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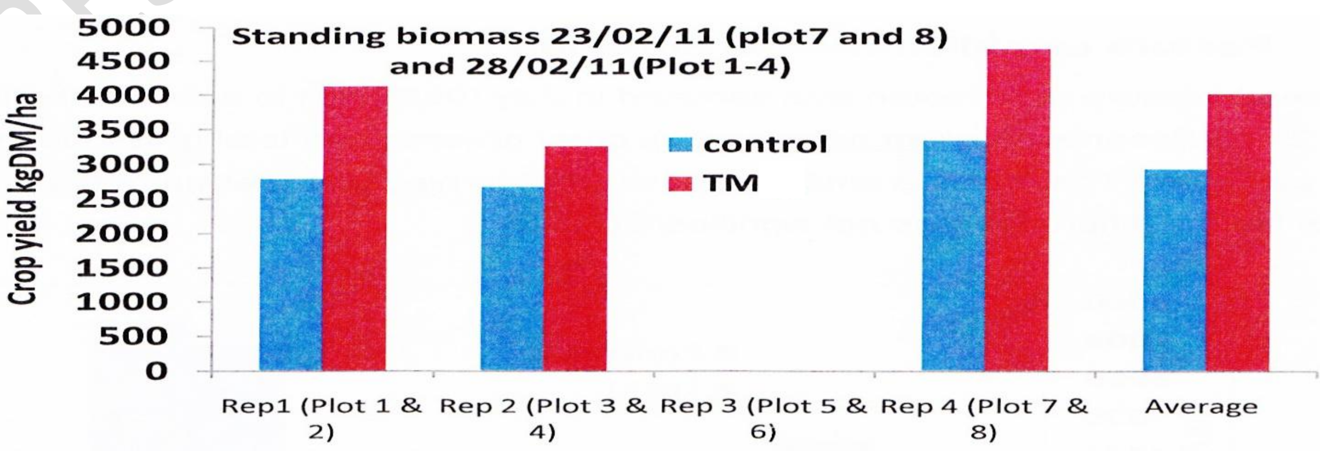
SOIL ACTIVATOR

BEEF and LAMB NZ FINAL REPORT
Evaluation of TM Soil Amendment

TM Agricultural:

Summary from Agresearch Trial Data:

- **Germination and Establishment;**
  - Positive effect on establishment and early growth with less visual variation on the TM trial plots.
  - 9% increase in new grass (Rye Grass) tiller numbers on the TM treated areas.
- **Pasture Characteristics;**
  - Tiller numbers were 11% higher on the plots treated with TM. The difference in tillering between treated and untreated sites reflects the difference between new pasture and old resident sward.
- **Soil Structure and Soil Moisture;**
  - July soil assessment. Soil moisture was lower on the plots treated with TM compared to untreated area.
  - Statistically significant difference (greater than 10%) in the soil moisture between untreated and TM treated plots. Higher in summer, Lower in winter.
- **Crop Growth Rates;**
  - Standing Biomass was 19% higher on the plots treated with TM compared to untreated plots.
  - Crop Re-Growth Rate on the TM averaged 61.6 KGDM/Ha/Day, compared with 27 KGDM/Ha/Day on the control for the 13-18 days between measurements in February. This represents a doubling in crop growth rate for this time of year.
- **Crop Yield;**
  - 16% higher average crop yield from TM treated areas compared to untreated areas prior to first grazing in December 2010.



farmer-initiated technology transfer (FITT) programme

FITT Final Report 10FT07
Evaluation of TM21_Soil amendment

Years of trial:	2010-11
Group that proposed the trial:	Alfredton Farm Business Group
Region:	Wairarpa
Contact person(s):	Alec Mackay or Chris Garland

(1) Introduction – background to the project

TM21 is described by the manufacturer, Basic Environmental Systems & Technology (BEST) Inc. http://bestenvirotech.com/, as a bio-stimulant that has been shown to enhance the performance of various crops when applied with the seed or as a field treatment. The bio-stimulant is made from plant extracts, lime, sulphur and other ingredients, which are not specified. In a liquid form the product is applied at 250ml/ha. Developed in Canada, TM21 is used as a soil conditioner in a number of countries and was recently (2009) imported into New Zealand. Observation to date from users in New Zealand indicates the product helps with surface and subsurface drainage of wet soils and improves soil structure. Some farmers have started to use the product as an amendment or addition to their current fertiliser programme. To date this product has not been evaluated in any structured studies in New Zealand. This study set out to evaluate TM21 as a soil amendment.

(2) Key aims – what was the project trying to achieve?

To assess the merits of TM21 as a soil amendment on a summer fodder crop and permanent pasture.

(3) Key findings & recommendations for farmers

- The merit of TM21 as a soil amendment was evaluated on two farms in 2010-11, one where a summer fodder crop was grown and the other with a permanent pasture
- Application of TM21 increased soil moisture in the weeks following application at the permanent pasture site at Tiraumea. There was no change in soil structure,

assessed by visual soil assessment by the farmer group in the weeks following the application of TM21 at either location.

