Report Title: Quantifying the Effect of Two Different Pasture Management Systems on Milk Production and Farm Profitability

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on behalf of the Northland Dairy Development Trust

Date submitted: 19th October 2015

This project has been funded by New Zealand dairy farmers through DairyNZ.

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Acknowledgements

This project was facilitated by the Northland Dairy Development Trust. Special thanks to:

- *Rodd Hodgson – NARF Farm Consultant*
- *Kate Wynn – Past DairyNZ Science Manager*
- *Peter Flood – NARF & NDDT Trustee*
- *Kerry Chestnut – NARF & NDDT Trustee*
- *Andrew Randall – Past NARF Chairman*
- *Other Farmers and Rural Professionals who have assisted and supported this project*

The Northland Dairy Development Trust thanks the support of sponsors who enabled this project to be undertaken:

- Bank of New Zealand
- Ballance Agri-Nutrients
- RD1
- LIC
- Fonterra
- Agriseeds
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1 Executive Summary

This study compared a predominantly kikuyu-based farm system (Kikuyu farmlet) with a farm system predominantly without kikuyu (Ryegrass farmlet) for three years. The Kikuyu farmlet included mulching and introduction of Italian ryegrass on all kikuyu-based pastures to improve pasture quality and cool season pasture production. Stocking rate was higher on the Kikuyu farmlet (3.2 cows/ha) than the Ryegrass farmlet (3.0 cows/ha) during the first two seasons however, during the third season, stocking rates were similar (3.0 cows/ha).

The Kikuyu farmlet grew less pasture during winter (0.57 t DM/ha/annum) and more during late summer and autumn (0.96 t DM/ha) than the Ryegrass farmlet. Both the Kikuyu and Ryegrass farmlets produced a similar amount (13.9 v 13.7 t DM/ha respectively) of total pasture per annum when averaged over the three seasons. Pasture covers followed pasture growth, with covers lower during winter and higher during autumn on the Kikuyu farmlet compared with the Ryegrass farmlet.

Feeding of palm kernel expeller (PKE) and maize silage supplementation was varied according to the need to fill feed deficits. During the first and second season, supplement use was higher on the Kikuyu farmlet than the Ryegrass farmlet (mean of 5.28 and 4.55 t DM/ha/annum respectively). In the third season, when stocking rates were similar, supplement use was identical between farmlets (2.76 t DM/ha). In all years the supplement use was higher on the Kikuyu farmlet during winter and lower during autumn than on the Ryegrass farmlet, a result of lower pasture growth on the Kikuyu farmlet as kikuyu pastures transition to temperate species. Encouraging this transition to occur as quickly as possible, as in the use of mechanical kikuyu control (mulching) and/or introduction of Italian ryegrass, is a strategy to minimise this greater supplement requirement during winter.

When averaged over the three seasons of the study, milk production was identical between farmlets (1154 kg MS/ha) Differences in seasonality between farmlets were small. It is likely that milk production differences between farmlets were somewhat masked by relatively high levels of supplement use. If supplement use had been lower, then significant differences in seasonality may have occurred. As with milk production, body condition score was similar between farmlets, again differences that might have occurred as a result of pasture type being masked by supplement use.

When averaged across the three seasons, farm working expenses were higher on the Kikuyu farmlet ($5,686/ha) compared with the Ryegrass farmlet ($5,236/ha). The main cause of this higher cost was the annual mulching and under-sowing of Italian ryegrass and the higher supplement use in the first two seasons. The average operating profit for the three seasons was higher on the Ryegrass farmlet ($2,921/ha) than the Kikuyu farmlet ($2,432/ha). This difference was mainly in the first season, when turnips were grown on the Ryegrass farmlet but not on the Kikuyu farmlet, significantly affecting milk production during summer. Turnips were grown on both farmlets in the following years and differences in farm profitability were small, though still showing an advantage to the Ryegrass farmlet.

This study has illustrated that, when managed appropriately, the production and profitability of kikuyu farms is likely to be slightly lower than that of ryegrass farms. However, comparison between farm systems was compromised by differences in farm management applied between farmlets in some years. This finding contrasts with a previous study by the same group that showed kikuyu systems having higher production and profitability than non-kikuyu systems. In the previous study brassicas were not sown for summer production on any farmlet and this possibly compromised the ryegrass-based farmlet to a greater degree than the kikuyu-based farmlets. Because the farmlet structure within this current study was better balanced than in the previous study, the results of this study should be treated with greater confidence. Overall, when kikuyu is well managed, such as the integration of short term ryegrass as used in this study, the presence of kikuyu within the system is likely to have little effect on farm performance, however this management can come at a cost.

For farmers, the current presence of kikuyu on farm may range from none to virtually total farm cover. This study suggests that, when managed appropriately, kikuyu presence may have little effect on farm profit. If kikuyu presence is high then the eradication of kikuyu from either part of a farm or the whole farm is unjustified due to the likely costs of eradication. However, if kikuyu can be kept out of the farm or parts of the farm at minimal cost, then this would likely simplify management and may have small benefits on farm profitability through lower costs.

2 Introduction

Kikuyu is an invasive subtropical grass that thrives in the Northland summer and autumn, but is very sensitive to cool weather in winter and early spring. As a result of the huge range in seasonal growth of kikuyu, farmers find it difficult to manage. If it is not managed correctly in autumn it forms a dense mat of stolon which results in low quality feed for the following season. Many farmers try to eradicate kikuyu from the farm system through spot spraying and re-grassing, however this is an endless battle. Others have decided to just work with the kikuyu. Consequently, pasture composition varies considerably in Northland from almost completely kikuyu to no kikuyu, and every combination in between, on both a paddock and a farm scale.

There is the perception in the industry that kikuyu pasture systems are less productive and profitable than ryegrass pasture systems. This perception was challenged by a four-year trial at the Northland Agricultural Research Farm (NARF), from June 2008 to May 2012, which compared the productivity and profitability of ryegrass with mulched kikuyu and non-mulched kikuyu pasture systems. Results averaged over the four years showed that the mulched and non-mulched Kikuyu farmlets grew and harvested more grass per hectare (12.6 t DM/ha and 13 t DM/ha harvested respectively) than the Ryegrass farmlet (10.9 t DM/ha harvested). This resulted in higher supplement use and grazing off farm on the Ryegrass farmlet. Milk production was also higher on the Kikuyu farmlets, averaging 1169 kg MS/ha for the mulched and 1101 kg MS/ha for the non-mulched, compared with 1086 kg MS/ha for the Ryegrass farmlet. There was very little difference between the farmlets in milk production to Christmas, however better summer and autumn growth rates placed the Kikuyu farmlets at an advantage. Despite having pasture management costs more than double the

other two farmlets, the mulched kikuyu farmlet was the most profitable system at an average of $3147/ha. The non-mulched Kikuyu and Ryegrass farmlets incurred operating costs of $3062/ha and $2205/ha respectively.

From this previous trial it could be concluded that kikuyu pasture systems are actually more productive and profitable than ryegrass pasture systems in Northland, however there were some problems with the trial set-up which may have affected the results. The main issue was that the Ryegrass farmlet struggled to perform throughout the four-year trial as much of the land area designated to this farmlet was located on the wetter and less developed areas of the farm. As a result, it was not possible to conclude that the kikuyu systems were more profitable than ryegrass systems if the same land resource was used.

This previous trial sparked considerable farmer interest and debate such that another trial was deemed appropriate to compare both pasture systems in a more balanced way and determine if the same conclusion could be made. The aim of this project is to determine if productive and profitable dairy farm systems in Northland can be achieved irrespective of pasture type provided systems are well managed. Therefore, the purpose is to provide farmers with robust, objective data which they can extrapolate to their farm business. By demonstrating management practices and changes on farm and operating under an 'open book' structure, farmers and rural professionals can observe the outcomes and have more confidence in managing their own farms.

3 Methods

Trial Set-up

The trial commenced in June 2012 and was completed in May 2015. The Northland Agricultural Research Farm was split into two farmlets (Ryegrass and Kikuyu farmlets) which were matched in terms of soil type, soil fertility, distance to the milking shed, drainage and topography. Pasture botanical composition was also used to allocate paddocks to farmlets. However, because each paddock had varying levels of kikuyu presence, the Ryegrass farmlet still had some kikuyu presence (30% kikuyu presence in March 2012), while the Kikuyu farmlet was not totally covered in kikuyu (72% kikuyu presence in March 2012).

The Kikuyu farmlet was 44 hectares and operated at a stocking rate of 3.2 cows/ha during the first two seasons, while the Ryegrass farmlet was 40 hectares and operated at 3.0 cows/ha. These different stocking rates were determined to utilise the expected greater pasture production from the kikuyu pastures. In the third year of the trial the stocking rate was reduced on the Kikuyu farmlet to match the Ryegrass farmlet (3.0 cows/ha).

Both farmlets started calving on 1st July for the first year, and 10th July for the second and third years. Cows were culled to maintain a constant replacement rate for each herd based on empty rate, incidence of mastitis, somatic cell count, production worth and breeding worth. Cows remained in their herds throughout the three seasons, unless culled.

Cropping, supplements and grazing off

Turnips were grown for summer feed supply and to aid kikuyu eradication on the Ryegrass farmlet in the first year at approximately 8% of farmlet area. It was thought that kikuyu growth on the Kikuyu farmlet would be sustained over summer, however very dry conditions in the first season resulted in low pasture growth on both farmlets and therefore, without the turnips the Kikuyu farmlet was at a feed disadvantage. In years two and three, turnips were grown on both farmlets at approximately 10% of

farmlet area. Crop paddocks rotated each year and were generally sprayed out in October and re-grassed in April. Crops yields averaged 12.4 t DM/ha in the 2013/14 season and 12.1 t DM/ha in the 2014/15 season. Turnips were fed from late December to early April based on target cow dry matter intake and crop yield measurements. At most times feeding levels were 3-4 kg DM turnips/cow/day.

