Project Report

GrassCheck 6 – Grass growth monitoring and the provision of information to improve grassland utilisation efficiency

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Research team: CAFRE: Stephen Gilkinson, Alistair Boyle, Ian McCluggage, AFBI: Andrew Dale, Scott Laidlaw, Conrad Ferris, Debbie McConnell, Nuria Valbuena

Report prepared by: Debbie McConnell and Nuria Valbuena

Agri-Food and Biosciences Institute, Agriculture Branch, Hillsborough, County Down, Northern Ireland BT26 6DR

1. Executive Summary

1.1 Introduction

Well-managed grass remains among the most cost-effective feedstuff for UK dairy cows (Kingshay, 2015). In Northern Ireland (N.I.) improving both grass utilisation by one tonne dry matter per hectare (t DM/ha) and grass quality on an average dairy farm has been estimated to be equivalent to an additional profit of £334/ha/yr (DAERA, 2016). However, the current performance of managed grasslands in N.I. remain sub-optimal with an estimated 7.5t DM/ha utilised on dairy farms, significantly behind levels achievable by modern day grass varieties (>12 t DM/ha; DAERA, 2016). The uptake of sward measurement and recording on grassland farms has been identified as one mechanism by which improvements in grass utilisation can be achieved.

To assist farmers in making grassland management decisions and encourage uptake of grass measurement, GrassCheck has provided livestock farmers in Northern Ireland with weekly grass growth and quality information during the main grazing season for the past 16 years. On-going collection of this information each year is crucial to understanding grass growth and quality conditions across N.I. The objectives of GrassCheck6 were to monitor grass growth rates and grass quality via cut plots throughout the 2016 growing season at two locations in Northern Ireland and provide weekly 7-day and 14-day grass growth rate forecasts throughout the growing season using the GrassCheck model.

1.2 Materials and Methods

During 2016, four sets of plots were laid down on established perennial ryegrass (*Lolium perenne*) swards: two sets located at CAFRE Greenmount and two at AFBI, Hillsborough. Plot areas were assessed for soil fertility in January 2016, prior to fertiliser application, and pH status, P, K, Mg and S. Each set of plots consisted of nine plots each measuring 5.0 x 1.5 m and was surrounded by 2.0 m discard area and a stock proof perimeter fence. The nine plots were divided into three series of three replicates and each randomly to one of three harvesting sequences.

Grass yield and quality was measured weekly on a three week rotational cycle. Plots were cut with a self-propelled cutting bar (Agria, Denmark) to a height of 4 cm. All herbage mass for each plot was collected and weighed. Seven and 14-day grass growth rate forecasts were generated on a weekly basis using the GrazeGro model (Barrett et al., 2004) and previous observed growth rates. Grass dry matter (DM), crude protein (CP), metabolisable energy (ME) and water soluble carbohydrate (WSC) content were determined by near infrared spectroscopy. The first herbage measurements were taken 7 March 2016, with weekly grass growth measurements continuing to 17 October 2016. Grass growth rates (measured and forecast) were published weekly throughout the season in the local farming press, on the AgriSearch website and on social media.

1.3 Results

During 2016, mean air temperature and total annual rainfall across N.I. were 9.3^{o}C and 1081mm, respectively (MetOffice, 2017). The Province recorded above average daily air temperatures (+0.4^{o}C) and total rainfall (+73mm) compared to the long term average (1981 – 2010).

Annual yield of grass dry matter production in 2016 across the four GrassCheck sites was 13.6 tonnes dry matter per hectare (t DM/ha), an increase of 0.5t DM/ha from 2015 and 2.4t

DM/ha greater than the long term GrassCheck average (11.2t DM/ha; 2007 – 2015). However, growth rates were highly variable throughout the season (Figure A). Spring, summer and autumn growth in 2016 was 90, 133 and 164% of the long-term average (2007 – 2015), respectively (Table A).