- There was an indication of better crop establishment, early growth and plant development on plots treated with TM21 in late December 2010. By February crop growth rates were more than doubled on plots treated with TM21, which would have put the cost-benefit of using TM21 in the positive zone.
- The positive result from the summer crop study warrants wider-scale trials of this soil amendment. There was also interest from the group members to learn more about what is in the product and also to develop an understanding of the mode of action of TM21. Funding to continue the study is currently being sought for both sites

(4) Methodology – what was done in the trial?

The effect on TM21 on pasture and crop production and soil structure was assessed at two sites in Wairarapa

1. **Alfredton sheep and beef (Appendix I)**
   TM21 was applied with herbicide to pasture 6 weeks before planting of the summer fodder crop (5th October 2010) and again 5 weeks after emergence of crop (3-5 leaf stage) (6th December 2010).

2. **Tiraumea hill country sheep and beef (Appendix II)**
   TM21 was applied to permanent pasture in early spring (7th October 2010) and again in early summer (7th December 2010)

Design Two treatments (0 and 250ml TM21/ha) and four replicates, randomised complete block design. Large plots (i.e. two, 2 ha paddock each divided into 4 x 0.5 ha plots= Total of 8 plots).

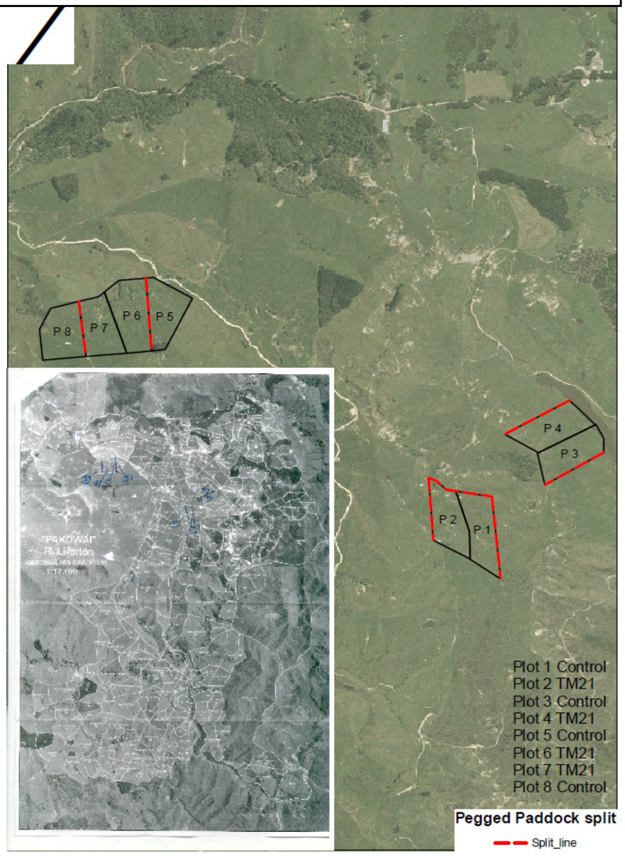
Alfredton	Tiraumea
	

Plate I Alfredton

Plate II Tiraumea

Measurements

The farmer group assessed the impact of the TM21_Soil amendment for the first time, at the two evaluation sites on 7th December 2010. The group was broken into 4 subgroups, with each subgroup assessing the soil structure using VSA, crop establishment, crop ground cover and pasture vigour through a visual assessment on each of the 8 plots (4 control plots and 4 TM21 plots) at each of the two field sites. Volumetric soil moisture contents in the top 10 cm were measured using a Time-Domain Reflectometer at the same time in December at both locations.

At the Alfredton site yield of the summer fodder crop was assessed before grazing on 28th December 2010 by cutting forage within 5 quadrats (0.55m x 0.82 m) from each of the eight plots that comprised the evaluation. The crop from the 5 cut quadrats was bulked and weighed fresh, before a subsample was taken to determine dry matter content. In addition to dry matter, crude protein, ash, acid detergent fibre (ADF), neutral detergent fibre (NDF), soluble sugars, starch, metabolisable energy (ME) and digestibility were also assessed on the crop harvested before the first grazing. Standing crop biomass on all plots (again 5 cut quadrats/plot) at Alfredton was measured again, after grazing in early February (10/02/11). This followed the third grazing of the crop by livestock. Crop growth was measured before the next grazing on plots 7 and 8 on 23/02/11 and on plots 1-4 on 28/02/11, again by cutting forage within 5 quadrats. Lambs grazed plots 5 and 6 before a measurement could be made.

At Alfredton an assessment of pasture establishment was made in early July (06/07/11) by taking 5 tiller plugs from each of the 8 plots and counting tillers of perennial (*Lolium perenne L.*) and other grasses. At the same time (06/07/11) at Tiraumea 10 tiller plugs were taken from each plot to assess the influence of TM21 on tiller number of the permanent pasture. Volumetric soil moisture content of the soils at both field sites was also assessed at that time.