Supplements were fed on both farmlets to achieve target cow feed intakes set each month. Maize silage was fed in all three seasons, being the dominant supplement in the first season, while Palm Kernel Expeller (PKE) was the dominant supplement in the last two seasons. Both were imported from outside the farm system. Supplement feeding rates varied between farmlets depending on the pasture available and the individual herd requirements.

Young stock were grazed off farm from weaning until two months prior to calving, and 30% of both herds were wintered off farm for six weeks in June and July during the start of the first and second seasons (no grazing off in the third season).

Nitrogen

Nitrogen was applied throughout each season as either urea, Sustain (urea) or Ammo 36. Nitrogen use tended to be similar between farmlets during winter and spring, however autumn applications varied according to timing of mulching and kikuyu growth.

Table 1. Total nitrogen use in all three seasons for the Kikuyu and Ryegrass farmlets (kg nitrogen/ha)

	Kikuyu farmlet	**Ryegrass farmlet**
2012/13	136	117
2013/14	154	179
2014/15	195	200
mean	**162**	**165**

Kikuyu Management

In the first two seasons all kikuyu based pastures on the Kikuyu farmlet were mulched and drilled with Italian ryegrass (cultivar Tabu). In the third season the Italian ryegrass seed was broadcast prior to grazing and mulching. This mulching and introduction of Italian ryegrass occurred during April and early May. The Italian ryegrass was sown at a rate of 20 kg seed/ha to provide feed over winter and early spring while the kikuyu lay dormant. Kikuyu areas on the Ryegrass farmlet were managed through grazing only.

Farm Management Decisions

Strategic farm management decisions were made by the NARF farm management committee. This mentor group consisted a farm consultant, farmers (chosen for their proven success in their own business, their profile within the industry and/or their perceived ability to motivate others and encourage management change on farm), rural professionals and the NDDT science manager. Decisions were made based on data collected by the farm manager (cow numbers, pasture growth rates, pasture covers, milk production and mating records) and observations made on the day by the farm committee. Farm financial budget revisions were completed at monthly financial meetings between the farm manager, accountant and NARF/NDDT trustees.

Extension

Results from the farm walk and notes from the management meeting were extended to farmers in the region through fortnightly email updates distributed through the DairyNZ database. Farmers in the region were also welcome to attend the management meetings, taken up by a few individuals on a regular basis.

Field days were held in March and June annually to provide farmers with a more practical and in-depth insight into the trial. These field days were held on farm and included a session on trial updates and management practices for the season, presentations from guest speakers and a farm walk. Information from the sessions and presentations were made available for farmers in field day handouts. The Northland Dairy Development Trust held a conference in November 2012 and 2013 and February 2015 which included an update on the NARF trial as well as presentations on other trial work undertaken by NDDT.

Data Collection

Milk production and somatic cell count data were collected using tanker pickup information (from the two separate vats). Herd tests were conducted four times a year to determine individual cow performance and the resulting information used to make culling decisions.

Animal health treatments for mastitis, lameness and inductions were recorded in the Fonterra Dairy Diary, being similar across farmlets.

Cow body condition was assessed by the farmer mentor group at the fortnightly management meetings using the DairyNZ scale of 1-10. Samples of the herds were assessed (>30 cows/herd) and the results used to make strategic decisions around feeding, milking frequency and culling.

Pasture growth rates and covers were calculated through weekly pasture walks with a rising plate meter. A constant equation (140 +500) was used through all seasons. Individual paddock cover assessments were used to create a feed wedge histogram which was used for feed allocation and to calculate round length. Pasture growth was calculated through calculating the differences between weekly pasture cover measures for those paddocks which were not grazed during that week.

Supplement use per herd was recorded daily in a Excel spreadsheet and amount of supplement on-hand assessed at management meetings.

From October to April of the third year of the trial, monthly pasture samples were collected from the next four paddocks to be grazed on each farmlet down to anticipated grazing height. A pooled sample from each farmlet was analysed for pasture quality (NIR) while individual paddock samples were analysed for botanical composition (kikuyu leaf, kikuyu stolon, perennial ryegrass, Italian ryegrass, kikuyu, *Poa annua*, legumes, weeds and dead matter).

Kikuyu presence in each paddock on the farm was assessed annually in February/March by taking 200 random points per paddock and determining if kikuyu was present or not.

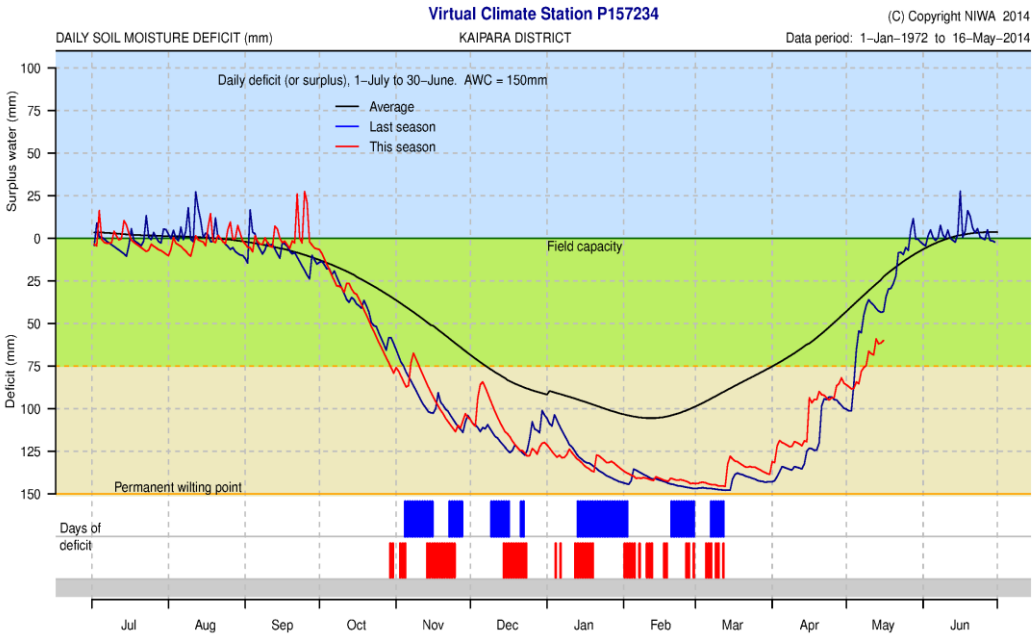
Turnip yields were measured by sampling two or more one square metre samples from each paddock to be grazed. Bulbs and leaf weight was measured fresh after which samples were weighed and dried to determine dry matter content.

Climatic Conditions

In the first two seasons very similar climatic conditions occurred with soil moisture levels dropping quickly in October due to below average spring rainfall (Figure 1). From December onwards very little rain was received which resulted in soil moisture levels just above permanent wilting point from January to March. During this period pasture growth rates dropped from approximately 50 kg DM/ha/day to less than 10 kg

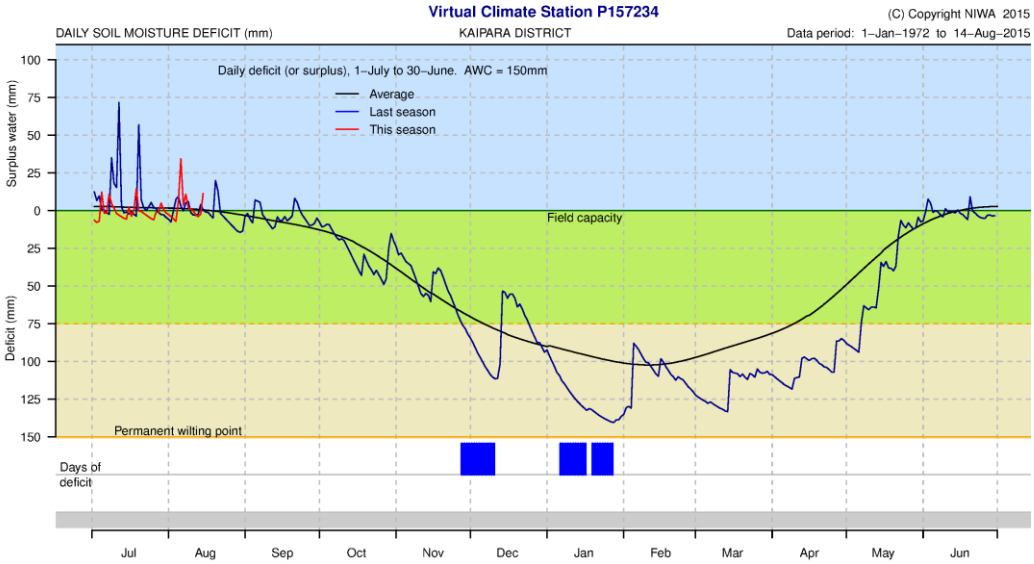
DM/ha/day which prompted the need for substantial use of feed supplements. Significant rain in April of both seasons broke the drought and allowed soil moisture levels to slowly start increasing back to field capacity by June.

Figure 1. NIWA soil moisture modelling for the region adjacent to NARF during the first two seasons (2012/13 and 2013/14).



The third season had a difficult start with a large rainfall event in July causing the majority of the farm to be flooded for three or more days (Figure 2). This, along with the light sediment that remained on pasture, reduced the feed cover significantly and resulted in a need for higher supplement inputs than would have otherwise been used during late winter. Soil moisture levels fluctuated from November onwards as a result of significant rainfall during December, February and March. This season was not as dry as the previous two seasons, though relatively dry conditions did continue through into May.

Figure 2. NIWA soil moisture modelling for the region adjacent to NARF during the third season (2014/15).



4 Evaluation of data by statistical analysis

No statistical analyses have been undertaken with the data.

