ON FARM TECHNOLOGIES – AN INVESTMENT FOR THE FUTURE OR JUST ANOTHER COST?

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Introduction

Dairy farmers are constantly confronted with new farming equipment, feed blends and animal health products. More often than not these new and improved on farm technologies have a perceived percentage improvement in productivity, efficiency or environmental control. However, why is it if you were to buy all these "perceived" improvements they don't lead to the cumulative total of all the new and improved equipment or input?

New on-farm technologies can have both small and large impacts on a farming business, and come with varying capital costs and rate of return. Although a new technology can be very attractive you must first ensure that the investment of the technology is based on need rather than want. This paper looks at how a farming philosophy currently used on our Taranaki dairy farm is used to make better decisions around whether to invest or not invest in a new piece of on-farm technology.

Farming Philosophy

The farming philosophy of *Plan, Measure, Manage and Review* can be broken down as having a Precise Plan, accurate and frequent measurements, using measurements to make proactive management decisions, and having a robust review process to constantly challenge your own thinking and ideas. This philosophy underpins the main objectives of our farming business and gives us a document to refer to when looking at investing in a new technology allowing for informed decisions to be made on the costs and responses to our business.

This paper will concentrate on two facets of the production system, *feed planning and management*, and our *fertiliser use policy*. The paper will aim to show how the adopted farming philosophy has been applied with respect to technology investments and the corresponding costs and responses.

Feed Planning and Management

Pasture production, utilisation and feed input management are broken down into three management levels Strategic, tactical and operational. Specific tools have been developed or acquired in each of these areas to increase milk solids production on farm from 1000 to 1500kgMS/ha using a similar input system(System 3) year on year.

Strategic Plan

An annual feed budget is undertaken at 10 daily intervals using average monthly pasture production data that has been collected on farm over the previous four seasons. This data is then run through a diet check to ensure the cows ration is balanced depending on her requirements (Milk Production (L), Milk Solids %, Live weight change (kg), stage of pregnancy (weeks)) (Table 1). Both a milk map (L and kgMS) and live weight target graph is produced for the herd and used as a tracking tool as part of the strategic plan.

Table 1. Ration planner used to balance feed quantities and qualities with desired production parameters.

	Ration Data								As Fed Data							
Ration	Utilised %	DM %	NDF %	ME (MJ/kgDM)	CP %	RDP (%/CP)	UDP (%/CP)	$/t	AsFed (kg)	DM (kg)	NDF (kg)	ME (MJ)	CP (g)	RDP (g)	UDP (g)	Cost ($)
Pasture	85%	100%	40%	12.0	23%	75%	25%	0	17	14.5	5.8	173.4	3324	2493	831	$ -
Wheat	95%	88%	12%	12.7	11%	78%	28%	400	3	2.5	0.3	31.9	276	215	77	$ 1.20
Canola	95%	88%	20%	12.0	38%	65%	35%	560	0.5	0.4	0.1	5.0	159	103	56	$ 0.28
Pasture Silage	80%	35%	48%	10.5	14%	77%	23%	140	0	0.0	0.0	0.0	0	0	0	$ -
Palm Kernal	90%	92%	33%	11.5	16%	70%	30%	250	0	0.0	0.0	0.0	0	0	0	$ -
Straw	80%	88%	75%	6.0	40%	72%	28%	300	0.5	0.4	0.3	2.1	141	101	39	$ 0.15
							Totals		21	17.7	6.4	212.4	3899	2912	1003	$ 1.63
							Cow Req				6.6	221.6	3331	2615	717	
							Variance				-0.2	-9.2	568	297	286	

Technology use in feed planning and management

The most important aspect of having an accurate plan is the ability to measure your performance along the way; this is where the right technology used to collect the right data can have a major impact on success or failure of your plan, there are a number pieces of technology that we use in our business to ensure our feed planning and management is successful. However, it is first important to consider what is required to be managed and therefore measured within the given system in order to ensure redundant technology or equipment is not invested in. Figure 1. shows how the farming philosophy (Plan/Measure/Manage/Review) at the management levels (Strategic/Tactical/Operational) was used to make technology and equipment investments on farm.