Since the start of the project **TM21** has been renamed TMagricultural.

(5) Results

Soil fertility

Before starting the study soil samples were taken from each plot at both locations (Plate I and II) to obtain background information on soil fertility. Little difference in soil test values were found between the control and TM21 plots (Table 1). Soil pH and Olsen P values at

Tiraumea where higher than the average values for the farm, while they were on par with the average soil test values at Alfredton.

Table 1 Soil test values averaged for control and TM21 plots at Alfredton and Tiraumea before the start of the study (5th October 2010).

	pH	P	K	Ca	Mg	Na	S(SO_4)
Alfredton							
Control	5.8	31	8	13	35	6	4.8
TM21	5.9	30	6	12	29	5	4.6
Tiraumea_							
Control	6.0	20	8	12	39	6	4.7
TM21	6.0	19	8	11	35	5	4.6

Soil structure and soil moisture

No difference was found in the soil structure between the control and TM21_Soil amendment at either site (Table 2 and Fig. 1 and 2) or in soil moisture content at Alfredton.

Table 2 Analysis of the visual soil assessment scores of the farmer group at Alfredton and Tiraumea, of the visual crop assessment by the farmer group at Alfredton and volumetric soil moisture contents at Alfredton and Tiraumea on 7th December 2010.

	Alfredton			
Measurement	**Control**	**TM21**	**Difference**	**Critical p value**
Volumetric soil moisture content (%)	26.8	26.3	Not significant	(p=0.877)
Visual soil assessment	22.5	23.6	Not significant	(p=0.299)
Crop emergence (%)	62.5	70.0 (12%)[1]	Not significant	(p=0.269)
Crop ground cover (%)	53.8	65.5 (21%)[1]	Not significant	(p=0.162)
	Tiraumea			
Volumetric soil moisture content (%)	23.2	25.9 (11%)[1]	Significant	(p=0.091)
Visual soil assessment	16.1	15.5	Not significant	(p=0.494)

[1]Increase over control

Notes for Table 2
1. The components of visual soil assessment include Soil Structure and Consistence, Soil Porosity, Soil Colour, Number and Colour of soil Mottles, Earthworm Count, Tillage Pan, Degree of Clod Development and degree of Soil Erosion.

2. Visual soil assessments, crop emergence and crop ground cover were assessed by the four farmer subgroups on each of the 4 replicates at both locations

3. In statistics, a result is called statistically significant if it is unlikely to have occurred by chance. As used in statistics, significant does not mean important or meaningful, as it does in everyday speech. The amount of evidence required to accept that an event is unlikely to have arisen by chance is known as the significance level or critical p-value: The significance level is usually denoted by the Greek symbol α (lowercase alpha). Popular levels of significance are 10% (0.1), 5% (0.05), 1% (0.01) and 0.1% (0.001). If a test of significance gives a p-value lower than the α-level, the null hypothesis is rejected. Such results are informally referred to as 'statistically significant'

In contrast at Tiraumea a difference in soil moisture content was found between treatments, with soil moisture higher (11%) on the TM21 plots. It is difficult to comment on the potential benefit of the slightly higher soil moisture status on pasture growth at Tiraumea, without more soil moisture data for further analysis. This exercise of assessing soil structure using VSA would be worth repeating if the study continued.