5 Results and Discussion

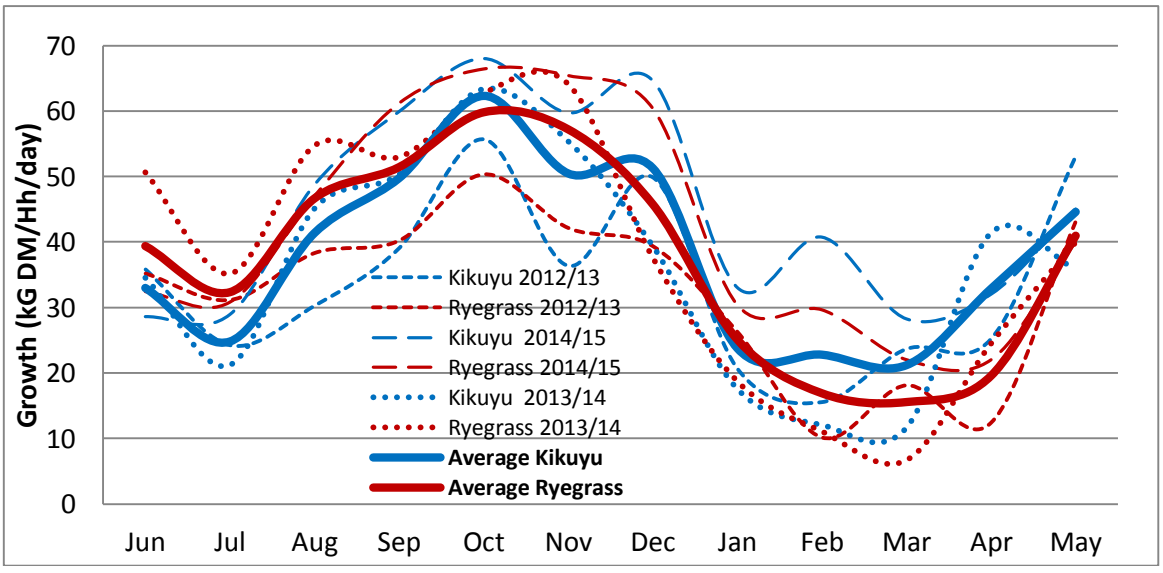
Pasture Growth

Calculated monthly average pasture growth rates for the two farmlets are shown in Figure 3. These farmlet averages are not a full reflection on kikuyu pastures and ryegrass pastures as >40% of the Kikuyu farmlet had no kikuyu and >20% of the Ryegrass farmlet had kikuyu.

Pasture growth rates were higher on the Ryegrass farmlet than the Kikuyu farmlet during June, July and August in all three years. Overall, through spring and summer pasture growth was similar on both farmlets. However, from February to May the Kikuyu farmlet showed higher growth rates than the Ryegrass farmlet in all three years.

Calculated pasture growth rate differences between farmlets followed a logical pattern. The lower growth during winter of the Kikuyu farmlet pastures was probably in response to the slower growth of the kikuyu during winter and the transition into temperate grasses. The undersown or broadcast Italian ryegrass was establishing during this period. By September the Italian ryegrass was established in the Kikuyu farmlet pastures and pasture growth was similar to the Ryegrass farmlet. From February to May the Kikuyu farmlet pastures showed greater pasture growth as the C4 grass started to grow. It is likely that the mulching of the kikuyu-based pastures on the Kikuyu farmlet during April and early May compromised the growth that could have occurred on these pastures during late autumn.

Figure 3. Average monthly pasture growth rates as calculated by weekly rising plate meter measures for the Kikuyu and Ryegrass farmlets.



Overall, average calculated annual pasture growth was slightly higher on the Kikuyu farmlet. However this did vary between seasons. There was significant variance between years in both total and seasonal pasture growth. The dry summer/autumn periods in 2013 and 2014 reduced the total production on both farmlets, while relatively good growing conditions during summer/autumn 2015 contributed to the higher annual growth for that year.

Interestingly, the pasture growth on the Kikuyu farmlet was not proportionally higher than the Ryegrass farmlet during the dry summer/autumns, dry conditions compromised both farmlets.

Pasture Covers

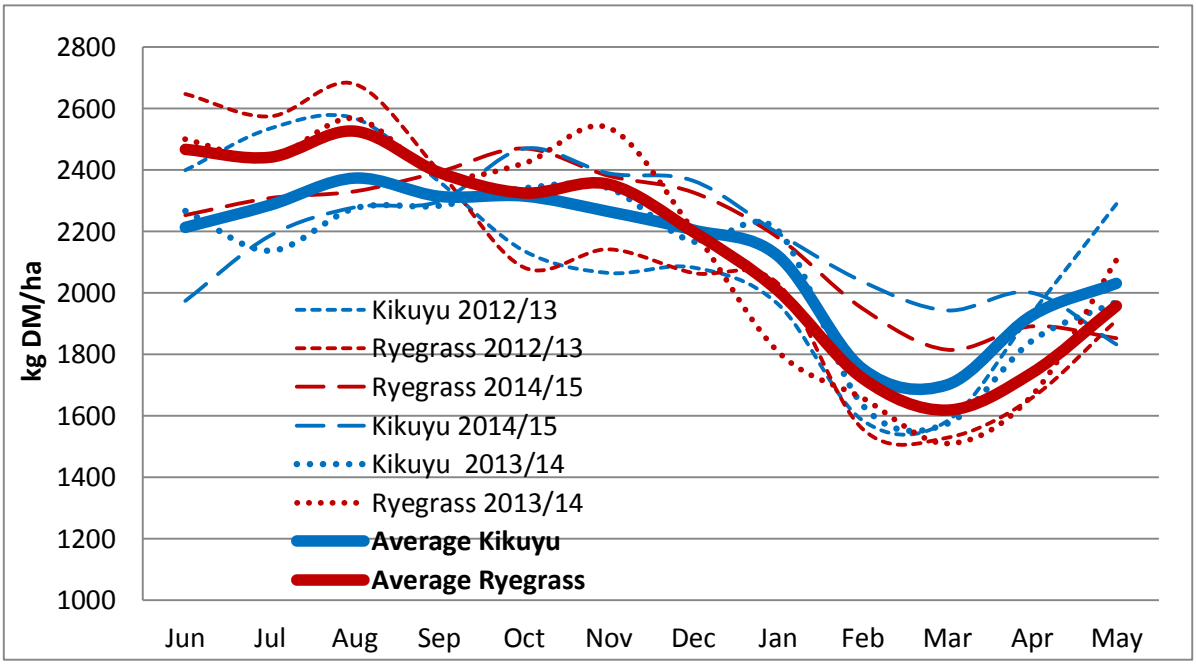
Figure 4 shows the average monthly pasture covers for the two farmlets. These were calculated from weekly pasture cover assessments.

The 2012/13 and 2013/14 seasons were exceptionally dry during summer and early autumn. This led to low pasture covers despite significant supplements being fed during those times on both farmlets. More consistent rainfall during summer/autumn 2014/15 season resulted in higher covers during that period.

Average pasture cover on the Ryegrass farmlet was consistently higher than on the Kikuyu farmlet during winter. From September to December pasture cover was relatively similar between the two farmlets. From January to May the Kikuyu farmlet tended to show higher pasture cover than the Ryegrass farmlet. Mulching of all kikuyu pastures on the Kikuyu farmlet during April and early May likely significantly reduced the pasture cover on that farmlet during late autumn compared with if that mulching had not occurred.

Average farmlet pasture covers are in response to many factors. Differences between farmlets are not a full reflection of pasture growth, as differences in stocking rate, rotation length and supplement used also had an influence. This would have been influenced by the higher stocking rate on the Kikuyu farmlet during the first two seasons (3.2 v. 3.0 cows/ha), whereas in the final season stocking rate was set at 3.0 cows/ha on both farmlets.

Figure 4. Average monthly pasture covers as calculated by weekly rising plate meter measures for the Kikuyu and Ryegrass farmlets.



Description of pastures

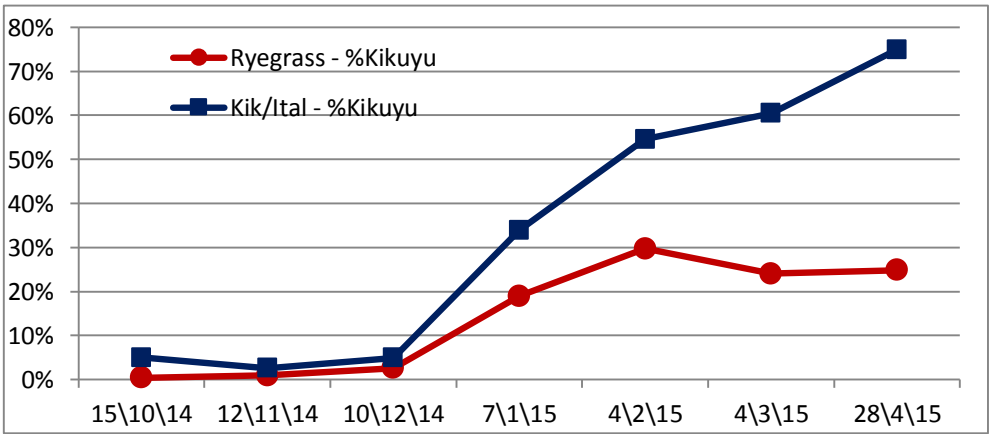
Kikuyu presence at NARF was sporadic depending on the history of the paddock and the level of invasion that has occurred on different areas. In the most recent survey of kikuyu presence (March 2015), 27% of paddocks had kikuyu coverage of <10% and 17% had coverage of >90%, thus most paddocks had a moderate level of kikuyu presence. Because of this varying kikuyu coverage and a need to balance farmlets for paddock location and productive capability (independent of kikuyu presence), farmlets were not entirely no kikuyu and total kikuyu. Table 2 shows the presence or coverage of kikuyu when surveyed at three times during the trial.

Table 2. Presence/coverage of kikuyu on the Kikuyu and Ryegrass farmlets on the dates when full paddock surveys were undertaken.