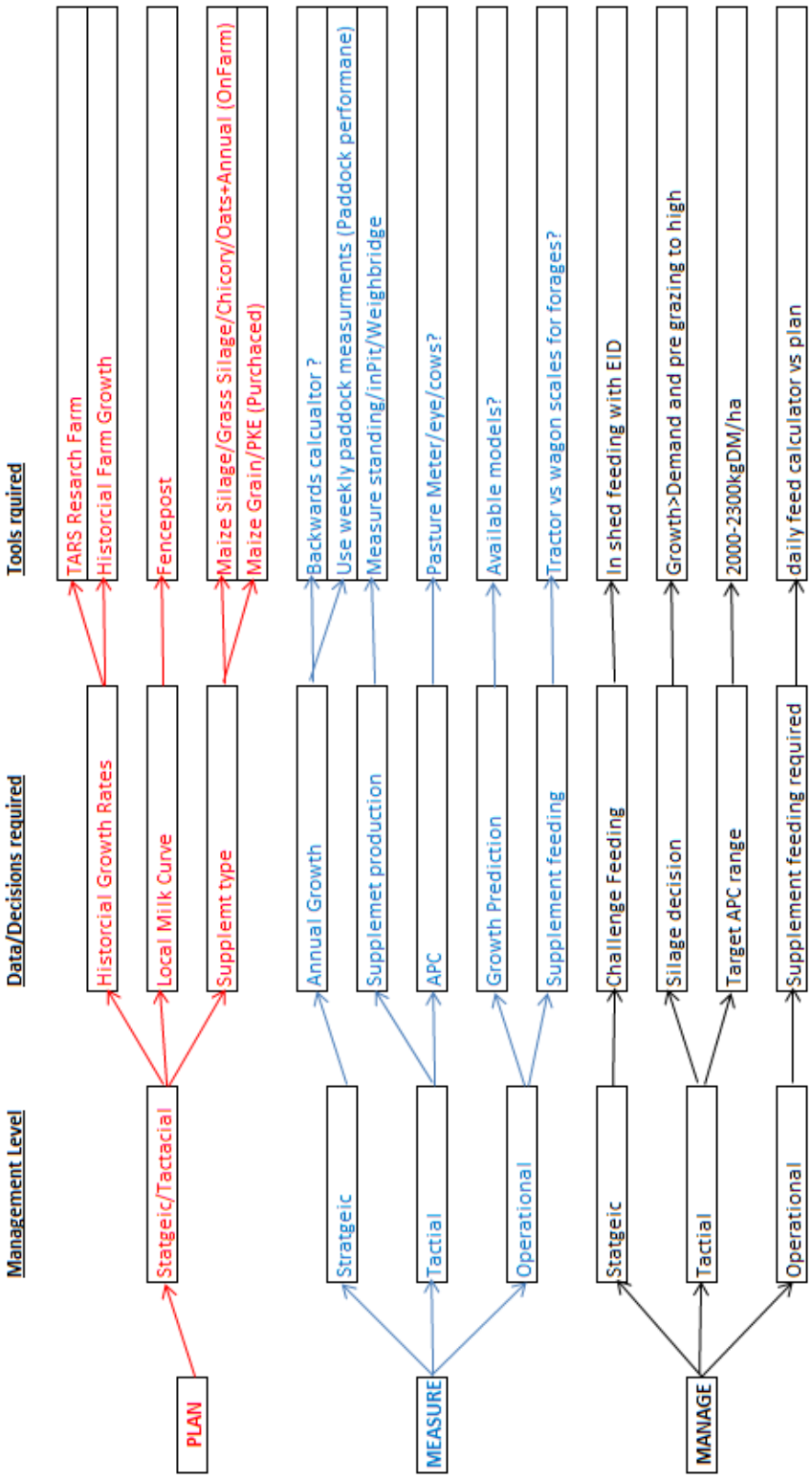

Figure 1. Using the Plan/Measure/Manage/Review philosophy to make new equipment and technology decisions on farm

Pasture Measurement/Management

The key aspect to our feed management plan revolves around pasture measurement. Individual pasture covers (kgDM/ha) and pasture growth (kgDM/ha/day) is collected weekly, this information feeds into our historical feed database but more importantly allows us to make informed tactical and operational feed management decisions. A feed wedge is produced using collected data to identify paddocks to be grazed and operational grazing decisions are made using a operational feed planning tool designed in Micorsoft Excel© that calculates kgDM/ha at grazing from last known measurement, total daily offered/cow (kgDM) and rotation speed. The operational feed planning tool is linked to data found in the feed wedge and allows the farm to maximize pasture and supplement efficiency whilst not compromising on milk solids production. The C-Dax pasture meter provided us with a fast and consistent way to achieve these measurements irrespective of who was collecting the data. The biggest limitation of this system is the growth prediction for the coming week, currently the relatively crude method below is used.