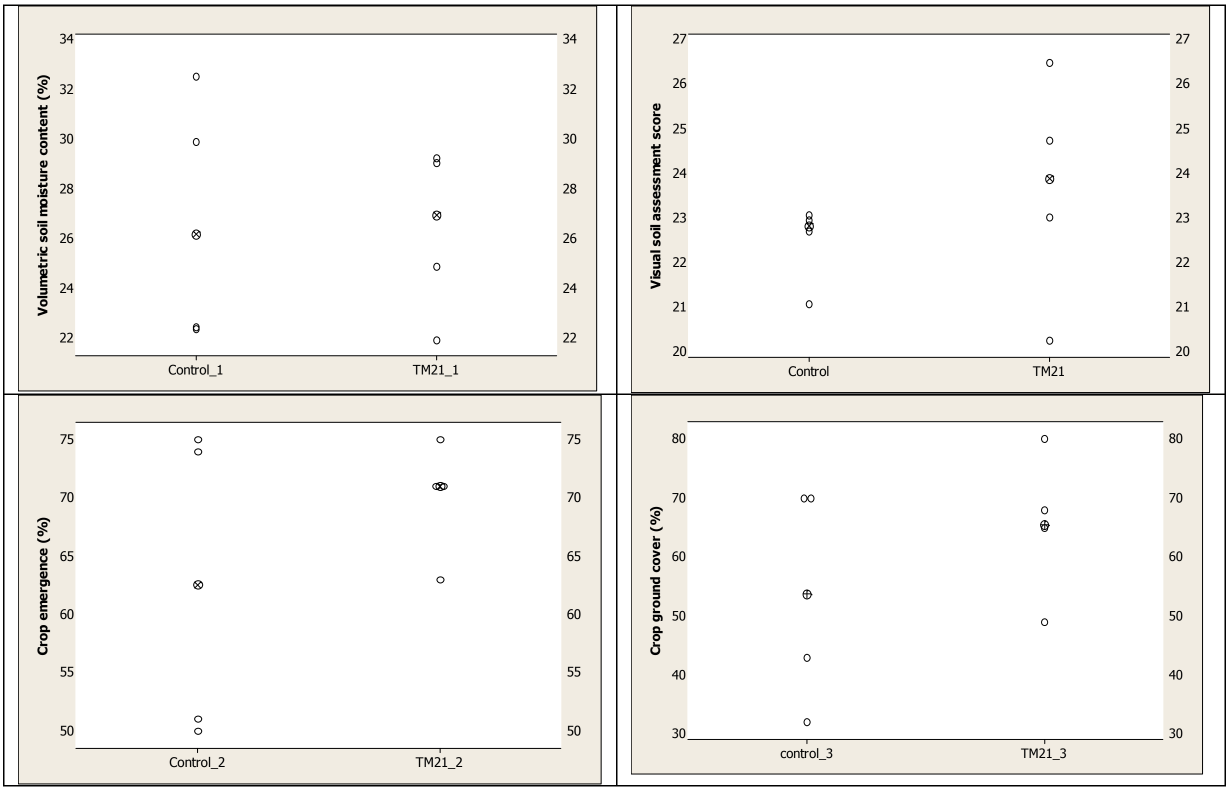


Fig. 1 Mean and range for volumetric soil moisture content and visual soil assessment score, visual crop emergence score and visual crop ground cover score by the farmer group on 7th December 2010, at Alfredton

Crop germination and crop ground cover

While not statistically significantly different, crop emergence and ground cover data at Alfredton, suggests that the application of TM21 might have enhanced establishment and early growth of the summer fodder crop (Table 2). It is important to note that the differences were not statistically significant, but may be reaching a point of difference of "biological interest". Two observations made on the day of the visual assessment of the crop at Alfredton were that there appeared to be less variation in the crop in the TM21 treated plots and the root systems appeared to be more developed in the TM21 plots, i.e. it was more difficult to pull the plant out of the ground in the TM21 plots.

The visual scoring of the pastures at Tiraumea could not be translated and analysed, because the scoring was confounded by differences in grazing pressure and times when last grazed. The intention at the next assessment by the farmer group was to have the livestock excluded from the plots 14 to 20 days prior to the evaluation.

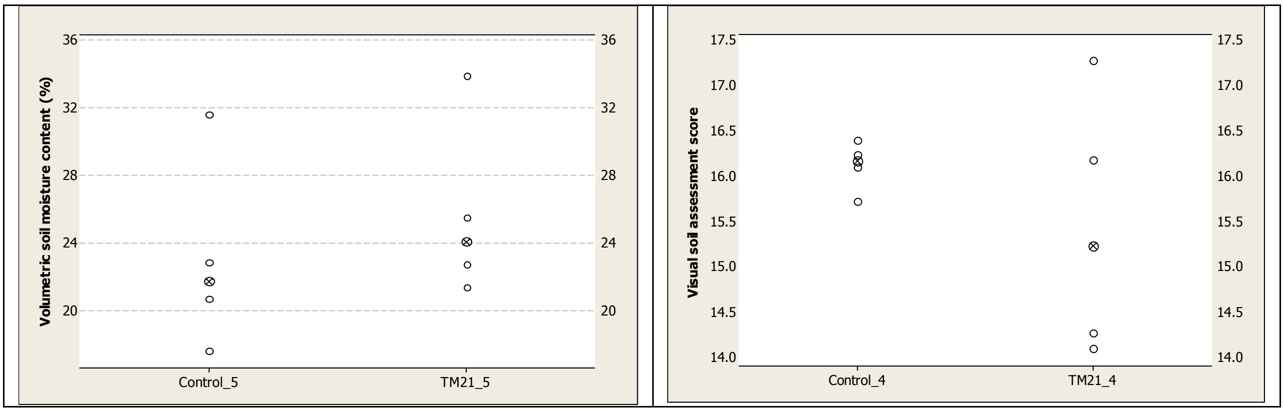


Fig.2. Mean and range of volumetric soil moisture content and visual soil assessment score by the farmer group on 7th December 2010, at Tiraumea.

Crop yield before first grazing (December 2010)

Average dry matter content of the crop was 8.75% at Alfredton. There was no statistically significant difference in the dry matter content of the crop between the control and TM21 plots.

