PRECISION AGRICULTURE IN NEW ZEALAND'S FARMING SYSTEMS

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ABSTRACT

To date New Zealand farmers do not realise how involved they are in Precision Agriculture (PA). As arable farmers we know how many kilograms of nitrogen (N) it takes to grow a tonne of wheat, how many kilograms of seed we can produce for every millimetre of water that is applied (through irrigation and/or rainfall) and yet we don't believe we are involved in PA. As dairy farmers we are matching feed requirements to the specific production level of individual cows. We are using effluent as a nutrient source with zonal management put around this and yet we still do not speak of being involved in PA.

Precision Agriculture in New Zealand is at a very exciting stage. Farmers are beginning to use technologies such as GreenSeeker®, Crop Circle™, EM and EC mapping along with yield maps to create management zones. We also use Decision Support Systems (DSS) such as The Sirius Wheat Calculator as we seek ways to maximise production and reduce inputs, while ensuring that we have limited impact on the environment.

Keywords: Precision Agriculture, New Zealand, zonal management, DSS, environment, arable, dairy, emissions trading scheme, greenhouse gas

INTRODUCTION

To date New Zealand farmers do not realize how involved they are in Precision Agriculture (PA). In the past the perception was held that PA was limited to the arable sector and involved GPS guidance, auto-steer and yield mapping which produced pretty but relatively worthless pictures. It was believed that these tools were best suited to the larger, broad-acre farming systems seen in Australia and the Unites States, not the smaller, more intensive systems prevalent in New Zealand agriculture. This resulted in a limited adoption within New Zealand farming systems. We have, however, been using other PA technologies across a large portion of New Zealand's agricultural scene.

As arable farmers we know how many kilograms of nitrogen (N) are required to grow a tonne of wheat. We know how many kilograms of seed we can produce

for every millimetre of water that is applied, whether that is through irrigation or rainfall and apply water accordingly. We apply exact amounts of chemicals in a precise manner at specific growth stages but still don't believe we are involved in PA.

As dairy farmers we are matching feed requirements to the specific production level of individual cows. Effluent is now being recognised for its nutrient value with zonal management utilised when applying to fields. GPS is being used to track and map the placement of irrigation water. But this isn't seen as being PA. This perception, however, of what Precision Agriculture or 'information rich farming" encompasses is gradually changing.

A SNAPSHOT OF AGRICULTURE IN NEW ZEALAND

There are about 63,000 farms in New Zealand with an average size of 232 ha. Farming animals, growing crops and plantation forestry covers more than half the country's available land area. 91% of what New Zealand farmers produce is exported. It includes 21.8 % of the world trade in dairy products, 55% world trade in sheep meat and 75% world lamb exports. We are also the largest exporter of farmed venison. Agriculture, including downstream processing, contributes approximately 15% to New Zealand's GDP and approximately 50% of our export earnings.

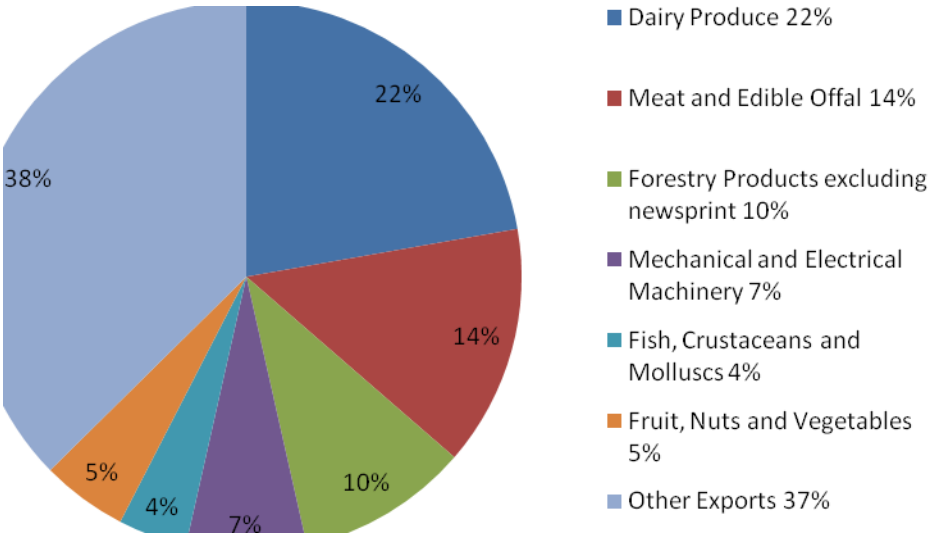

Fig. 1. New Zealand's percentage of exports by type (Federated Farmers of New Zealand, 2009)