Predicted growth (kgDM/ha/day)= (Measured Growth + Historical growth) / 2

This method can be very accurate (<5% Variation from measured actual), however also very crude (>100 variation from actual), therefore, in the future it is hoped that using existing data collected on farm (pasture growth, soil moisture, soil nutrient status, sunshine hours and pasture species) an accurate model can be built that will allow for an increase in accuracy of operational and tactical management decisions made on farm.

Challenge feeding

The farm is equipped with a Delaval Alpro milking system and has milk meters, and individual feeding. Maize grain is used as an in-shed feed. In the first two years on the property blanket feeding was used. To make more efficient use of the grain challenge feeding was adopted. Based on peak liters cows are feed in six different feed groups where higher producing cows are feed more whilst low producing cows are feed less through the dairy shed, the average daily feed stays the same, using the available technology combined with this management approach an increase in farm production of 21% has been acheived whilst using the same amount of inputs.

Measuring on-farm Supplement production

In order to sufficiently feed plan an approach to measuring supplements made on farm was required, as well as grass silage the farm uses an 18 month cropping rotation of Maize(22T/ha) followed by Oats + Annual (14T/ha) followed by chicory (14T/ha) on 14% of the milking platform to grow 50T/DM/ha in 18 months (35T DM/ha in 12 months), however, due to the variability in climatic conditions these tonnages can vary, therefore, in order to constantly know the businesses feed position it was considered important to measure these as accurately as possible. Grass Silage is measured using the C-Dax pasture meter pre and post mowing and multiplied by 85% to resemble harvester and truck losses, the pit is then core sampled to acquire DM% and ME values. Every load of Maize Silage is weighed on a weigh bridge to get total wet weight and pit core samples taken 2 weeks after harvest to obtain DM% and quality parameters. Both chicory and Oats + Annual crops are measured using the C-Dax pasture meter on an adjusted winter formula because of the lower density of these crops.

Feeding out of forages

The weighing out of supplementary feed on the feed pad was the missing link to our feeding accuracy, as mentioned previously we were accurate with our pasture measurement (pasture meter), our in shed feeding (DeLaval Individual feeders), and measuring supplements grown on farm, however the weighing out of forages including PKE was done by bucket and wagon capacity rather than weight, to improve the accuracy of this feeding LoadRite loader scales were installed, this option was chosen due to the versatility of having onboard scales for weighing out feed as well as fertiliser.

Fertiliser Use Policy

Nutrient replacement is a critical part of continual pasture production on a dairy farm. The spatial distribution of these nutrients is not equal across a farm; therefore, because fertiliser is one of the single largest farm working expenses it makes both financial and environmental sense to spatially manage this unequal nutrient resource.

For the previous four seasons our farm has aimed to reduce variation at the paddock scale by both mining and applying the required nutrients based off soil test data. This program followed the precision farming philosophy of plan, measure, manage, and review and incorporated the use of both on-farm and off-farm technologies.

Plan

The nutrient application plan involved taking 10 geo referenced soil samples from every paddock on the 85ha farm, the farm was originally three blocks of land that had been put together over time and previously were under different farming types, therefore within paddock variation was high (Table 2). The target ranges were set at or slightly above optimum levels for pasture production. Olsen P in particular was given a target range of 40-50 (recommended optimum = 30), this was due to the current high level on the farm that did not want to be completely mined back.

Table 2. Initial soil test value ranges at start of project and set target ranges for individual paddocks.

	Olsen P	Quick Test K	Sulphate-S	pH
Farm Value Range	**32-106**	**5-18**	**6-17**	**5.9-6.5**
Farm Target Range	**40-50**	**10-12**	**10-12**	**6.0**

Measure

Soil test measurements were taken in October every year between 2009 and 2012 with the help of Ravensdown staff and processed at the ARL laboratory. Measurements showed the high values of Olsen P (Figure 2) across the farm existed as well as moderate Quick Test K levels (Figure 3). Individual soil test values were used to make individual paddock nutrient recommendations.