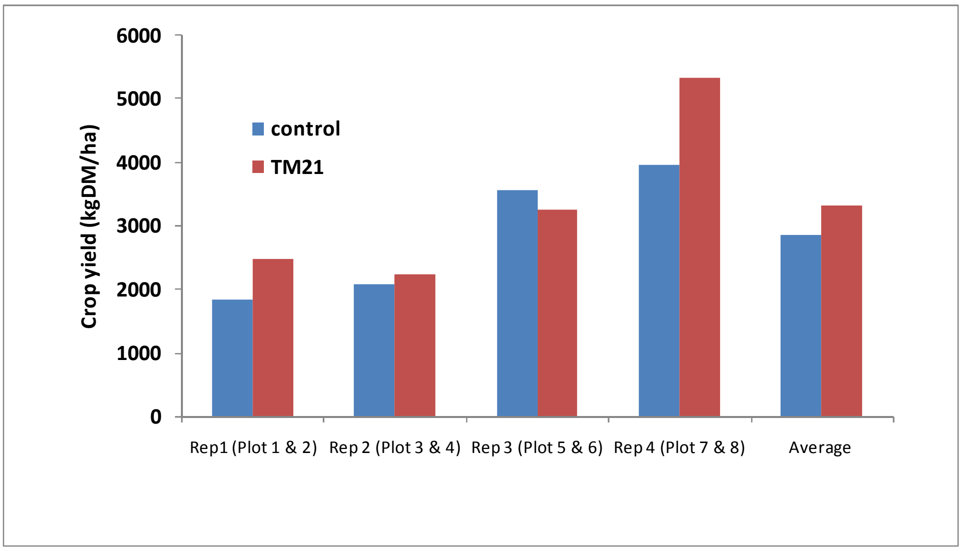


Fig.3 Crop yield for each of the 8 plots and the average sampled in December 2010 at Alfredton

Crop yield varied nearly 3-fold across the 8 plots from <2000 kgDM/ha on plot 1 to >5000 kg DM/ha on plot 8 (Fig. 3). An observation made during the cutting of the crop was the ease at which plants came out of the ground in the control plots, while in the TM21 plots plant root systems appeared to anchor the plants more effectively. Overall, the average crop yield from the TM21 plots was higher (16%) than from the control plots, but this difference was not statistically significant. Factors contributing to the lack of a significant difference include:

- The large variation in yield across the eight plots indicates there were factors other than the treatments imposed (control versus TM21) contributing to yield differences.
- Two of the four replicates (Rep 1 and Rep 4), TM21 plots had higher crop yields than the control. In the other two replicates, little difference in yield was found between the TM21 and control plots.

An examination of the crop characteristics suggests no difference between treatments in feed quality (Fig.4). ADF and NDF provide empirical estimates of the less digestible structural carbohydrates in forages. ADF consists mainly of cellulose and lignin with small amounts of nitrogen and minerals. The NDF fraction includes the hemicelluloses in addition to the ADF component of plant tissue.

Feed digestibility is simply defined as the proportion of forage dry matter able to be digested by the animal. It is largely influenced by the maturity of the plant species and declines as the plant matures because of increasing levels of the structural carbohydrates. Within pastures, the species type also influences digestibility. For example, clovers retain a higher leaf:stem ratio with increasing maturity compared with temperate grasses and so maintain a higher digestibility relative to grasses.

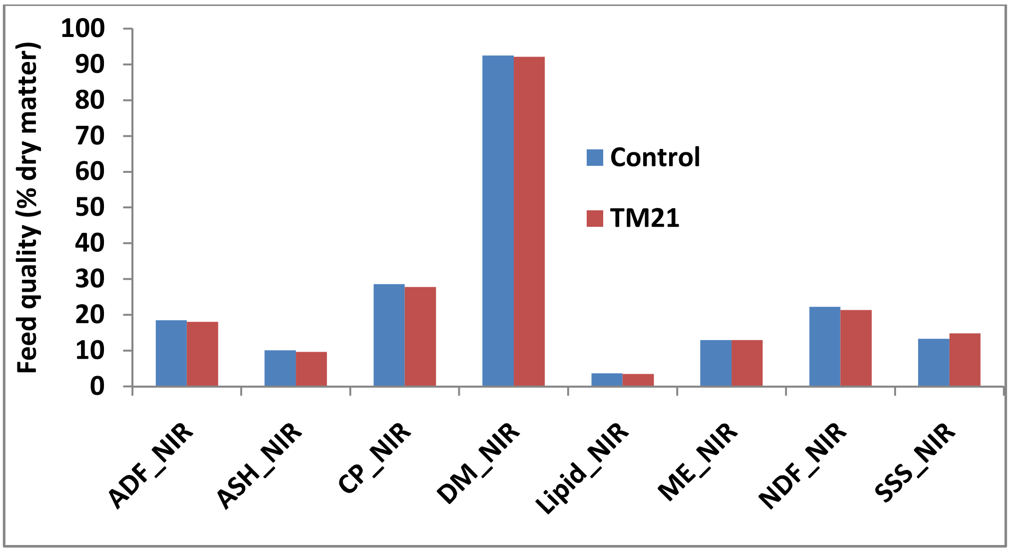


Fig.4 Feed quality attributes of the summer crop in December 2010 at Alfredton.