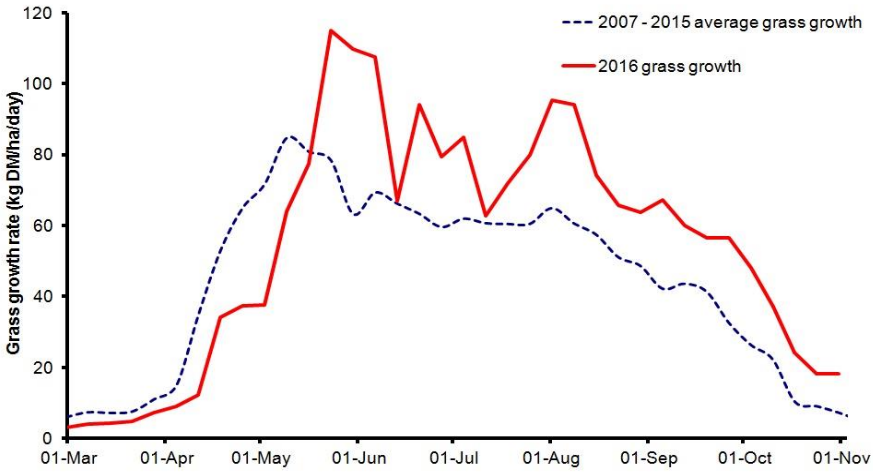

Figure A. Measured daily grass growth rates for 2016 and average daily grass growth rates 2007 - 2015 from plots at Greenmount and Hillsborough

The GrazeGro model was employed to inform seven (7d) and fourteen (14d) day predictions of grass growth rates throughout the 2016 grazing season. Despite the high variability observed in growth rates throughout the 2016 season, measured growth rates were highly correlated with both the 7d and published forecasts.

Grass crude protein, metabolisable energy and acid detergent fibre remained on average, comparable to the long term average; however grass dry matter content and water soluble carbohydrate content were lower during the summer period (Table A).

Table A. Summary of grass growth and grass quality observed on the GrassCheck during 2016, compared to the long-term average (2007- 2015)

	2016	**2007 - 2015**
Grass growth (kg DM/ha/day)	59.4	49.9
Spring (t DM/ha)	1.0	0.7
Summer (t DM/ha)	10.4	7.8
Autumn (t DM/ha)	2.4	1.6
Dry matter (%)	15.6	17.5
Crude protein (%)	19.5	19.6
Metabolisable energy (%)	11.5	11.7

1.4 Conclusions

Despite high variability in grass growth rates, good growing conditions during 2016 facilitated high rates of annual growth on both measurement sites averaging 13.6t DM/ha.

Grass growth forecasts provided for both seven and 14 days were highly correlated with subsequent measured values for the Hillsborough site, however more widespread data from multiple sites are required to reflect the variation in grass growth conditions across N.I.

2. Introduction

Well-managed grass remains among the most cost-effective feedstuff for UK dairy cows (Kingshay, 2015). With an increased global demand and fluctuations in both the availability and cost of imported feedstuffs, efficient forage utilisation is, and will continue to be, a key driver of profitability on UK dairy farms. In Northern Ireland (N.I.) improving both grass utilisation by one tonne dry matter per hectare (t DM/ha) and grass quality on an average dairy farm has been estimated to be equivalent to an additional profit of £334/ha/yr (DAERA, 2016).

In N.I. grazed or ensiled grass remains the dominant forage source, occupying an estimated 93% of the total farmed area. However, the current performance of managed grasslands in N.I. remain sub-optimal with an estimated 7.5t DM/ha utilised on dairy farms, significantly behind levels achievable by modern day grass varieties (>12 t DM/ha; DAERA, 2016). This is echoed by a continuing decline in milk production from forage on N.I. dairy farms, which has fallen steadily from 3228 litres/cow/year in 2000 to 1686 litres/cow/year in 2014 (CAFRE, 2016).