	12/03/12	**27/02/14**	**4/03/15**
Kikuyu farmlet	72%	57%	56%
Ryegrass farmlet	30%	19%	27%

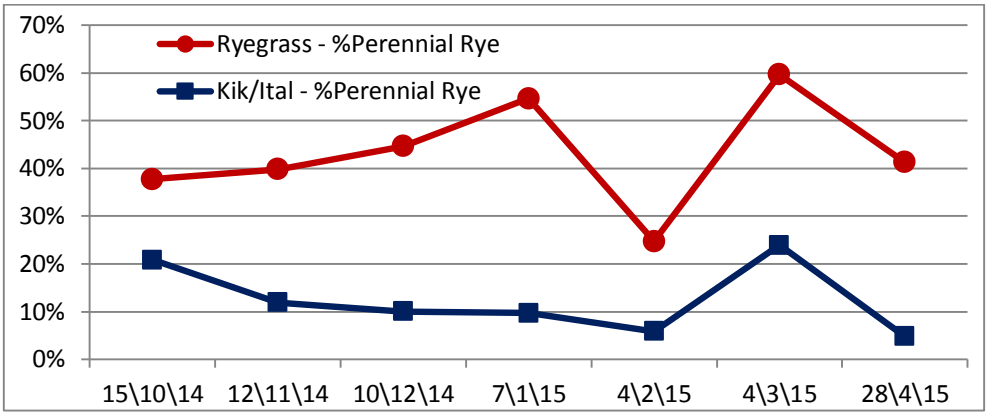
The proportion of Kikuyu within the pasture on a dry matter basis changed dramatically during the season. Figure 5 shows the pattern during the period when the pastures were monitored. This shows the kikuyu proportion rising to >70% during autumn on the Kikuyu farmlet. Though not monitored during winter, the proportion of pasture as kikuyu tended to drop away dramatically from June onwards as temperate grasses became more dominant.

Figure 5. Percentage of pasture as kikuyu from pre-grazing paddocks for the Ryegrass and Kikuyu farmlets.



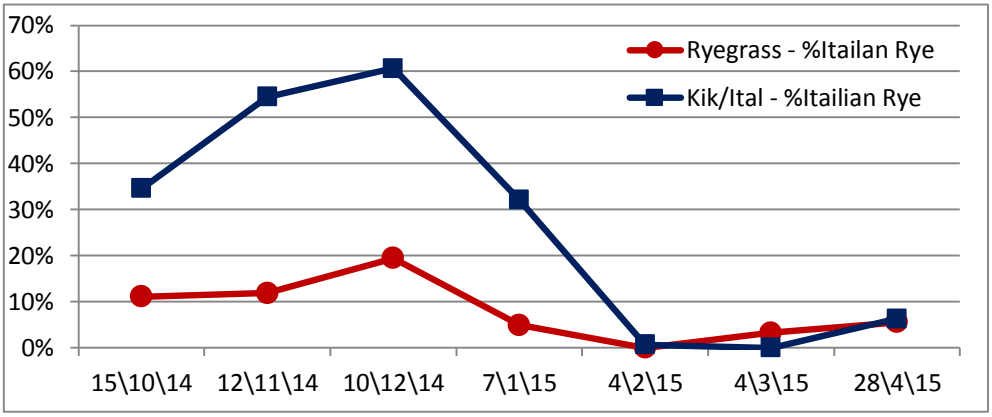
Perennial ryegrass presence in the pastures was patchy. Paddocks that had been re-sown with perennial ryegrass within the past two years tended to have good presence, whereas older pastures tended to have poor presence, especially where kikuyu was present. Figure 6 shows the greater presence of perennial ryegrass within the Ryegrass farmlet.

Figure 6. Percentage of pasture as perennial ryegrass from pre-grazing paddocks for the Ryegrass and Kikuyu farmlets.



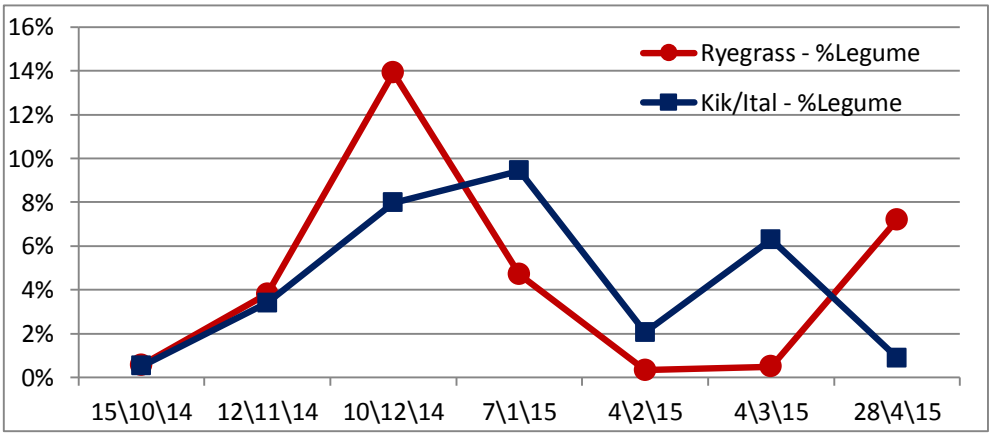
The proportion of Italian ryegrass within these pastures increased as winter progressed and then dropped off quickly during summer. This pattern is shown in Figure 7.

Figure 7. Percentage of pasture as Italian ryegrass from pre-grazing paddocks for the Ryegrass and Kikuyu/Italian Rye farmlets.



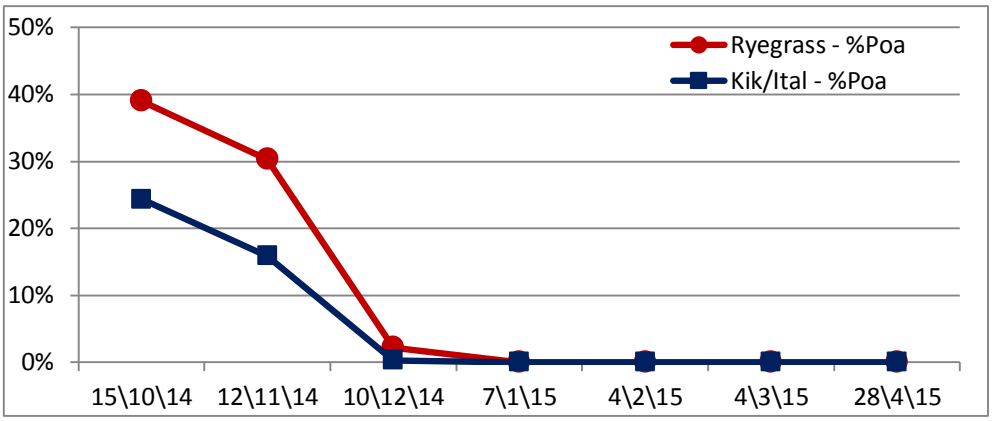
Legume presence within the pastures was generally low. The summer of 2014/15, when pasture composition was monitored, was noted to have higher levels than the previous two seasons. The proportion of pasture as legume is shown in Figure 8. Legume presence was almost entirely white clover.

Figure 8. Percentage of pasture as legume from pre-grazing paddocks for the Ryegrass and Kikuyu farmlets.



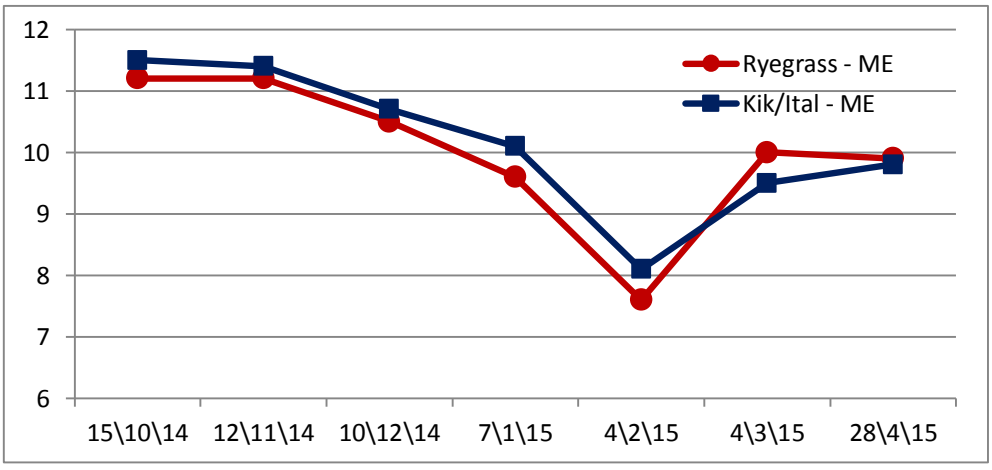
The dry summers of 2013 and 2014 resulted in open pastures during autumn. This was mainly filled by *Poa annua*. Figure 9 shows the greater proportion of *P. annua* within pastures on the Ryegrass farmlet during the monitored period, making up to 40% of the pasture during spring. The Kikuyu farmlet pastures were probably less open and so it was harder for *P. annua* to establish.

Figure 9. Percentage of pasture as *Poa annua* from pre-grazing paddocks for the Ryegrass and Kikuyu farmlets.



Pasture quality, determined as metabolisable energy, averaged 0.3 MJ ME/kg DM higher on the Kikuyu farmlet compared with the Ryegrass farmlet during spring and early summer (Figure 10). This was probably due to the higher quality Italian ryegrass in the Kikuyu farmlet pastures during this time. Also likely the greater presence of *P. annua* in the Ryegrass farmlet would have lowered pasture quality as it flowered and died during spring. This effect was reversed during autumn as the Ryegrass farmlet tended to show higher pasture quality than the Kikuyu farmlet, likely caused by the build-up of kikuyu stolon.

Figure 10. Metabolisable energy (MJ ME/kg DM) of pasture samples collected from pre-grazing paddocks for the Ryegrass and Kikuyu farmlets as measured by NIR analysis.



Supplement fed

Supplement was used to fill pasture deficits. All supplements were imported onto the farm. Supplement consisted of maize silage, PKE and grazing off (this was considered a supplement for the purpose of this analysis).

