected soil friendly fungi and bacteria is applied to improve soil health and speed nutrient cycling. Application of such essential elements is important for intensive pastures, especially for clover.

	Clover % in pasture	
	properties (6) with DoloZest & CalciZest	properties (6) without DoloZest & CalciZest
September	**20%**	11%
October	**24%**	12%
November	**31%**	12%
December	**35%**	18%

Clover plays an important role in pastoral New Zealand (e.g. Ledgard 2001). Clovers are able to provide sufficient nitrogen for high producing intensive dairy farming. More clover grown means: higher total milk, meat, and wool yields; less nitrogen fertiliser required; and lower overall costs. Essential elements can also provide benefits such as reduction in metabolic disorders.

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Farmers' observations
The Rotorua Lakes and Land Trust is aware of a number of farms (dairy, deer and sheep farms) on different soil and climatic conditions that have been following this method for over 5 years. Some of these farms are intensively monitored by farmers. They use cages for biomass production, soil penetrometers for soil compaction, and refractometers to measure brix (sugar) levels in pastures. In general these farms have increased their farm pastoral production levels, noted considerable increases in root mass and importantly, experienced major savings on their conventional fertiliser costs (70-90% drop in urea use).

Other observations include:

- Reduction in soil compaction and soils are noticeably softer to walk on.
- Decrease in bare patches of soil.
- Increase in the percentage of clover in the sward – with bigger leafed and longer stemmed clover plants.
- Decrease in fertility patches in paddocks – i.e. more even growth between the front and back of paddocks.
- Stronger and more persistent growth of grass and clover under trees and fence lines.
- A change in grazing behaviour takes place with animals grazing immediately on entering a new break or paddock.
- Decrease in the damage caused by grass grub, black and brown beetle, and clover flea.
- Faster reincorporation of dung into the pasture soil - often almost completely within three weeks.

The common and accepted practise is that it is the scientists who will do research under laboratory and field conditions, and then give the information to farmers as knowledge sharing. However, in this study scientists need to do research based on farmers' observations to verify the results and also to explore the reasons for positive changes in the soil, plant and animal health.

Aims and objectives of this project:
This project aims to provide an innovative and environmentally sustainable solution to building deeper root zones and improved top soils for New Zealand pastures. It is based on the premise that increasing bacteria and fungi increases the soil microbial activity and in turn, topsoil development and which may reduce farm nutrient leaching.

Methods
This project is requested by farmers, directed by farmers, for the benefit of farmers. RLLT has approached Scion (Crown Research Institute) to help with scientific research to verify farmers' observations.

General survey
A survey of farms that are currently under biological farming principles will be conducted. The questionnaire to the farmers will include information regarding area of the farm, type of farming, how long they have been using this system, reasons for switching from conventional to present system, fertiliser usage history, any monitoring programmes, their observations on soil, plant and animal health, and possibly on their savings. Farmers' observations will give enough background information for the research.

Experimental sites
We aim to establish field experiments at five sites with different management regimes (e.g. dairy and sheep) with different soil and rainfall, which are already under conventional and biological farming. However, if such sites are not available, we will set up some experimental sites to study these farming systems. Fertiliser application will be similar to normal farming practices.

The field trials are expected to answer a number of queries including the role of the "smart fertiliser" product in increasing the soil biota and rooting depth; amounts of N uptake – improvement in productivity, brix (sugar) levels; any change in urine N; and amount of N leaching from soil under two contrasting farming systems.

A statistician will be used for an overview of the methodology to ensure adequate replication, number of samples, data analysis and accurate interpretation. Scion scientists will work to ensure that data collection, sample storage and analysis are consistent with the protocols required to maintain the project, and that the knowledge gained is disseminated as widely as possible.

N leaching will be monitored for a period of at least three years. This will give robust and practical time series data on nitrate leaching. Monitoring over time will allow understanding of different seasonal effects, and impacts of extreme climate events (intense rain) etc. We will install at least 15 suction cup samplers below rooting depth on each treatment site to collect soil water. The samples will be collected monthly, and in some cases after heavy rainfall events, to measure N concentrations at Veritec, an analytical laboratory within Scion. We will set up rainfall gauges at the experimental sites to measure precipitation. It is expected that the field experiment would take three years to complete.

Information dissemination and sharing
Information will be shared with farmers, Maori landowners and incorporations (e.g. Te Arawa FOMA), local and central government agencies, research providers and the general public. The results will be used for implementing new fertiliser regimes to save costs, and increase sustainable biomass production by farmers. A number of steps will be taken to make sure that the information is made available to the target audience through a range of communication and evaluation methods. These include: farmer newspapers, internet links, radio, farmer field days, and land use focus group meetings.

Expected benefits
This project is expected to provide a range of economic and environmental benefits to New Zealand farmers and the country. This project is expected to: increase farm productivity by reducing the reliance on costly conventional fertiliser systems that can be harmful to the environment; reduce nitrogen leaching into waterways by building deeper root zones; increase the scientific knowledge and understanding of biological farming systems and their potential impacts on farm productivity.

Conclusion
Farmers using alternative systems have observed positive changes to soil, plant and animal health and have made savings in fertilizer costs without losses in productivity. This has given an opportunity for the scientists to explore the reasons for such changes.

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