There are a number of factors which are likely to be contributing to poor grassland utilisation on N.I. dairy farms such as poor soil nutrition, limited sward renewal, climatic shifts, falling fertiliser application rates and changing animal genotype. Importantly the absence of regular, robust measurement of growth rates and quality makes it difficult to improve grass growth and utilisation.

Most recently the Sustainable Agricultural Land Management Strategy for Northern Ireland (2016) has called for an increase in the uptake of ‘sward assessment and grass utilisation measurement and recording’ on grassland farms as one mechanism by which improvements in grass utilisation can be achieved. Within the UK, centralised data on grass growth and quality remain extremely limited, with few data sources. This continues to be a significant concern given the importance of grazed and ensiled grass in our livestock production systems.

To assist farmers in grassland management decisions and encourage uptake of grass measurement, GrassCheck has provided livestock farmers in Northern Ireland with weekly grass growth and quality information during the main grazing season for the past 16 years (1999-2002; 2004-2006; 2007-2010; 2011-2012; 2013-2015). During this time GrassCheck has continued to develop. For example, the addition of the growth prediction element in 2004 was developed by AFBI (Barrett et al., 2005), providing farmers with an estimate of grass growth rates for up to two weeks ahead. Additional sub-models (e.g. CloverCheck) have also been developed (Laidlaw et al., 2007). On-going collection of this information each year is crucial to understanding grass growth and quality conditions across N.I.

3. Objectives

The objectives of GrassCheck6 were to:

- Monitor grass growth rates and grass quality via cut plots throughout the 2016 growing season at two locations in Northern Ireland
- Provide weekly 7-day and 14-day grass growth rate forecasts throughout the growing season using the GrassCheck model
- Publish grass growth and quality information on a weekly basis in the farming press with complementary management notes.

4. Materials and Methods

4.1 Field site description

The study was conducted on two grassland sites (approximately 324 m^2) at CAFRE Greenmount (54°22'N, 07°37'W) and AFBI Hillsborough (54°27'N, 06°04'W). Soils from both sites are classified as Stagnosols (WRB, 2014) and are representative of 60% of N.I. agricultural soils.

Four experimental areas were constructed in established perennial ryegrass (*Lolium perenne*) swards: two sets located at CAFRE Greenmount and two at AFBI, Hillsborough. Plot areas were selected to be visually uniform and representative of the field, avoiding low lying areas, steep slopes, boundaries, shading and areas of poor sward composition or soil structure. Plot areas were assessed for soil fertility in January 2016, prior to fertiliser application, and pH status, P, K, Mg and S determined by standard laboratory methods. Results of the soil analyses can be found in Appendix 1. Nutrient deficiencies identified were addressed in accordance with RB209 The Fertiliser Manual 7th edition recommendations (DEFRA, 2000). All experimental areas identified for the 2016 season were previously employed in the GrassCheck project during 2015. As per protocol, plot locations are changed after a maximum of three years to avoid potential structural changes in the sward induced by cutting.

Each experimental area consisted of nine plots each measuring 5.0 x 1.5 m and surrounded by a 2.0 m discard area and a stock proof perimeter fence. The nine plots were divided into three series of three replicates and each randomly to one of three cutting sequences (Figure 1).

Figure 1. The allocation of the nine plots into three series of three replicates.