Figures 11 and 12 show the total supplement fed on both farmlets during the three year study. Supplement use was high in the first two seasons in response to the very dry conditions during summer/autumn. In addition, high milk prices influenced the decision to use supplement to support milk production during the latter part of these two seasons. Maize silage was the predominant supplement in the first season and PKE during the second and third season.

Supplement use on the Kikuyu farmlet was 21% higher/ha than the Ryegrass farmlet during the 2012/13 season and 12% higher/ha during the 2013/14 season. These were the two seasons when stocking rate on the Kikuyu farmlet was higher than the Ryegrass farmlet. The higher supplement use on the Kikuyu farmlet during these first two seasons was equivalent to approximately two thirds of the total extra feed used. In the third season, when the stocking rate was the same across both farmlets, supplement use was identical. In summary, the extra supplement used on the Kikuyu farmlet can be explained by the higher stocking rate.

Supplement use was identical between the two farmlets during the final season, when the stocking rate was similar across both farmlets.

Figure 11. Supplement fed to the Kikuyu and Ryegrass farmlets on a per hectare basis (kg DM/ha/annum)

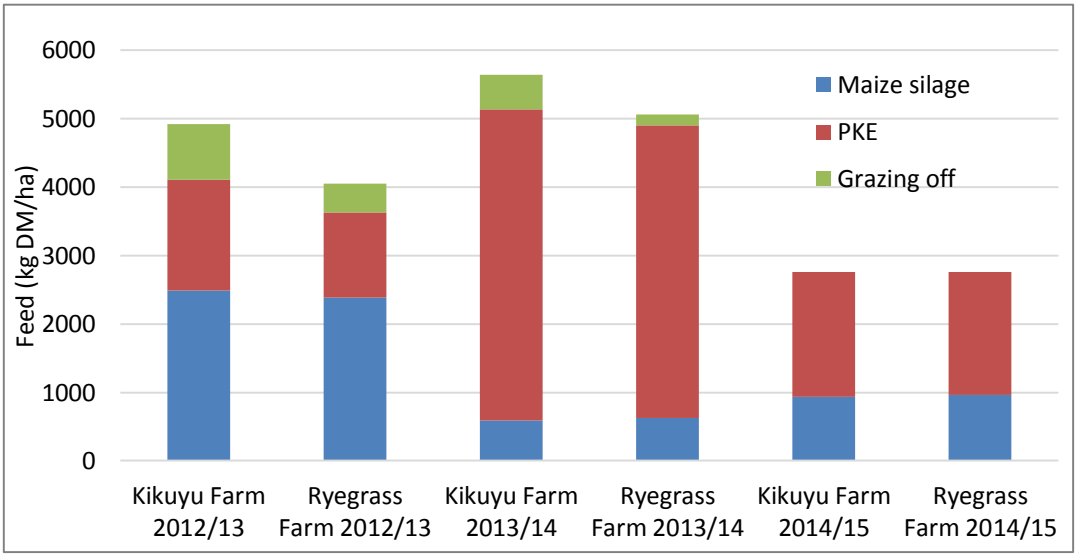
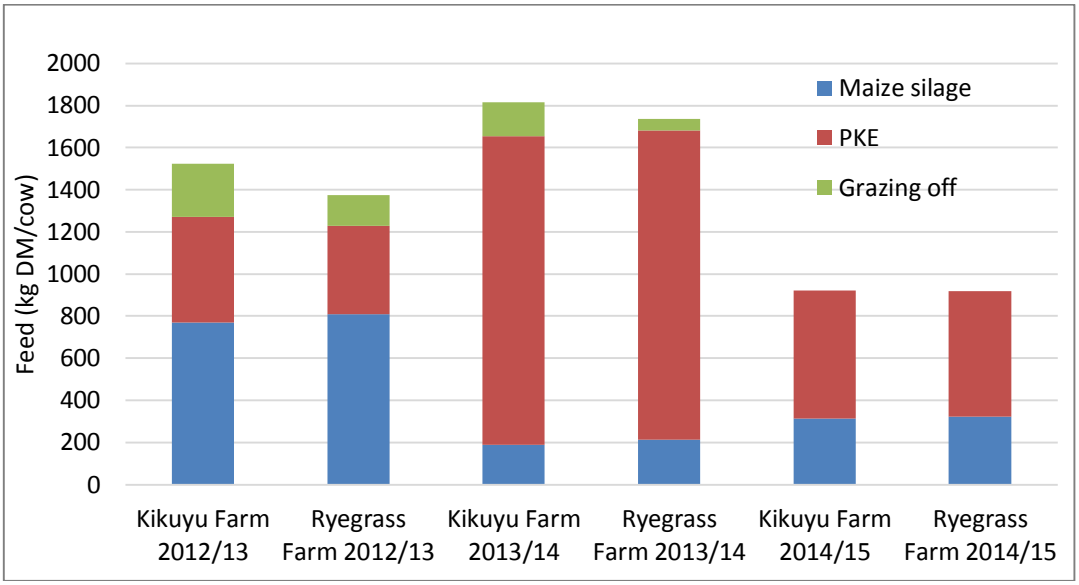


Figure 12. Supplement fed to the Kikuyu and Ryegrass farmlets on a per cow basis (kg DM/cow/annum)



Figures 13 and 14 show the seasonality of supplement use, average of the three seasons. This shows that the Kikuyu farmlet used more supplement during winter and early summer. This must be considered in the light of the higher stocking rate of the Kikuyu farmlet in the first two years resulting in higher supplement use overall. In the third season, when stocking rate was similar on both farmlets, supplement use was still higher on the Kikuyu farmlet during winter, but was higher on the Ryegrass farmlet during summer.

During winter, supplement use was 35% higher on the Kikuyu farmlet than the Ryegrass farmlet. This higher use during winter mirrors the lower pasture covers at this time compared with the Ryegrass farmlet. This is the period where kikuyu pastures are transitioning from kikuyu to temperate grasses. Encouraging this transition as quickly as possible through mechanical kikuyu control (mulching) and/or introduction of short rotation ryegrasses will assist in reducing supplement required during this period.

The higher pasture covers on the Kikuyu farmlet during autumn, compared with the Ryegrass farmlet, did not always translate into lower supplement use. This may have occurred because of a build-up of kikuyu stolon with poor digestibility and palatability within the kikuyu pastures

Figure 13. Seasonality of supplement fed per hectare, average of three years (kg DM/ha/month)

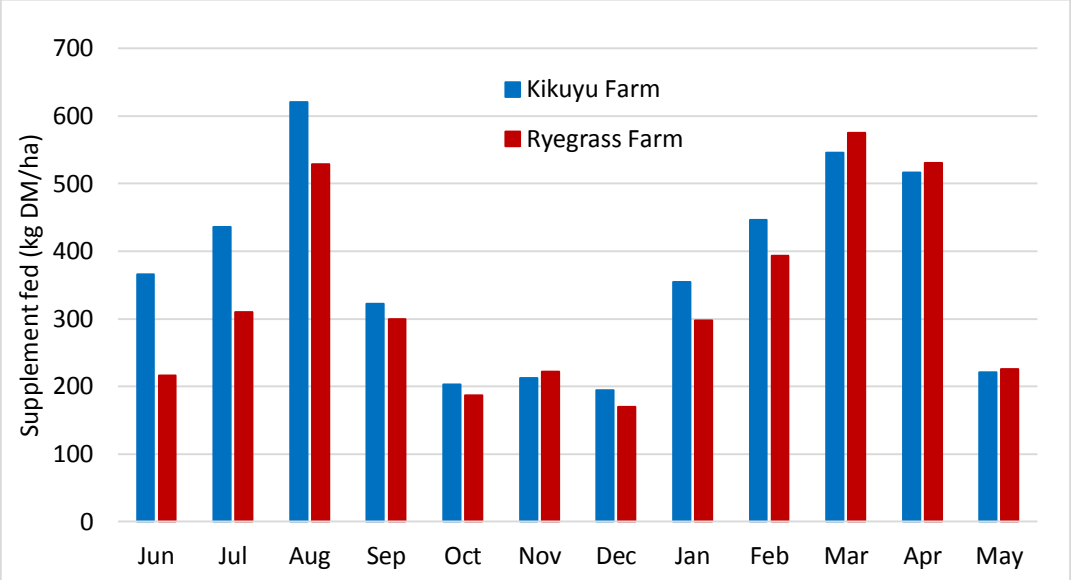
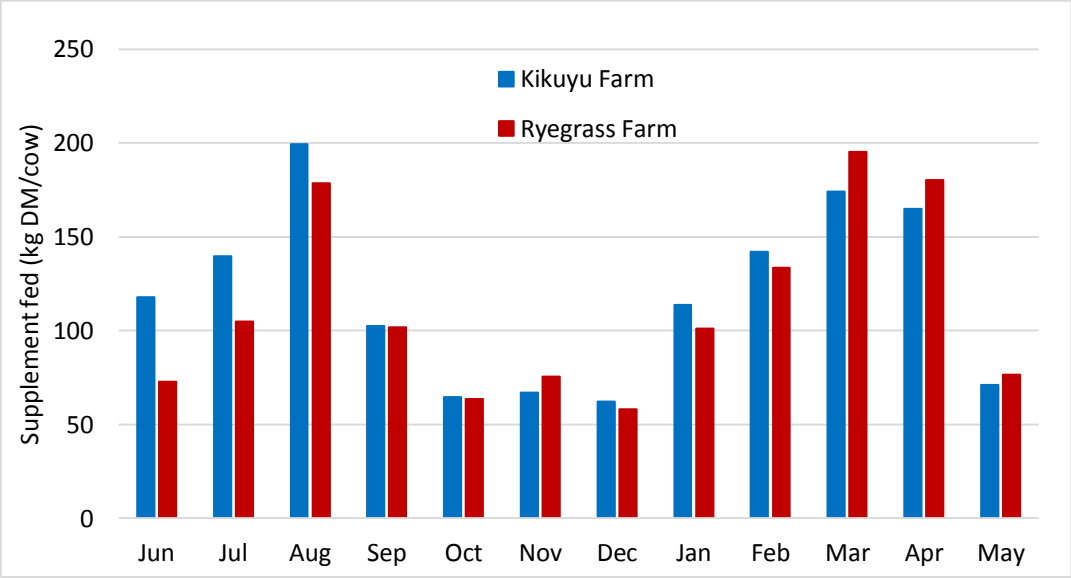


Figure 14. Seasonality of supplement fed per hectare, average of three years (kg DM/cow/month)



Milk Production

Milk production per hectare, when averaged over the three years of the study, was identical for both farmlets at 1154 kg MS/ha. However, there were variations between the years (Figures 15 and 16).