The agriculture sector is the largest single source of greenhouse gas emissions in New Zealand, making up approximately 46 per cent of our total emissions. (Ministry for the Environment, 2010)

CURRENT PRECISION AGRICULTURAL PRACTICES IN NEW ZEALAND

Arable Farming Systems

To grow ryegrass seed crops we now know that approximately 200kgN/ha is the optimum dose rate to achieve the highest yield possible (Foundation for Arable Research, 2009) and we know that it takes approximately 25kg of N to grow each tonne of wheat (Foundation for Arable Research, 2008). Deep soil mineral N tests are taken after harvest to determine what residual N is remaining from the previous crop. Once we have the result of soil N we then make the calculation as to how much N we will need for the crop yield we are aiming to achieve, making sure we include the soil N.

We know we can grow 22-26kg of wheat for every millimetre of available water whether it is rainfall or applied irrigation. Decision Support Systems (DSS) are becoming more widely used. Many farmers are using the Sirius Wheat Calculator (Ministry of Agriculture and Forestry, 2009) This DSS calculates the amount of N and irrigation required utilising plant variety and soil type information along with regular weather data added throughout the growing season. Use of this calculator is allowing for improved timing of nutrient and irrigation applications increasing their effectiveness and maximising crop yield potential. Maize and potato calculators have been designed that work in a similar way.

To date yield mapping on harvesters has been limited to a small amount of machines. Adoption has been held back as no one has really known how to utilise the maps a farm level. A lack of specialised consultants in this area is having a significant impact on farmer uptake. Several companies have recently been established to bridge this gap.

Dairy Farming Systems

Many dairy farmers are grain/supplement feeding their cows now and the leading producers are pushing this to fairly high levels to complement the traditional pasture based system used throughout NZ.

To ensure the best value from the grain fed, on our dairy farm and many others, cows are fitted with individual Radio Frequency Identification (RFID) tags which are read each time the cows come onto the milking platform. This allows them to be automatically delivered a measured feed ration. The amount of cereals, protein, minerals and sugar are all specifically matched to the individual cow's production and adjusted on a regular basis. Milk meters are used to ensure that quality standards are being met for each individual cow and to record her production for each milking. The milking sheds also have automatic cup removers, teat sprayers, milk heat detection and auto drafting systems.

Fertiliser inputs for these pastoral systems are managed through nutrient budgets. A DSS, The Overseer® Nutrient Budget model (AgResearch Ltd, 2006)

is a government approved budgeting programme that is utilised by farmers throughout the country along with NZ's two largest fertiliser companies, Ballance Agri Nutrients Ltd and Ravensdown Fertiliser Co-operative Ltd.

Robotic dairy systems are relatively new with the first commercial robotic dairy farm commencing operation in New Zealand in 2008 with a further farm established in 2009. Adoption of robotic systems will be limited by price and their ability to be integrated with a grass based grazing system.

TECHNOLOGY AND APPLICATIONS IN NEW ZEALAND

To date GPS has had a slow uptake in agricultural NZ and the variation in terrain and the smaller farm size have not helped here. However GPS guidance and auto-steer are now becoming increasingly popular as young New Zealand farmers bring the benefits of this technology home when returning from working overseas, particularly from Australia, UK and USA. The main adoption of this technology has been within arable systems.

Data is now being gathered from proximal sensors such as GreenSeeker® as well as electromagnetic (EM) and electrical conductivity (EC) sensors along with yield maps. Some farmers are using EM maps to identify zones so variable rate irrigation can be used to better utilise a limited resource. There is increasing use of zonal maps to determine sites for soil sampling. This is followed up with variable rate prescription maps with fertiliser and/or trace elements applied accordingly.