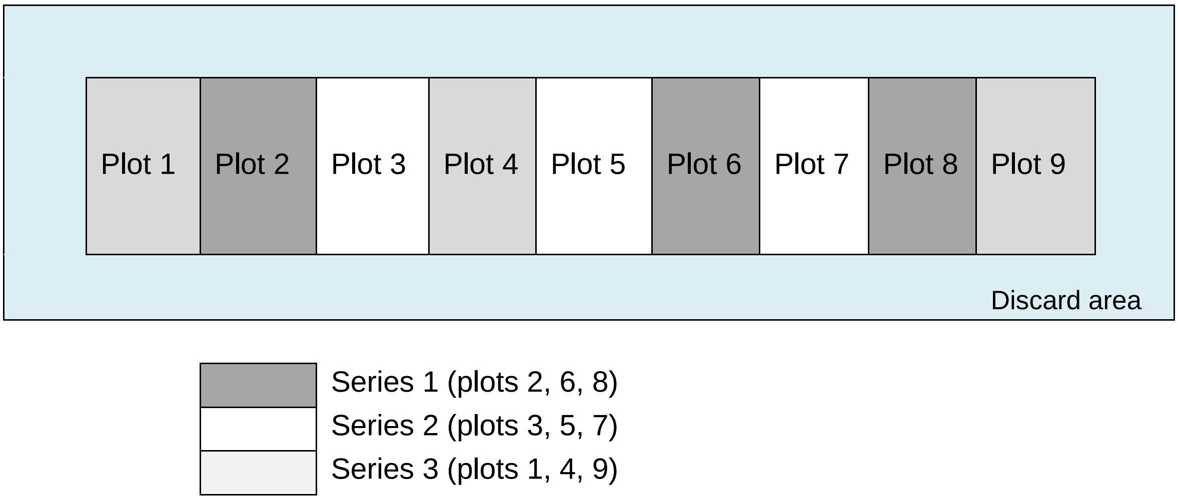

Figure 1. The experimental design with the allocation of the nine plots into three series of three replicates.

4.2 Plot management

Plots were cut on 15 February 2016 prior to the project starting to remove winter growth. Urea fertiliser was applied at a rate of 28kg N per ha, immediately following cutting. Throughout the season, all plots received 270kg N/ha with rate and form of fertiliser matched to plant demand and stage of season (Table 1). Fertiliser recommendations were in accordance with The Fertiliser Manual (RB209) 7th edition (DEFRA, 2000). Fertiliser was weighed for each individual plot and applied by hand post cutting.

Table 1. Fertilizer application during the study period for Series 1.

Series 1 cutting date	Nitrogen application rate (kg N/ha)	Fertiliser type
15 Feb	28	Urea (46% N)
7 Mar	28	
28 Mar	35	Chalk N (27% N)
18 Apr	35	
9 May	35	
30 May	25	
20 Jun	25	
11 Jul	25	
1 Aug	17	
22 Aug	17	
12 Sep	0	N/A
3 Oct	0	

4.3 Meteorological measurements

A met-office weather-station located at AFBI Hillsborough recorded daily rainfall, mean, minimum and maximum air temperature, and percentage of cloud cover.

The forecasted meteorological parameters required to run the model and obtain the weekly grass growth simulation were provided by www.metcheck.com.

4.4 Soil moisture measurements

Soil moisture measurements were taken on a weekly basis at each site. Six soil core samples (2.5cm of outer diameter by 7.5cm length) from the area surrounding the plots were taken. Gravimetric soil moisture was determined by oven drying samples at 100ºC for a 24 hour period.

4.5 Grass measurement

Grass measurements were performed weekly on a three week rotational series. Series 1 grass measurement cuts began on 7 March 2016, Series 2 on 14 March and Series 3 on 21 March. Plots were cut with a self-propelled cutting bar (Agria, Denmark) to a height of 4 cm. All herbage mass for each plot was collected and weighed. Herbage from the discarded area of each plot was harvested and removed from the plots following the grass cut measurements.

Supplementary herbage height (cm) measurements were also recorded at AFBI Hillsborough by a rising platemeter (RPM, Jenquip; New Zealand). A total of eight RPM readings per plot where taken on a weekly basis from each plot before and after harvesting. Grass DM cover was calculated using the following equation [1]:

$$[1]\ RPM\ cover\ \left(kg\frac{DM}{ha}\right) = (\text{herbage height } \text{x } 316) + 330$$

4.6 Grass quality measurement

Herbage quality was measured weekly. Four grass samples were obtained for each series at cutting. Three samples of 250g each were used to determine the gravimetric grass dry matter content by oven drying at 100ºC for 24 hours, a fourth sample was collected for herbage quality analysis. Dry matter (DM), crude protein (CP), metabolisable energy (ME), acid detergent fibre (ADF) and water soluble carbohydrates (WSC) were determined by near infrared spectroscopy (NIRS) by the Hillsborough Feed Information System at AFBI.