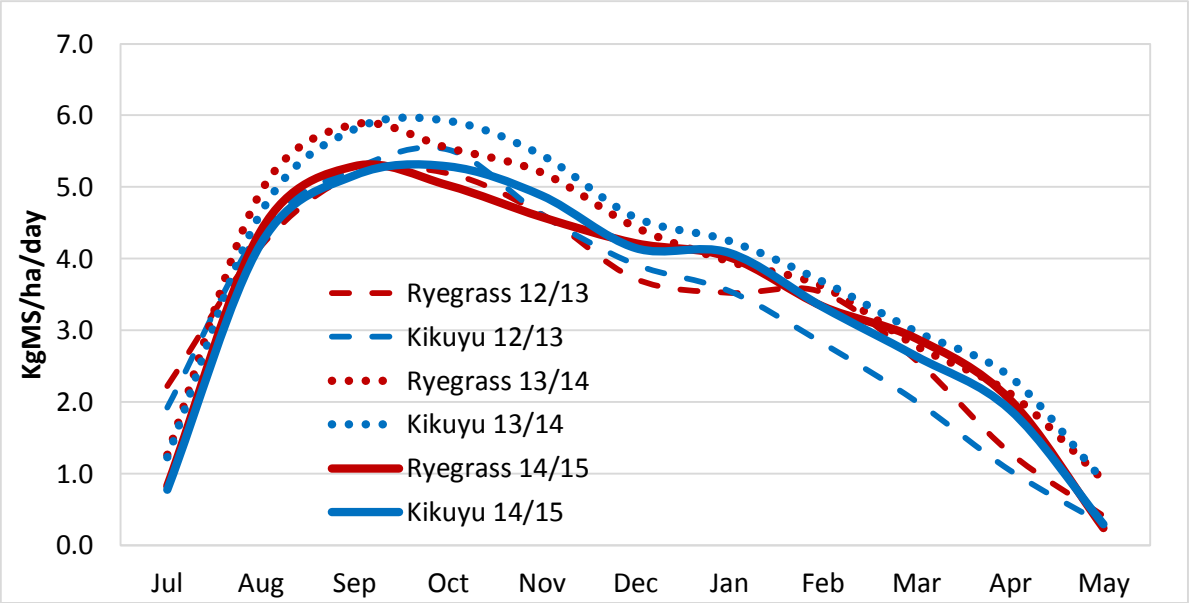
In the 2012/13 season, milk production was 3% higher on the Ryegrass farmlet compared with the Kikuyu farmlet. Production was slightly greater on the Kikuyu farmlet during spring but this switched from February to May when milk production on the Ryegrass farmlet was 28% higher. This was as a result of the dry summer with turnips being grown and fed on the Ryegrass farmlet but not on the Kikuyu farmlet.

In the latter two years turnips were fed on both farmlets and milk production was 3% higher on the Kikuyu farmlet compared to the Ryegrass farmlet in 2013/14, with both farmlets very similar in 2014/15 season. Milk production for both farmlets

was highest in the 2013/14 season as the high milk price meant feeding high levels of supplement was profitable.

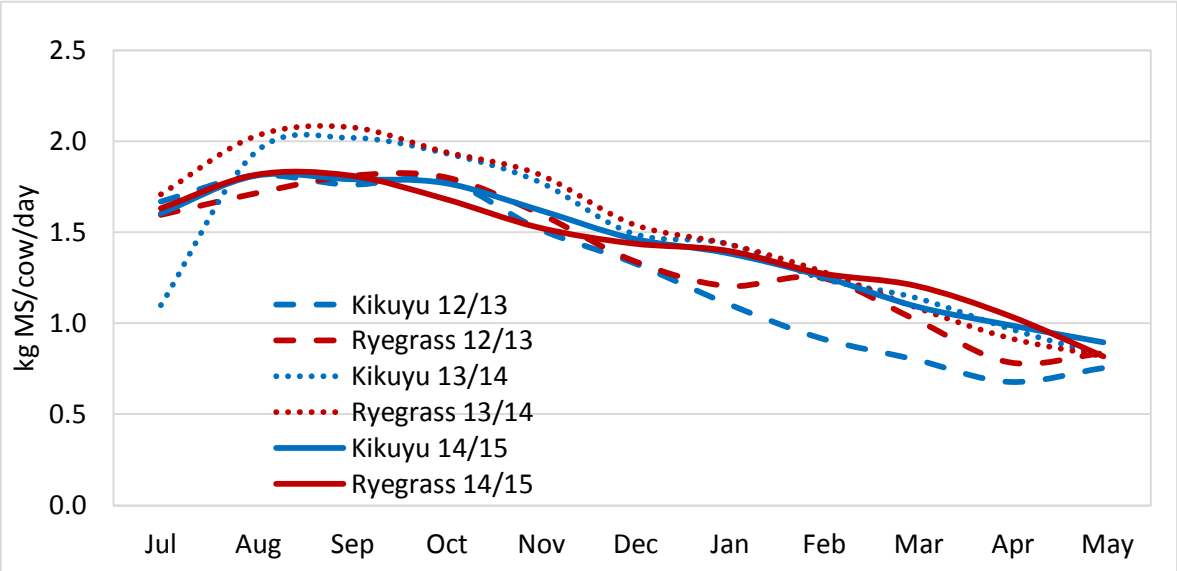
Within a season, milk production per hectare tended to be slightly higher on the Ryegrass farmlet compared with the Kikuyu farmlet during early spring. This was reversed during late spring, possibly due to the better quality and quantity of feed being grown by the Italian ryegrass within the kikuyu based pastures. As the kikuyu growth kicked in around April/May, milk production per hectare was higher on the Kikuyu farmlet as more cows had been milked for longer.

Figure 15. Average daily milk solids production per hectare (kg MS/ha/day).



On a per cow basis, milk production was higher on the Ryegrass farmlet than the Kikuyu farmlet for both the 2012/13 and 2013/14 seasons. In the third season total milk production per cow was identical, as it was on a per hectare basis.

Figure 16. Average daily milk solids production per cow (kg MS/cow/day).



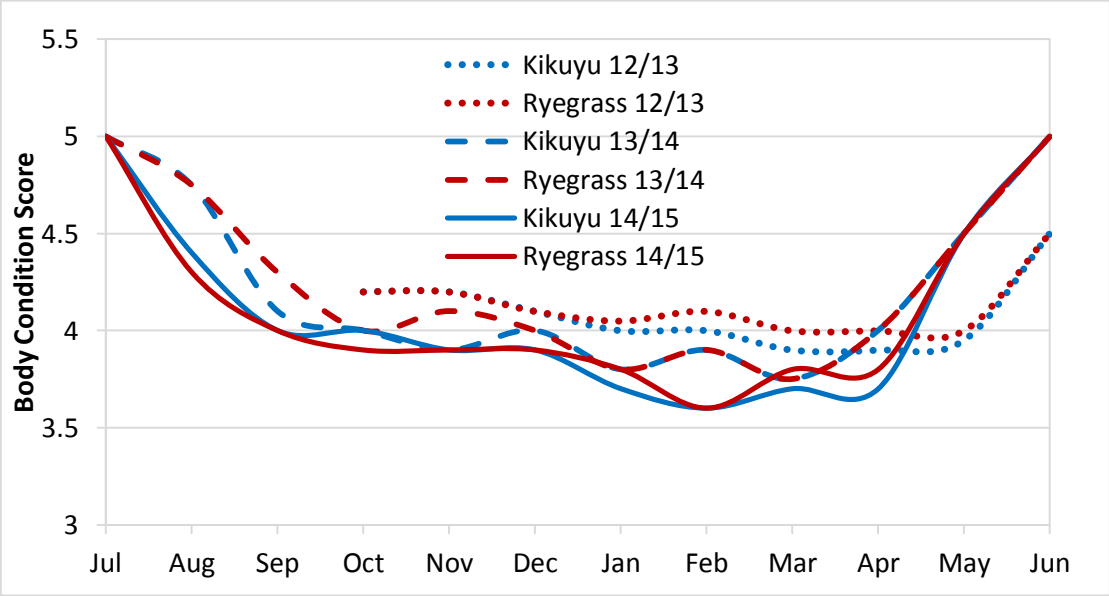
Body Condition

Body Condition, using a sample of >30 cows from each herd, was assessed every two weeks and compared with industry targets. In all three seasons both herds achieved target BCS of 5 at calving and lost condition after calving. In the 2013/14 season cows lost only a small amount of condition in the month after calving, however BCS quickly dropped in the month before mating. In contrast, cows in the 2014/15 season lost condition very quickly after calving which was likely due to feed availability after the flood. In no season was herd BCS able to increase following mating according to the target. Body condition tended to be lower for the Kikuyu farmlet, particularly during summer and early autumn. This may be a result of the poorer pasture quality of the kikuyu pastures at this time.

Body condition score held at around 4 during the summer of 2012/13 however this required increased use of supplement. Cows with a BCS of less than 4 were dried off from early to late March with the remainder of the herd dried off late April. Through the summer of 2013/14 BCS fluctuated between 3.75 and 4 resulting in 7-10% of both herds being put on once-a-day milking in January. The proportion on once-a-day increased as the dry weather continued. This helped conserve cow condition and enabled a later dry off, in late May.