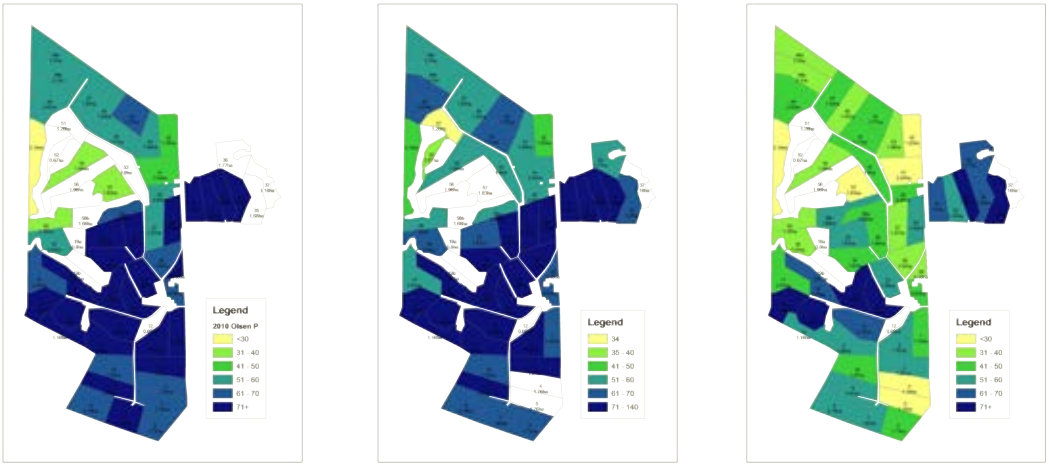

Figure 2. Spatial distribution of Olsen P values from soil testing in 2010, 2011 and 2012

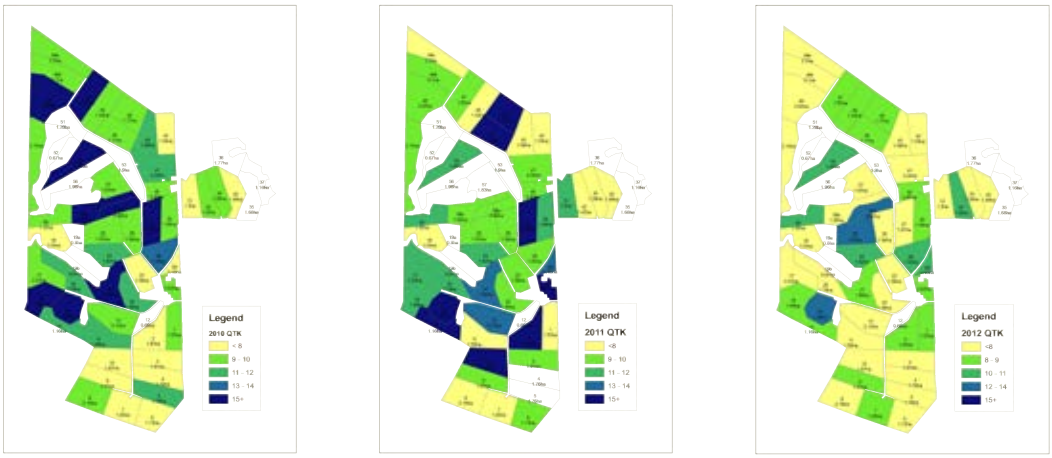

Figure 3. Spatial distribution of Quick Test K values from soil testing in 2010, 2011 and 2012

Manage

In order to manage the variation found within individual paddock soil sampling seven nutrient application programs were developed, this meant that no matter what the Olsen P or Quick Test K values were there was a fertiliser recommendation to match that aimed at achieving the target ranges set in Table 2 over time. There was a certain area of the property where heifers are grazed that had to be blanket applied using a helicopter, therefore this area was always given maintenance levels unless all paddocks in this area required no application as measured during soil sampling. If a soil test resulted in not fitting into any of the application programs it was deemed to have above optimum requirements for both P and K and therefore no application been required. Phosphorus requirements were applied using Super Phosphate (9% P) and Potassium requirements were applied using Potassium Chloride (50% K) (Table 3).

Table 3. Fertiliser application decision table based off individual paddock soil test values

Olsen P	QT K	Fert Mix	Nutrient Values
<40	>10	Full maintenance P, No K	50 P,0 K
<50	>10	Half maintenance P, No K	25 P, 0 K
<40	<10	Full maintenance P, Full maintenance K	50 P, 50 K
<50	<10	Half maintenance P, Full maintenance K	25 P, 50 K
>50	<10	No P, Full maintenance K	0 P, 50 K
N/A	N/A	Heifer maintenance P, Heifer maintenance K	30 P, 35 K
N/A	N/A	No Application	0 P, 0 K

Individual paddock application maps were created in a GIS system every year and loaded into Ravensdown's computer system that generated the required files to be downloaded into Sanford's Spreading trucks for on farm application. Six, three, three and six fertiliser mixes were used in 09/10, 10/11, 11/12 and 12, 13 seasons respectively. Initially in 2009/10, 23% of the farm received no application of nutrients, in the 10/11 and 11/12 seasons this dramatically increased to 44% and 53% respectively, however, in the 12/13 seasons this was reduced to 9%, mainly due to the increased area that required capital Potassium (Figure 4).