4.7 Grass growth rate calculations and forecasting

Grass growth rate was calculated weekly as a function of the herbage mass harvested from each plot, herbage DM content and the plot area harvested.

Seven day and 14 day forecast grass growth rates were calculated using the GrazeGro model (Barrett et al., 2004), a herbage growth model constructed for use in a decision support system (Mayne et al., 2004). Model validation against independent historical European data showed output predictions to be sufficiently accurate to make it a useful aid for on-farm decision-making processes (Barrett et al., 2005).

GrazeGo is primarily based on plant physiological processes at the leaf and tiller level. The model accounts for reproductive growth, growth response to soil nitrogen, and changes in herbage quality in the form of CP and organic matter digestibility (OMD). Grass growth is determined as the balance of the supply (source) and demand (sink) of carbon allocation. Both supply and demand process are largely dependent on the temperature and solar radiation and hence on the photosynthetic rate and leaf production. When the demand is consistently greater than the supply, a negative carbon balance results and the plant draws from the reserve pool. Otherwise growth proceeds and reserves are replenished when supply is greater than the demand. Inputs required to run the model are daily photosynthetically active radiation (PAR), mean air temperature, mean rainfall, and rate of nitrogen fertilizer application in the sward. The PAR was estimated [2] by the mean average daily cloud cover from 2005 until 2012 ($\overline{\mathrm{X}}_{\mathrm{long}}$) and the average daily cloud covered measured at the weather station ($\overline{\mathrm{X}}_{\mathrm{meas}}$).

$$[2]\ Mean\ daily\ PAR\ = \frac{\overline{\mathrm{X}}_{\mathrm{long}} + (50 - \overline{\mathrm{X}}_{\mathrm{meas}})}{100 \times \overline{\mathrm{X}}_{\mathrm{long}}}$$

All the above parameters were used to calculate the simulated herbage production on weekly basis. After the simulated period, the actual measured on site meteorological parameters were inputted to the model and the next simulation started.

Model outputs were assessed on a weekly basis by an AFBI scientist and forecast growth rates were generated. In situations where projected forecasts from the model alone were deemed to be extreme outliers i.e. significantly different from expected at that time of year, a correction factor was applied. This correction factor took into account the performance of the model in the previous weeks relative to actual measured data. The estimated herbage by RPM on the plots to be harvested at Hillsborough one week later was also considered.

4.8 Dissemination

Grass growth rates (measured and forecast) were published weekly throughout the season in the local farming press, on the AgriSearch website and on social media. This information was accompanied by technical guidance notes supplied by CAFRE Greenmount (Appendix 2).

5. Results and Discussion

5.1 Meteorological data

During 2016 mean air temperature and total annual rainfall across N.I. were 9.3 °C and 1081mm, respectively (Table 2; MetOffice, 2017). The Province recorded above average daily air temperatures (+0.4 °C) and total rainfall (+73mm) compared to the long term average (1981 – 2010).

Table 2. Monthly rainfall (mm) and mean daily air temperature (°C) for N.I. during 2016 compared with the 1981 – 2010 average (MetOffice, 2017)

	Rainfall (mm)				Air temperature (°C)		
	2016	**1981 – 2010**	**Difference (%)**		**2016**	**1981 – 2010**	**Difference**
January	176	86	151		5	5.8	0.8
February	109	76	130		4	3.7	-0.3
March	73	90	77		6	6.2	0.2
April	81	75	108		6.3	5	-1.3
May	61	71	84		11.2	12.2	1
June	97	70	127		14.2	15.6	1.4
July	102	76	126		14.6	14.6	0
August	70	90	71		15	15.7	0.7
September	104	90	114		13.6	14.8	1.2
October	50	78	43		9.9	10.3	0.4
November	81	104	72		5.2	3.9	-1.3
December	78	103	68		6.5	8.5	2
Total	**1081**	**1008**	**107**	**Mean**	**9.3**	**9.7**	**+0.4**