Body condition score was consistently well below target for the 2014/15 season. This was most noticeable in February when body condition score for both herds was 3.6 resulting in a third of both herds being put on once-a-day milking. This low condition probably resulted from lower levels of supplement being fed at this time compared with the previous two seasons. Both herds were placed on once-a-day milking at the end of March with light cows or low producers dried off through April. Final dry off date was the start of May.

Figure 17. Average body condition score (1-10 scale).



Reproduction (Table 3)

The first season had high CIDR usage at 28% of the herd however the response was good as 90% of those cows became pregnant. After the first season the management team reviewed its policy around CIDR use and decided not to use CIDR in the latter two seasons. In all three seasons the first calvers were put onto

once-a-day milking in early September to prevent further weight loss and get them on track to achieving good condition prior to mating. Although this halted the decline in body condition for the 2012 mating, they were already light going into mating (BCS 3.8) resulting in an empty rate of 15% compared with 10% for the whole herd. Empty rate of the first calvers for the 2013 mating decreased considerably to 6% compared with 10.5% for the whole herd.

In all three seasons the three-week submission rate met or succeeded the industry target of 90% with very little difference between farmlets. The six-week in-calf rate was 5% higher for the Kikuyu herd than the Ryegrass herd in the 2013/14 season despite having a much higher empty rate. The following season the Ryegrass herd achieved a higher six-week in-calf rate and lower empty rate. The reason for these differences is not known as cow condition was very similar between farmlets and seasons, and cows ate target feed intakes. Overall, the differences between farmlets do not appear to be related to the pasture type.

Table 3. Farmlet reproductive performance.

	3 Week Submission Rate		6 Week In Calf Rate		Empty Rate	
	Kikuyu	Ryegrass	Kikuyu	Ryegrass	Kikuyu	Ryegrass
2012/13	95%	95%	72%	72%	10%	10%
2013/14	90%	90%	78%	73%	13%	9%
2014/15	90%	92%	72%	76%	10%	5%
Target	**90%**		**78%**		**5%**	

Farmlet Profitability

Farmlet income and expenditure for each season is summarised in Tables 4 and 5. Most of the values are actuals, however a few adjustments have been made to reflect a commercial farm rather than a research farm. The categories that have been adjusted are wages (adjusted to reflect the labour costs of one farm manager and one farm worker running a 260 cow farm), re-grassing costs (adjusted to reflect contractor rates for mulching and purchase and drilling of Italian ryegrass into kikuyu at $350/ha for the first two seasons and $310/ha for the third season) and administration (adjusted to reflect “normal” annual accounting/admin fees).

Milk income for each season has been calculated based on the final season milk price plus dividend, which includes retrospective payments that would normally be received the following season. The capacity adjustment was accounted for in the third season. Income from stock sales was calculated on a per cow basis as a proportion of the total farm income.

Expenses were calculated on either a per cow (Animal Health, Breeding, Dairy, Electricity and Stock Grazing) or per hectare basis (Cropping, Fertiliser, Weed & Pest, Vehicles & Fuel, Repairs & Maintenance and Rates) as a proportion of total farm expenses. Supplement and Nitrogen were calculated based on the quantity used on each farmlet.

The financial summary shows that the Ryegrass farmlet was almost twice as profitable as the Kikuyu farmlet for the first season. This was in part due to slightly higher milk production over summer from feeding turnips but mostly due to much lower farm working expenses. On a per kilogram of milk solids basis, farm working

expenses were 19% higher on the Kikuyu farmlet. This was as a result of considerably higher re-grassing costs associated with mulching and drilling the whole farmlet area, but also more supplement use over summer and dry cow grazing over winter.

Profitability of the Ryegrass farmlet was only marginally greater in the latter two seasons which was again due to lower farm working expenses. Although re-grassing costs were much higher on the Kikuyu farmlet, supplement and stock grazing costs were very similar to the ryegrass farmlet. All other expenses and income were also very similar between farmlets in these two seasons indicating that re-grassing is the only factor reducing kikuyu profitability.

Table 4. Comparison of farmlet income, expenses and profitability per hectare.

	Average - 3 years		**2012/13**		**2013/14**		**2014/15**	
Income	**Kikuyu**	**Ryegrass**	**Kikuyu**	**Ryegrass**	**Kikuyu**	**Ryegrass**	**Kikuyu**	**Ryegrass**
Income from milk	**$ 7,537**	**$ 7,513**	$ 6,632	$ 6,824	$ 10,800	$ 10,508	$ 5,178	$ 5,208
Livestock sales	**$ 583**	**$ 577**	$ 269	$ 263	$ 701	$ 674	$ 777	$ 794
Total Income	**$ 8,119**	**$ 8,091**	**$ 6,901**	**$ 7,087**	**$ 11,501**	**$ 11,182**	**$ 5,955**	**$ 6,002**
Expenses								
Wages	**$ 1,285**	**$ 1,253**	$ 1,105	$ 1,034	$ 1,395	$ 1,341	$ 1,355	$ 1,385
Animal Health	**$ 298**	**$ 289**	$ 362	$ 339	$ 291	$ 280	$ 242	$ 247
Herd Improvement	**$ 225**	**$ 218**	$ 196	$ 183	$ 328	$ 315	$ 151	$ 155
Dairy Expenses	**$ 125**	**$ 121**	$ 109	$ 102	$ 140	$ 135	$ 124	$ 127
Electricity	**$ 211**	**$ 205**	$ 199	$ 186	$ 237	$ 228	$ 196	$ 201
Supplements	**$ 1,388**	**$ 1,287**	$ 1,559	$ 1,333	$ 1,732	$ 1,658	$ 873	$ 870
Cropping	**$ 66**	**$ 88**	$ -	$ 65	$ 104	$ 104	$ 96	$ 96
Stock grazing	**$ 529**	**$ 490**	$ 466	$ 363	$ 634	$ 609	$ 487	$ 497
Re-grassing	**$ 339**	**$ 75**	$ 350	$ 65	$ 356	$ 80	$ 310	$ 80
Nitrogen	**$ 306**	**$ 312**	$ 393	$ 368	$ 231	$ 269	$ 293	$ 300
Fertiliser & Lime	**$ 3**	**$ 3**	$ -	$ -	$ -	$ -	$ 9	$ 9
Weed & Pest	**$ 50**	**$ 49**	$ 56	$ 53	$ 66	$ 66	$ 26	$ 26
Vehicles & Fuel	**$ 239**	**$ 232**	$ 323	$ 302	$ 197	$ 197	$ 196	$ 196
Repairs & Maintenance	**$ 293**	**$ 289**	$ 160	$ 149	$ 404	$ 404	$ 315	$ 315
Administration	**$ 171**	**$ 171**	$ 171	$ 171	$ 171	$ 171	$ 171	$ 171
Rates	**$ 146**	**$ 144**	$ 100	$ 94	$ 143	$ 143	$ 195	$ 195
Total Working Expenses	**$ 5,686**	**$ 5,236**	**$ 5,592**	**$ 4,838**	**$ 6,429**	**$ 6,000**	**$ 5,038**	**$ 4,869**
Operating profit	**$ 2,433**	**$ 2,855**	**$ 1,309**	**$ 2,249**	**$ 5,072**	**$ 5,182**	**$ 917**	**$ 1,133**

Table 5. Comparison of farmlet income, expenses and profitability per kilogram of milksolids

	Average - 3 years		2012/13		2013/14		2014/15	
Income	**Kikuyu**	**Ryegrass**	**Kikuyu**	**Ryegrass**	**Kikuyu**	**Ryegrass**	**Kikuyu**	**Ryegrass**
Income from milk	**$ 6.43**	**$ 6.44**	$ 6.16	$ 6.16	$ 8.50	$ 8.50	$ 4.64	$ 4.65
Livestock sales	**$ 0.50**	**$ 0.50**	$ 0.25	$ 0.24	$ 0.55	$ 0.55	$ 0.70	$ 0.71
Total Income	**$ 6.93**	**$ 6.93**	**$ 6.41**	**$ 6.40**	**$ 9.05**	**$ 9.05**	**$ 5.34**	**$ 5.36**
Expenses								
Wages	**$ 1.11**	**$ 1.08**	$ 1.03	$ 0.93	$ 1.10	$ 1.08	$ 1.21	$ 1.24
Animal Health	**$ 0.26**	**$ 0.25**	$ 0.34	$ 0.31	$ 0.23	$ 0.23	$ 0.22	$ 0.22
Herd Improvement	**$ 0.19**	**$ 0.19**	$ 0.18	$ 0.17	$ 0.26	$ 0.25	$ 0.14	$ 0.14
Dairy Expenses	**$ 0.11**	**$ 0.10**	$ 0.10	$ 0.09	$ 0.11	$ 0.11	$ 0.11	$ 0.11
Electricity	**$ 0.18**	**$ 0.18**	$ 0.18	$ 0.17	$ 0.19	$ 0.18	$ 0.18	$ 0.18
Supplements	**$ 1.20**	**$ 1.11**	$ 1.45	$ 1.20	$ 1.36	$ 1.34	$ 0.78	$ 0.78
Cropping	**$ 0.06**	**$ 0.08**	$ -	$ 0.06	$ 0.08	$ 0.08	$ 0.09	$ 0.09
Stock grazing	**$ 0.46**	**$ 0.42**	$ 0.43	$ 0.33	$ 0.50	$ 0.49	$ 0.44	$ 0.44
Re-grassing	**$ 0.29**	**$ 0.06**	$ 0.33	$ 0.06	$ 0.28	$ 0.06	$ 0.28	$ 0.07
Nitrogen	**$ 0.27**	**$ 0.27**	$ 0.37	$ 0.33	$ 0.18	$ 0.22	$ 0.26	$ 0.27
Fertiliser & Lime	**$ -**	**$ -**	$ -	$ -	$ -	$ -	$ -	$ -
Weed & Pest	**$ 0.04**	**$ 0.04**	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.02	$ 0.02
Vehicles & Fuel	**$ 0.21**	**$ 0.20**	$ 0.30	$ 0.27	$ 0.16	$ 0.16	$ 0.18	$ 0.17
Repairs & Maintenance	**$ 0.25**	**$ 0.25**	$ 0.15	$ 0.13	$ 0.32	$ 0.33	$ 0.28	$ 0.28
Administration	**$ 0.15**	**$ 0.15**	$ 0.16	$ 0.15	$ 0.13	$ 0.14	$ 0.15	$ 0.15
Rates	**$ 0.13**	**$ 0.12**	$ 0.09	$ 0.08	$ 0.11	$ 0.12	$ 0.17	$ 0.17
Total Working Expenses	**$ 4.92**	**$ 4.52**	**$ 5.19**	**$ 4.37**	**$ 5.06**	**$ 4.85**	**$ 4.52**	**$ 4.35**
Operating profit	**$ 2.01**	**$ 2.41**	**$ 1.22**	**$ 2.03**	**$ 3.99**	**$ 4.19**	**$ 0.82**	**$ 1.01**

6 Conclusions

This study was initiated to understand the differences in production and profitability between kikuyu and non-kikuyu based dairy grazing systems. Overall, each system had its strengths and vulnerabilities, mainly around the seasonality of pasture production.