Protein content of forage is directly related to nitrogen content in these plants, which varies with growing conditions, plant species, and maturity of the plant. Crude protein (CP) requirements are dependent on the class of livestock being fed. For example, a maintenance requirement for a dairy cow may be as low as 12% protein, whereas a range of 16 – 20% protein is needed for growth and lactation.

Metabolisable Energy (ME) is an estimate of the energy content of the feed potentially available for maintenance and production in ruminant animals. It is that proportion of feed energy absorbed from the digestive tract and retained for metabolic processes and the value is expressed as a proportion of the dry matter (MJ/kg). Although ME is a frequently sought measure of feed quality, it is a value derived from other feed factors such as *in vivo* digestibility and cannot be measured directly. As such it has a number of limitations.

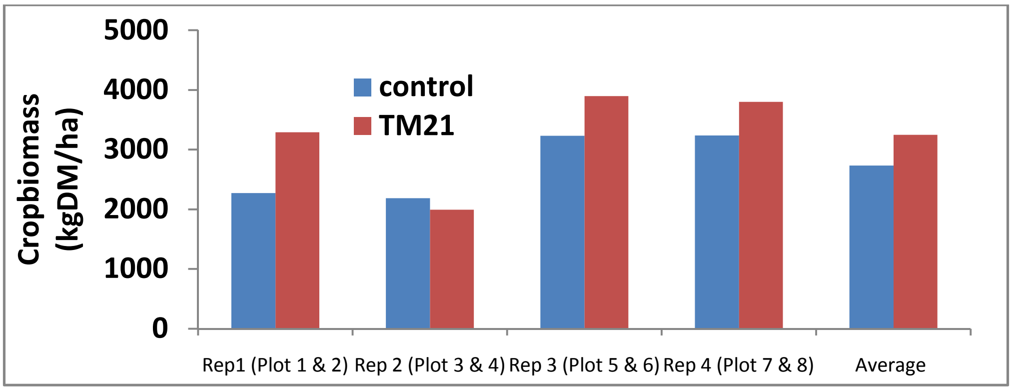


Fig.5 Crop biomass for each of the 8 plots in early February (10/02/11).

Crop growth rate in summer (February)

Standing crop biomass was 19% higher on the plots that had been treated with TM21 (Fig.5), but this difference was not statistically significant. This aligns with the difference in crop yield measured at the end of December, before the first grazing. Volumetric soil moistures were slightly higher on the plots treated with TM21 (29%) compared with controls (27.6%). There was a significant difference (p=0.02) in standing crop biomass yield between the control and TM21 treatments when sampled in late February (Fig.6).

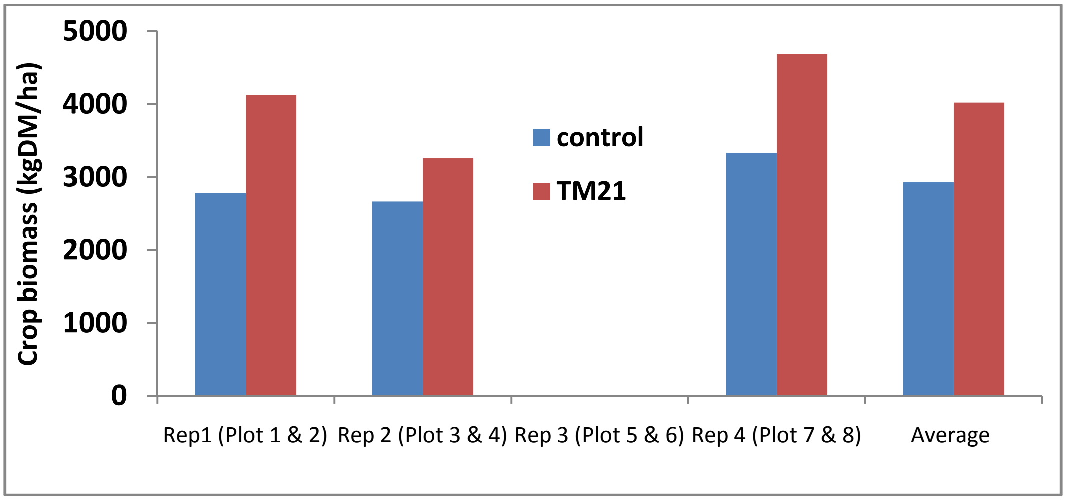


Fig.6 Crop biomass on plots 7 and 8 on 23/02/11 and plots 1-4 on the 28/02/11

Crop growth rate was significantly (p=0.052) higher in the TM21 than control plots with the average crop growth in the TM21 plots 62 kg DM/ha/day, compared with 27 kg DM/ha/day in control plots for the 13-18 days between measurements in February. This represents more than a doubling in crop growth rate for this period of time. They align with the farmer's previous experience of improved crop vigour and yield resulting from use of TM21.