During the study period cumulative rainfall at the AFBI Hillsborough site was 533 mm, equating to 60% of the annual precipitation recorded at Hillsborough 2016 (Figure 2). Mean daily air temperature at the site was 10.8°C and ranged from -2 to 25 °C between February and October 2016. Through 2016, mean air temperature at AFBI Hillsborough was on average 0.9°C higher than the long term average of the Province. Total annual rainfall at Hillsborough was 806mm, 80% of the 2016 N.I. average (Figure 2.)

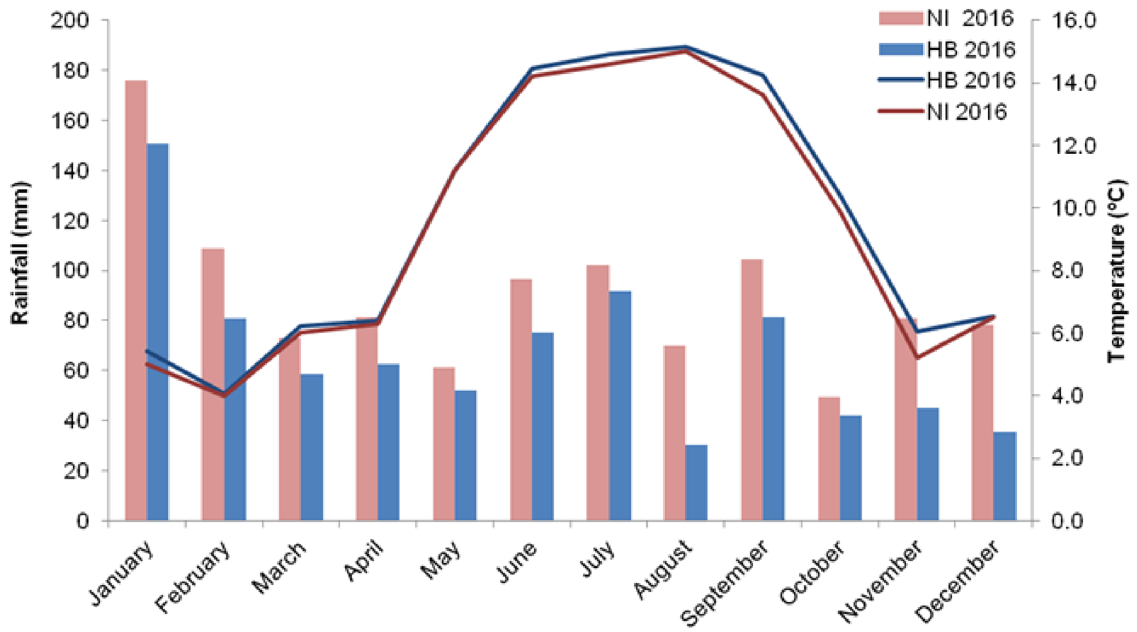

Figure 2. Monthly total rainfall (bar) and average daily air temperature (line) during 2016 from Hillsborough (HB) and Northern Ireland (NI)

5.2 Soil moisture conditions

Throughout 2016, gravimetric soil moisture content (ratio of moisture to dry soil) tended to be higher at both Greenmount field sites (average = 0.70) compared to the Hillsborough sites (average = 0.57; Figure 3) however over both sites, gravimetric soil moisture content was 30% higher than the 2010 – 2015 average. Higher soil moisture levels were particularly notable in the months of July and August, a time when soil moistures have previously been found to limit grass growth.

