Nitrogen Use Efficiency Trial 14/15 Milestone Cut Report 1: 1st December 2014 – 30th March 2015

Key messages for your farm:

- Nitrogen application to kikuyu can be profitable provided the extra feed can be effectively utilised by the milking herd
- Nitrogen applied every grazing gave higher response than every second grazing
- Nitrogen application improved forage quality by 0.7 MJ ME/kg DM and the total MJ ME/ha available for grazing by 50 to 100%
- Therefore improving kikuyu forage quality by nitrogen application, tight rotation, and residue management can produce 50 to 100% more milk/ha from kikuyu.

Figure 1: Trial Site

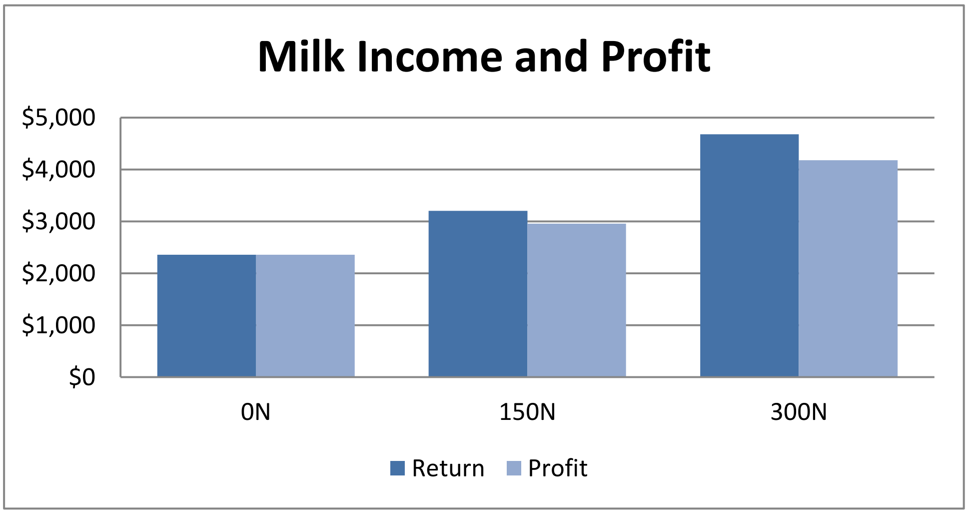

Figure 2: Returns and Profit from Nitrogen applied over four harvests.

Background:

The nitrogen rate trial was established at James Neal's dairy, Oxley Island, in a well-established, fertile kikuyu pasture. The objective of the trial is to establish three nitrogen regimes over the kikuyu growing season: very deficient (0 kg N/ha), deficient (150 Kg N/ha) and adequate for high production (300 kg N/ha). The aim is to then compare the effect of these treatments on ryegrass establishment and growth after the kikuyu growing season.

Cutting and removing harvested material provides an increased (80 to 100%) demand on nitrogen compared to grazing, where 85% of the nitrogen is returned to the paddock in dung and urine. Therefore the rates chosen are not excessive and the zero treatment is aimed at reducing nitrogen availability over time. The higher treatments are aimed at maintaining nitrogen levels.

The site chosen is adequate for Phosphorus (P), Potassium (K) and Sulphur (S) after a history of effluent dispersal and typically receiving no nitrogen over summer. White Clover was present in patches at the beginning of the trial but was removed by herbicides to improve nitrogen uniformity over the trial period. Existing urine patches were also evident and affected some plots in the first two harvests.

Treatments

The three nitrogen treatments (0,150,300 Kg N/ha/season) were commenced 22nd December 2014 after annual ryegrass had seeded and was grazed out. While the intent was to apply fertiliser after every second grazing, slow growth of the kikuyu meant fertiliser was applied in the first, third and fourth harvest to achieve the target nitrogen rate before ryegrass sowing. Treatments for each harvest were 0, 50, 100 kg N/ha applied as urea granules to each plot within 24 hours of harvest.

First growth period began on the 9th January and continued until March 24th. The plots were harvested when the kikuyu reached the 4.5 leaf stage. In this period, four kikuyu harvests were taken with plot mowers leaving a 6 cm residue. This occurred at 21 to 28 days intervals where normally 14 to 16 days was expected. All material was removed from the plots and cows excluded by electric fence.

Tissues tests for nitrogen, nitrate and feed quality (ME, CP, NDF) were taken at each harvest from the harvested material on each of 60 plots. Samples were dried at 60^{o}C for48 hours in an oven. Results are presented for each of tests current testing.

Results

Soil Tests

Soil test results indicate highly fertile conditions in all nutrients with the exception of sulphur.