There is no simple explanation for the improved crop yield in plots treated with TM21. Some of the difference can probably be attributed to improved establishment and early growth (Table 2). Associated with the higher crop ground covers was an observation made by the farmer group during the visit in early December that there appeared to be less variation in the crop in the TM21 plots. In late December when crop yield was assessed before the first grazing (Fig. 3) the observation was also made of improved rooting of the crop in plots treated with TM21. This also suggests better plant development. No difference in soil moisture content was found between control and TM21 plots in February at Alfredton.

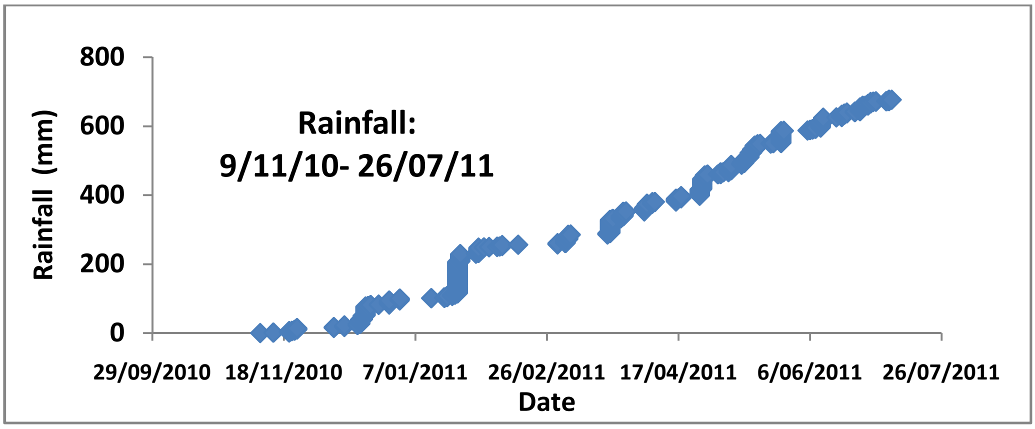


Fig.7 Cumulative rainfall from 9/11/10 through to 26/07/11

Cumulative rainfall during the period from early November 2010 through to the end of February 2011 amounted to 257 mm (Fig. 7).

Value of TM21 as a soil amendment on a summer crop

With monitoring of crop yield limited to sampling before the first grazing in late December and between two grazing events in February, it is not possible to value the benefit that TM21 had on crop yield and how that might have contributed to increased animal production. In the absence of a data set to undertake the necessary analysis, the following commentary is provided following discussion with Simon Mckay and input from Chris Garland (Baker and Associates) who provided the costs and prices listed below.

Commentary: From Simon McKay: The summer crop in 2010/11 produced on average 850 kg of lamb liveweight gain /ha from late December to March. This is down on an average year where lamb production would be closer to1000 kg liveweight/ha. Using an average lamb weight of 35 kg (30-40 kg) and assuming 1 kg liveweight gain for a 35 kg lamb requires 4.67 kg DM (35 kg lamb eating 4% of body weight/day and growing at 300 g/day) and a total of 850 kg of lamb liveweight gain was obtained/ha, the crop would have produced 4000 kg DM /ha

Questions

1. **How much more feed would the crop have to grow to cover the cost of TM21 and its application?**

The cost of TM21is $16/ha. This was applied twice during the study period. Assuming application cost = $12/ha total, because one of the application was in tandem with another spray (i.e. herbicide). **Total treatment cost** = $44/ha

@ $44/ha @ $3.50/kg LWG = 12.57 kg LWG

@ 4.67kgDM/kg LWG = 58.7 kg DM/ha extra required to cover cost of TM21.

This equates to only a +1.46% increase in forage production to cover costs.

2. **What would be the value of a +10%, +20% and +30%increase in crop yield over the 4000 kg DM/ha**

Using the same assumptions as above, the respective values are: -

+10% = 440 kgDM/ha = 85.9 kg LWG @ $3.50/kg LWG = **$300/ha**

+20% = 880 kgDM/ha = 171.8 kg LWG @ $3.50/kg LWG = **$600/ha**

+30% = 1320 kgDM/ha = 257.7 kg LWG @ $3.50/kg LWG = **$900/ha**

The above values assume the following:

- Feed quality and utilisation is the same at the higher crop yield
- There are no additional net costs associated with the higher yield (i.e. additional weight goes into existing lamb numbers. No extra lambs, no extra holding interest cost). In practice, there may be higher stock numbers and higher animal health and labour costs

Pasture establishment at Alfredton

There was an apparent small increase (9%) in ryegrass tiller numbers on the TM21 plots, but the difference was not significant (p=0.662) (Fig.8).