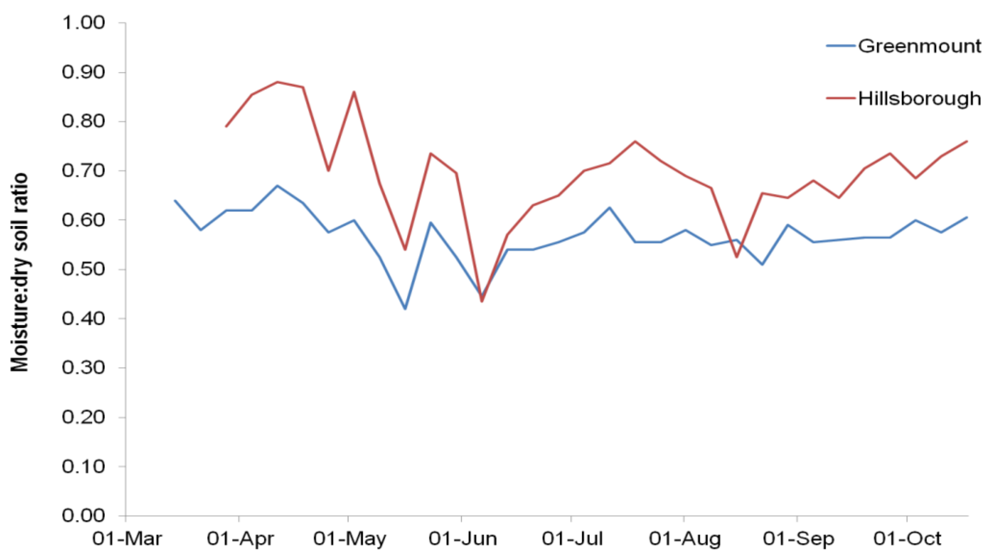

Figure 3. Average daily soil moisture from Greenmount and Hillsbrough sites during 2016

Publically available weather data from regions across Northern Ireland are limited and hence it is difficult to provide a detailed picture of grass growing conditions across the Province during the 2016 growing season. However farmer and advisor feedback during 2016 suggests there was a significant disparity in grass growth conditions across the Province with western areas experiencing higher precipitation levels throughout the summer months. Data from Omagh shows an extra 315 mm of rainfall fell during the period from June to September compared with the Hillsborough site (Figure 4).

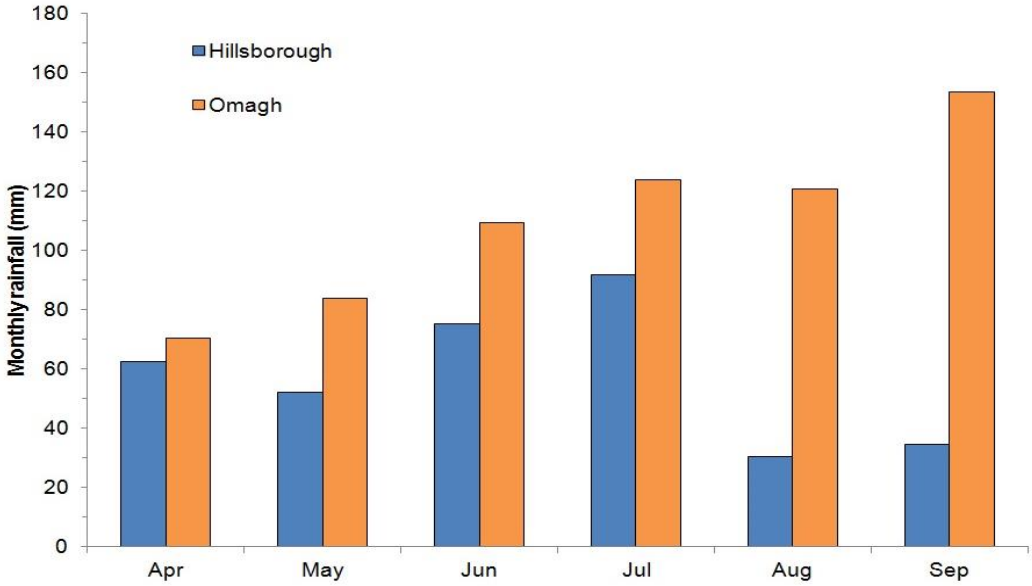

Figure 4. Monthly cumulative rainfall (mm) measured from April to September 2016 at Omagh and Hillsborough (Omagh data courtesy of K Alcorn)