Zones are being identified with GreenSeeker® where there are in-crop issues with the soil/plant testing taken in these sites. The sites are then treated accordingly to resolve the identified issue.

PRECISION AGRICULTURE AND THE ENVIRONMENT

Environmental pressure to be able to reduce the environmental impact of farming and economics are starting to drive people towards PA.

Effluent management is becoming more precise. Effluent is being tested and then applied to a greater field area and this is taken into account when constructing nutrient budgets. It is now possible for effluent systems to have GPS tracking and mapping systems attached to increase efficiency and provide proof of placement.

Some irrigation systems now have a similar technology fitted to help with accurate placement. A Whole Farm Irrigation Calculator has been developed. It is currently in a pilot phase on several farms and looks very promising. This should be available to the wider industry in the near future.

Fertigation is becoming more popular on centre pivot irrigation systems.

The benefit of accurate placement of fertiliser and chemical along with proof of placement is now able to be valued from an environmental perspective. The accurate and site-specific placement of nitrogen through the use of crop sensing technology is in its infancy. It is believed that this will reduce N inputs by up to 40%, leading to further reductions in NO_3^- leaching and N_2O emissions. Research is currently being undertaken in this area.

Agriculture in NZ produces just under 50% of the county's GHGs and will be included in New Zealand's Emissions Trading Scheme (ETS) from 2015. (Ministry for the Environment, 2009)

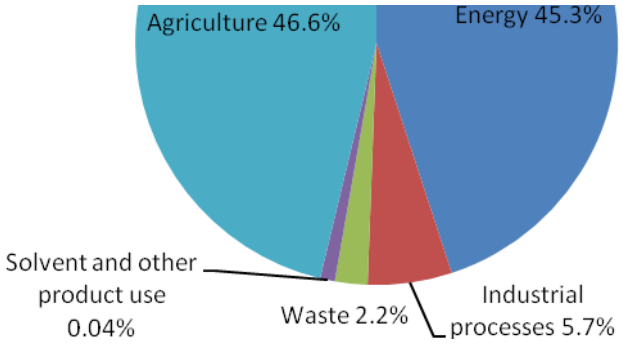

Fig. 2. New Zealand's percentage of emissions by sector in 2008 (Ministry for the Environment, 2010)

The emissions trading scheme will cover all the major agricultural sources of methane (CH_4) and nitrous oxide (N_2O), such as methane from ruminant animals and nitrous oxide from urine, dung and nitrogen fertiliser applied to pasture. The term 'agriculture emissions' refers to the non-carbon dioxide (CO_2) greenhouse gas emissions from agricultural production. Methane from livestock makes up approximately two-thirds of these, and N_2O, from animal excrement and the use of nitrogen fertiliser makes up the remaining third (Ministry for the Environment, 2009).

The efficiencies gained by using PA technology are beginning to play an essential part in the reducing of GHGs. They could prove to be a very quick way to make significant progress in the reduction of NZ's agricultural GHG emissions liability.

THE FUTURE OF PRECISION AGRICULTURE IN NEW ZEALAND

Precision Agriculture or "information rich farming" is at a very exciting stage in New Zealand. We are at the cusp of significant change in our traditional farming techniques. The greater understanding of the farm environment that comes through the use of this advanced technology will enable the farmer to make decisions based on specific facts rather than assumed cause and effects. We are beginning to use technologies such as GreenSeeker®, EM and EC mapping along with yield mapping to create management zones. We also use DSS such as The

Sirius Wheat Calculator and Whole Farm Irrigation Calculator as we seek ways to maximise production and reduce inputs, while ensuring that we have limited impact on the environment. The adoption of the 5 R's of PA into New Zealand intensive farming systems will ensure that New Zealand farmers are maximising PA to its fullest potential, enabling them to operate in the most economic and environmentally sustainable manner possible. It is highly likely that this will provide the added benefit to farmers of reducing their liability under New Zealand's Emissions Trading Scheme.

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