Table 1: Soil Test Results 12/12/2014

	pHCaCl	P Colwell	K Colwell	S KCL	C%	N%	C:N	CEC
		mg/kg	mg/kg	mg/kg				Meq/100g
Trial	6.1	180	370	9.2	5	0.54	9.25	31
Ideal	>5.5	>80	150	10	>3		<10	

Dry Matter Harvests

Table 2: Dry Matter Yield Kikuyu (kg DM/ha) 2014/15 and NUE kg DM/kgN/ha

	Dry Matter Yield (**Kg DM/ha**) and NUE (kg DM/Kg N/ha)		
N Rate (**Kg N/ha**)	**0**	**150**	**300**
9/1/2015	1248	1483 (4.7)	3037 (17.9)
2/2/2015	702	843	991
28/2/2015	746	1051 (6.1)	1318 (5.7)
24/3/2015	1155	1521 (7.3)	1634 (4.8)
Ave Growth Rate (kg DM/ha/day)	41	53	75

Table 3: Nitrogen % and Leaf Nitrate

	Nitrate NO3-N mg/kg			**Nitrogen % of DM**		
N Rate (**Kg N/ha**)	0	150	300	0	150	300
9/1/2015	164	246	573	3.1	3.3	3.6
2/2/2015	381	530	1490	2.9	3.1	3.6
28/2/2015	13	13	172	3.0	3.2	3.6
24/3/2015	99	680	786	3.0	3.8	3.8
Ave	**164**	**367**	**755**	**3.0**	**3.3**	**3.7**

Table 4: Nitrogen Uptake and Percentage N recovery in the leaf

	Nitrogen Uptake (Kg N/ha)			**% N Recovery**		
N Rate kg N/ha	**0**	**150**	**300**	**0**	**150**	**300**
9/1/2015	38	49	110	-	21	72
2/2/2015	20	26	36	-	12	16
28/2/2015	22	34	47	-	23	25
24/3/2015	34	58	62	-	47	28
Total N Removed	115	166	255			

Feed Quality

Feed quality improved with nitrogen rate in each harvest for both ME and CP. However even at high nitrogen 8.7 MJ ME/kg DM was below average for kikuyu leaves (9.5 MJ ME/kg DM) and well below requirement for milking feed. This may be because taller nitrogen fertilised kikuyu when cut to 6 cm included some stem material.

Table 5: Feed Quality of Harvested Kikuyu

	Metabolisible Energy Mj ME/kg DM			Crude Protein %			NDF %		
N Rate (Kg N/ha)	0	150	300	0	150	300	0	150	300
9/1/2015	7.7	8.1	8.5	20	21	23	58	58	56
2/2/2015	7.9	8.0	8.6	18	19	22	58	59	57
28/2/2015	8.1	8.6	8.8	19	21	23	59	58	58
24/3/2015	8.2	9.1	9.0	19	23	23	57	55	55
Ave ME	**8.0**	**8.4**	**8.7**	**19**	**21**	**23**	**58**	**58**	**56**

Soil Moisture

Two plots were monitored with capacitance moisture probes from 10, 20, 30, 40, 50, 60 cm to identify when moisture stress limited N response. Results indicate periods of drying between harvests in the kikuyu phase but not severe moisture stress. In contrast the ryegrass establishment period remained wet and even waterlogged in April through May.