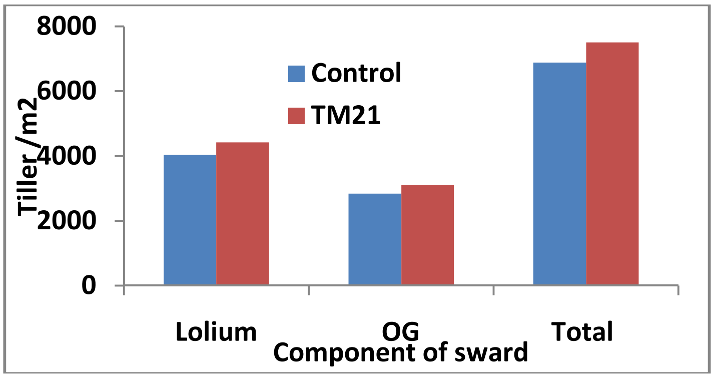


Fig.8 Perennial ryegrass (*Lolium*), other grasses (OG) & total grass tiller number at Alfredton.

There was little difference in soil moisture content between plots at Alfredton in July (Fig. 9). Soils on all plots were wet.

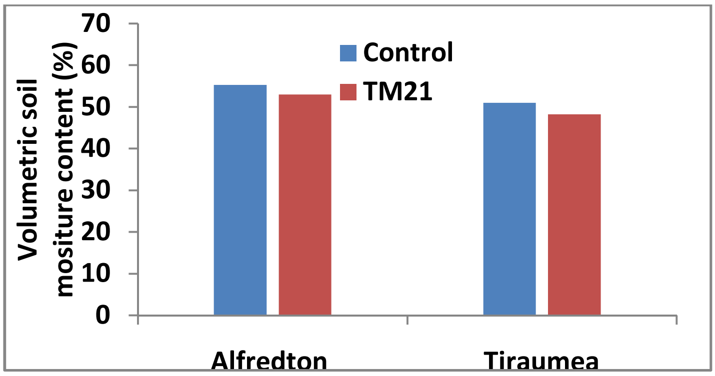


Fig.9 Volumetric soil moisture content of the soils in early July (06/07/11)in the TM21 and control plots at the two field sites

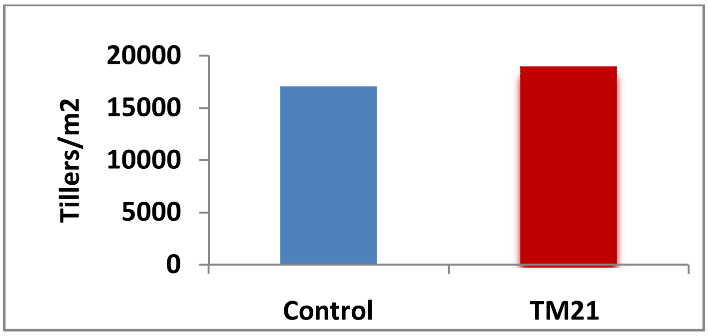


Fig.10 Tiller numbers on the control and TM21 plots in July (06/07/11) at Tiraumea.

Pasture characteristics at Tiraumea in winter (July)

Tiller numbers were slightly higher (11%) in the plots treated with TM21 (Fig 10), but again not significant. The difference in tiller number between the Alfredton (Fig 8) and Tiraumea sites (Fig.10) reflect the difference between a new and permanent pasture, respectively.

Soils were at the wet end of the scale at Tiraumea in July, with average soil moisture contents slightly lower in the plots treated with TM21 (Fig 9), but this difference was not significant

(6) Conclusions – what are the 'take home' messages?

This study was in response to farmer interest in TM21 as a soil amendment or addition to their current fertiliser programme. To date this product has not been evaluated in any structured study in New Zealand. The positive result from the summer crop study with TM21 warrants a wider-scale evaluation. There was interest from the group members to learn more about the product, to develop a better understanding of the mode of action of the product and establish if the positive result could be repeated on a commercial scale.

(7) How will the group apply the project results to their agri-businesses?

One producer has been using the product for a number of seasons. The interest from the group in the use of TM21 on the summer crop extended to include the potential benefits on the new pasture at Alfredton. The group was also keen to collect more information on the effect of TM21 on soil moisture levels and the performance of the permanent pasture at Tiraumea. To that end funding to continue the study at both sites is currently being sought.

(8) Contact points for more information

Dr Alec Mackay Scientist AgResearch Grasslands Private Bag 11008 Palmerston North
Phone 06 3582861 alec.mackay@agresearch.co.nz

Chris Garland Agribusiness Consultant Baker & Associates PO Box 900 Masterton
Phone 06 3788174 chrisg@bakerag.co.nz

To find out more about other FITT projects, freephone Beef + Lamb New Zealand on 0800 BEEFLAMB.

END[•]
Prepared by: Alec Mackay
Date: 29 September 2011