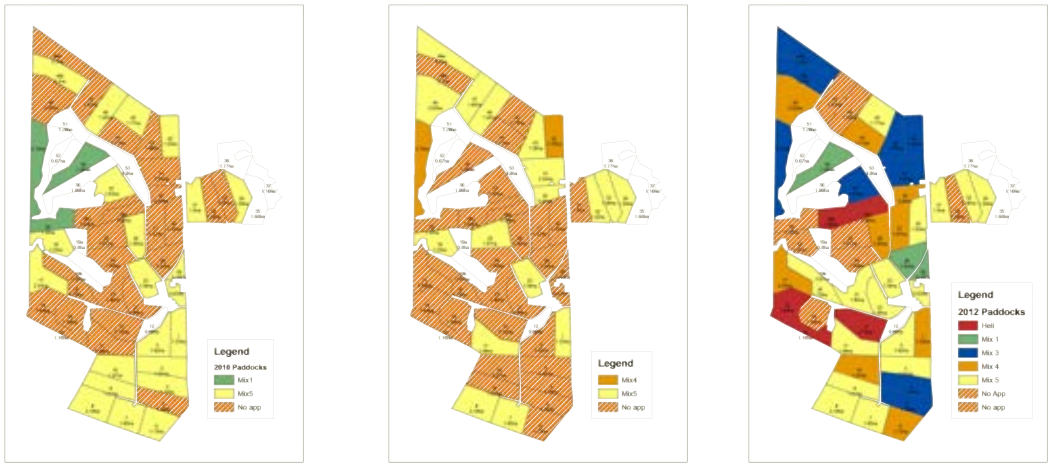

Figure 4. Nutrient application maps for 2010, 2011 and 2012

Table 3. Fertilser usage (T and $) over the four years of using the individual paddock testing and application approach

	2009/10	2010/11	2011/12	2012/13
Fertiliser apllied using current program				
Super P (T)	10.31	7.75	2.05	11.73
KCL (T)	5.12	4.1	4.05	6.47
$ Value	$8,027	$6,251	$4,213	$9,689
$/ha	$94	$74	$50	$114
Fertiiser aplied under old blanket program				
$ Fert/ha	$279	$279	$279	$279
Less aditional costs				
Soil tests ($/ha)	$34	$34	$34	$34
Program savings				
Annual Savings($/ha)	$150	$171	$195	$131
Total Savings	**$12,756**	**$14,532**	**$16,570**	**$11,094**

Review

The precision fertiliser program has delivered significant cost savings over the four year period, originally the fertiliser cost to the business was $279/ha, this has dropped to between $50 and $114 per ha, when considering the extra cost of soil sampling ($34/ha) this equates to an

annual saving of between $131 and $195/ha (Table 1). Because of the high initial nutrient status of the soil it was expected that savings at the start of the program would be higher than what they would be year on year as soils became closer to achieving their target ranges for nutrient status, however, it is expected that this program will still deliver financial benefits greater than that achieved using the standard blanket application program. The adoption of this program over a period of time has lead to less fertiliser been applied, as well as the financial benefits of this it is also seen as environmentally responsible by the farming business.

Technology use in fertiliser application and management

Within this fertilsier program a number of technologies are utilised from GPS soil sampled sites, to the creation of geo referenced application maps through to the trucks onboard mapping software to ensure the right product is put on the right paddock as accurately as possible. Previous research has shown that correctly using driving aids such as a GPS guidance systems have a cost benefit of $12/ha/year on a Waikato dairy farm, so when combining this technology with a managed fertiliser plan it is evident that both large savings combined with minimising the environmental footprint can be achieved without comprising pasture production.

Summary

This paper has presented two key themes around pasture and fertiliser utilisation on a working dairy farm and how a simple philosophy (Plan, Measure, Manage and Review)combined with the appropriate adoption of technologies has been used to increase productivity but also reduce the environmental impact of the farming business. Key messages from this paper include:

- Have a clear farming philosophy (Plan/Measure/Manage/Review) that underpins the major fundamentals of your farming business.
- Use planning tools to identity what needs to be measured to provide information for proactive decision making rather than collecting data that just makes a historical database.
- Use trigger points (i.e. APC for pasture and Soil test results for fertiliser) to invoke a change in management plan.
- Adopt technology that fits your farming system rather than changing your farming system to fit the technology.