Overall, the Kikuyu and Ryegrass farmlets produced a similar amount of total pasture per annum. However, higher pasture growth on the Ryegrass farmlet during winter, and lower during summer/autumn, than the Kikuyu farmlet altered the need for feed supplements within each of the systems. When stocking rates were similar, the kikuyu farmlet required more supplement during winter and less during summer than the Ryegrass farmlet.

When averaged over the three seasons of the study, milk production was identical between farmlets. Differences in seasonality of milk production between farmlets were small, likely masked by relatively high levels of supplement use.

Farm working expenses were higher on the Kikuyu farmlet ($5,686/ha), compared with the Ryegrass farmlet ($5,236). The main cause of this higher cost was the annual mulching and under-sowing of Italian ryegrass and the higher supplement

use required in the first two seasons due to the higher stocking rate (cows/ha). The average operating profit for the three seasons was higher on the Ryegrass farmlet ($2,921/ha) than the Kikuyu farmlet ($2,432/ha). This difference was mainly caused by the first season, where turnips were grown on the Ryegrass farmlet but not on the Kikuyu farmlet, significantly affecting milk production during summer. In the following seasons turnips were grown on both farmlets and the differences in farm profitability were small, though still showing an advantage to the Ryegrass farmlet.

This study has illustrated that when managed appropriately the production and profitability of kikuyu farms can be similar to ryegrass farms. Management decisions within this study at times compromised farmlet performance, especially within the Kikuyu farmlet. If these effects are accounted for then the differences between farmlets is small. The results of this study contrast with the previous study by the same group that showed kikuyu systems having higher production and profitability than non-kikuyu systems. Overall, it should be concluded that where kikuyu is well managed, such as the integration of short term ryegrass as used in this study, the presence of kikuyu within the system is likely to have little effect on farm performance.

This study suggests that, if managed appropriately, kikuyu presence may have little effect on farm profit, the eradication of kikuyu on either a part farm or whole farm basis may be unjustified, due to the likely costs of eradication. However, if kikuyu can be kept out of the farm, or parts of the farm, at minimal cost then this would likely simplify management and may have small benefits on farm profitability.

Appendix – Main data tables

Table 6. Average monthly pasture growth rates (kg DM/ha/day) and total annual pasture growth rates (kg DM/ha) as calculated by weekly rising plate meter measures for the Kikuyu and Ryegrass farmlets.

	Average – 3 years		**2012/13**		**2013/14**		**2014/15**	
	Kikuyu	**Ryegrass**	Kikuyu	Ryegrass	Kikuyu	Ryegrass	Kikuyu	Ryegrass
Jun	**33**	**39**	36	35	35	51	29	32
Jul	**25**	**32**	24	31	21	35	29	31
Aug	**41**	**47**	30	38	45	55	49	47
Sep	**50**	**51**	39	40	50	53	60	61
Oct	**62**	**60**	56	50	63	63	68	66
Nov	**50**	**57**	36	42	55	64	60	65
Dec	**51**	**46**	50	39	39	38	65	60
Jan	**24**	**25**	21	26	18	19	33	30
Feb	**23**	**17**	16	10	12	11	41	30
Mar	**21**	**16**	24	18	12	7	28	22
Apr	**33**	**20**	25	12	41	24	32	22
May	**45**	**41**	53	43	36	40	45	40
Annual Total	**13,935**	**13,718**	**12,459**	**11,759**	**13,008**	**13,957**	**16,340**	**15,439**

Table 7. Average monthly pasture covers (kg DM/ha) as calculated by weekly rising plate meter measures for the Kikuyu and Ryegrass farmlets.

	Average - 3 years		**2012/13**		**2013/14**		**2014/15**	
	Kikuyu	**Ryegrass**	Kikuyu	Ryegrass	Kikuyu	Ryegrass	Kikuyu	Ryegrass
Jun	**2214**	**2467**	2399	2648	2267	2500	1975	2254
Jul	**2287**	**2441**	2535	2575	2138	2440	2187	2309
Aug	**2375**	**2527**	2569	2680	2276	2568	2279	2331
Sep	**2315**	**2392**	2362	2396	2285	2385	2299	2395
Oct	**2316**	**2325**	2137	2083	2341	2421	2470	2471
Nov	**2266**	**2354**	2064	2142	2342	2537	2390	2382
Dec	**2205**	**2199**	2082	2065	2168	2204	2366	2328
Jan	**2121**	**2007**	1964	2031	2204	1809	2196	2182
Feb	**1753**	**1722**	1585	1557	1635	1658	2038	1950
Mar	**1700**	**1618**	1582	1528	1574	1510	1944	1816
Apr	**1926**	**1739**	1932	1658	1844	1666	2001	1892
May	**2031**	**1957**	2289	1910	1971	2109	1833	1853

Table 8. Average daily milk solids production per hectare (kg MS/ha/day).

	Average - 3 years		2012/13		2013/14		2014/15	
	Kikuyu	**Ryegrass**	Kikuyu	Ryegrass	Kikuyu	Ryegrass	Kikuyu	Ryegrass
Jul	**1.88**	**2.11**	2.25	2.76	2.04	2.08	1.33	1.49
Aug	**4.37**	**4.46**	4.39	4.17	4.52	4.82	4.21	4.39
Sep	**5.41**	**5.45**	5.26	5.17	5.81	5.88	5.16	5.29
Oct	**5.58**	**5.25**	5.53	5.19	5.92	5.55	5.29	5.02
Nov	**4.98**	**4.80**	4.62	4.62	5.44	5.20	4.88	4.58
Dec	**4.31**	**4.17**	4.07	3.84	4.57	4.44	4.28	4.21
Jan	**3.88**	**3.80**	3.44	3.41	4.25	3.96	3.94	4.02
Feb	**3.27**	**3.49**	2.82	3.53	3.65	3.61	3.33	3.33
Mar	**2.56**	**2.78**	2.08	2.67	2.89	2.78	2.71	2.88
Apr	**1.75**	**1.82**	1.05	1.30	2.36	2.12	1.85	2.03
May	**1.10**	**1.18**	0.76	1.07	1.40	1.41	1.16	1.06
Total	**1154**	**1154**	**1077**	**1108**	**1271**	**1236**	**1115**	**1120**

Table 9. Average daily milk solids production per cow (kg MS/ha/cow/day).

	Average - 3 years		2012/13		2013/14		2014/15	
	Kikuyu	**Ryegrass**	Kikuyu	Ryegrass	Kikuyu	Ryegrass	Kikuyu	Ryegrass
Jul	**1.46**	**1.65**	1.67	1.60	1.10	1.71	1.61	1.63
Aug	**1.85**	**1.85**	1.81	1.71	0.94	2.03	1.81	1.81
Sep	**1.86**	**1.90**	1.76	1.81	2.02	2.08	1.79	1.81
Oct	**1.83**	**1.81**	1.79	1.80	1.94	1.94	1.77	1.68
Nov	**1.64**	**1.65**	1.52	1.61	1.78	1.82	1.63	1.53
Dec	**1.43**	**1.44**	1.33	1.35	1.49	1.55	1.47	1.44
Jan	**1.31**	**1.35**	1.11	1.21	1.44	1.44	1.39	1.40
Feb	**1.14**	**1.27**	0.92	1.25	1.25	1.29	1.26	1.27
Mar	**1.01**	**1.11**	0.80	1.02	1.14	1.09	1.10	1.21
Apr	**0.88**	**0.92**	0.68	0.79	0.97	0.92	0.99	1.04
May	**0.82**	**0.82**	0.76	0.84	0.82	0.82	0.90	0.82
Total	**416**	**429**	**351**	**370**	**461**	**482**	**436**	**436**

Table 10. Average body condition score (1-10 scale).

		2012/13		2013/14		2014/15	
	Target	Kikuyu	Ryegrass	Kikuyu	Ryegrass	Kikuyu	Ryegrass
Jul	**5.0**			5.0	5.0	5.0	5.0
Aug	**4.5**	4.2		4.75	4.75	4.4	4.3
Sep	**4.2**			4.1	4.3	4.0	4.0
Oct	**4.0**	4.2	4.2	4.0	4.0	4.0	3.9
Nov	**4.1**	4.2	4.2	3.9	4.1	3.9	3.9
Dec	**4.25**	4.1	4.1	4.0	4.0	3.9	3.9
Jan	**4.2**	4.0	4.05	3.8	3.8	3.7	3.8
Feb	**4.0**	4.0	4.1	3.9	3.9	3.6	3.6
Mar	**3.9**	3.9	4.0	3.75	3.75	3.7	3.8
Apr	**4.0**	3.9	4.0	4.0	4.0	3.7	3.8
May	**4.25**	3.95	4.0	4.5	4.5	4.5	4.5
Jun	**4.5**	4.5	4.5	5.0	5.0	5.0	5.0