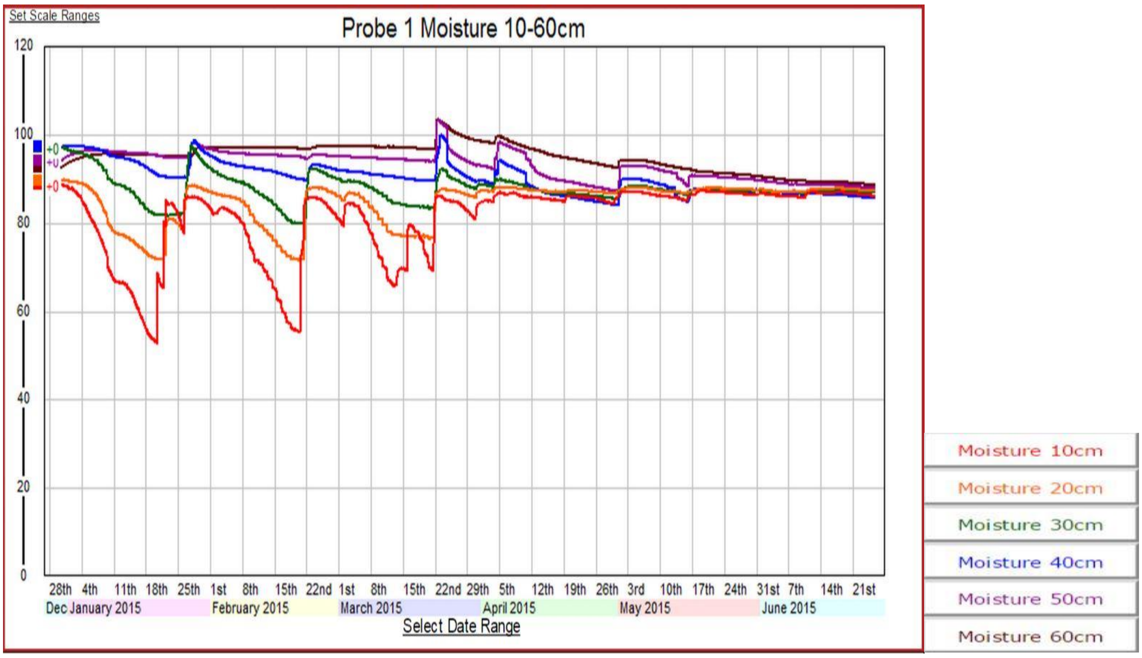

Figure 2: Soil Moisture Profile Probe 1

Discussion

Research over many years shows kikuyu responds well to nitrogen (20 to 25kg DM/ha /kg N applied) up to 300 kg N/ha/yr and when soil moisture is adequate (Mears 1970, Kemp 1975). In this trial responses were much lower 5-10 kg DM/ha/kg N applied which can be explained to some extent by high soil N contribution to the nitrogen pool.

The soil C of 5% and N of 0.54% indicates total N reserves of 700 kg N/ha in the top 10 cm and 2100 kg N/ha in the top 30 cm. With a C:N ratio of less than 10 indicates net mobilisation of nitrogen was occurring in this pasture, that is the nitrogen in the organic matter was being released to be used by the kikuyu.

In the zero treatment 115 kg N/ha was removed in the four harvests coming directly from the soil. This is compared to 166 and 255 kg N/ha in the 150 and 300 kg N/ha treatments. Application and removal figures are closely aligned.

The Crude Protein (CP), Nitrogen %, and Nitrate nitrogen of the high N plots all indicate nitrogen content in the leaves was above requirements for optimum growth. In addition in the first two cuts the influence of urine stains were substantial in some plots.

Although responses were small they could have still been economic if the cows had converted the extra growth to milk (Table 6). The key lies in identifying and managing the surpluses through the use of the right rotation tool so that silage is cut at the best quality that is when the paddock would have been grazed.

Table 6: Potential Milk Production and Profit/ha

Milk Produced		**0N**	**150N**	**300N**
1st Cut	litres	1364	1711	3688
2nd Cut	litres	790	957	1221
3rd Cut	litres	860	1291	1648
4th Cut	litres	1352	1972	2101
Total Milk	litres	4367	5930	8658
Return	$/ha	2358	3202	4675
N Cost	$/ha		248	495
Profit	$/ha	2358	2955	4180

When 1 litre milk is produced for every 7.0 MJ ME/ha and at $0.55 c/litre

While the treatments were meeting the objective of providing three distinct nitrogen regimes before ryegrass sowing, the data shows that N requirements for adequate kikuyu growth can be met to a large extent by soil nitrogen where the N pool is high and the C:N ratio is relatively low. With such large nitrogen inputs on dairy farms it suggests real savings can be made by more accurate prediction of nitrogen needs and responses.

Although the quality of the kikuyu improved by 0.5 to 0.7 MJ ME/kg DM with nitrogen application, the levels measured, 7.7 to 9.1 MJ ME/kg DM are well below potential for kikuyu at 9.5 MJ/ME/kg DM for leaf material (Garcia et al 2014). This maybe confounded by the higher nitrogen treatments, being taller, contains more stem reducing the quality of the sample.

Past research and experience has shown cows grazing kikuyu rarely remove more than 1300 to 1400 kg DM/ha of leaf material. In the absence of N application the dry matter over 5 cm harvest height was well below this level in two of the four harvests and would have restricted intake even if quality was maintained.

Figure 3 Nitrogen Fertilised kikuyu foreground, zero to the left background

Growth rates only exceeded 60 kg DM/ha per day in the highest N rate of 300 kg N/ha. This concurs with past research at Taree by Kemp (1975) where growth rate of over 60 kg DM/ha/day were only recorded for 6 days with 170 kg N/ha/yr but for 154 days per year with 640 kg N/ha/yr. In Kemp's work high N rate extended the growing season from 5 to 9 months.

Current NSW DPI recommendations (Griffiths et al 2011) promote 45 kg N/ha application every second grazing. In this trial and others conducted by the author, this practice produced a vastly reduced yield in the second cut. This suggests most of the applied N is assimilated by the pasture system in the first cut growth period and that only small amounts are available to for the next grazing. It produces a seesaw pattern of grass growth that may make management more difficult.

However this also suggests that stopping nitrogen application at the second last grazing before sowing ryegrass will reduce the vigour of the pasture during ryegrass establishment. It also follows that short term application of N to kikuyu over summer may not have significant carryover of N to affect ryegrass N requirements.

The cost of N application every grazing is high when labour and spreading costs are included. Although there was little to be gained with current slow release products in work conducted by the author, there remains a need to pursue slow release option or at least lower cost application methods.

References:

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Kemp D.R. (1975) The growth of three tropical pasture grasses on the mid-north coast of New South Wales. *Australian Journal of Experimental Agriculture* **15**, 637-644.

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