5.3 Grass growth

5.3.1 Annual growth

Annual yield of grass dry matter production in 2016 across the four GrassCheck sites was 13.6 tonnes dry matter per hectare (t DM/ha), an increase of 0.5t DM/ha from 2015 and 2.4t DM/ha greater than the long term GrassCheck average (11.2t DM/ha; 2007 – 2015). Total grass production at the Greenmount and Hillsborough sites was 12.6t DM/ha and 14.6t DM/ha, respectively.

Daily grass growth rates were higher than the long-term trend (49.9kg DM/ha/d; 2007 - 2015), averaging 59.4kg DM/ha/d. However daily grass growth rates exhibited greater variability than in previous seasons (2016 standard deviation = 32.4, 2007 – 2015 = 26.9), particularly during the summer months (Figure 5).

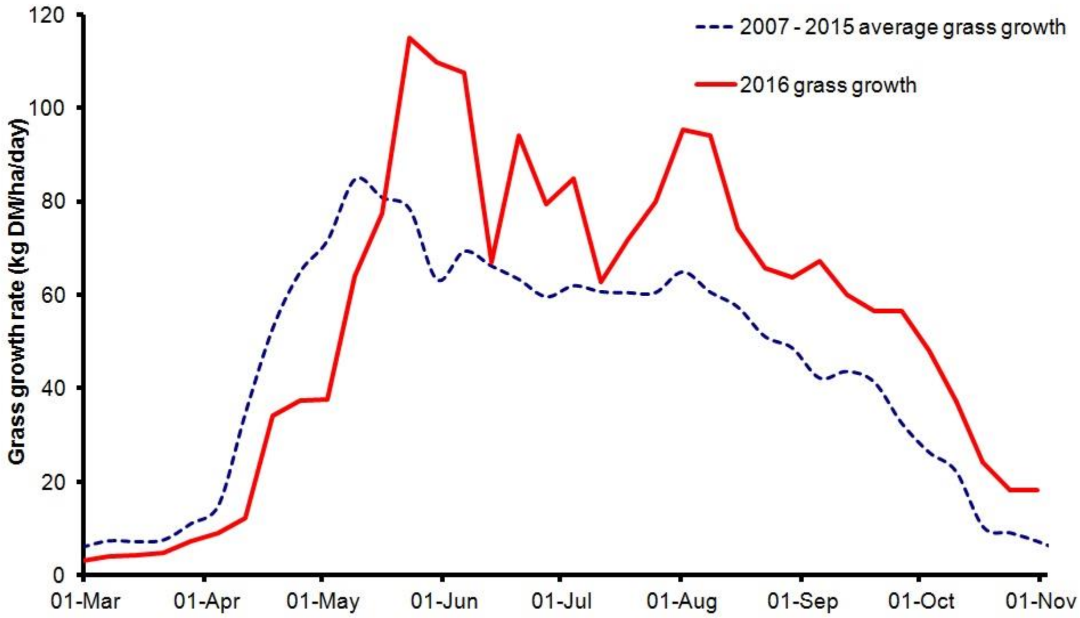

Figure 5. Measured daily grass growth rates for 2016 and average daily grass growth rates 2007 - 2015 from plots at Greenmount and Hillsborough

5.3.2 Seasonal growth

Although total grass production throughout the 2016 growing season was 21% high than expected, considerable variation in seasonal growth was evident across the year. Spring, summer and autumn growth in 2016 was 90, 133 and 164% of the long-term average (2007 – 2015), respectively.

Grass growth conditions in early spring were poor, with below average soil temperatures and above average rainfall between January and April across Northern Ireland. By the end of April cumulative rainfall were 20% higher than the average cumulate rainfall for this time of year (Table 2). This impacted heavily on grass growth during the month of April with grass production 54% of that expected during this month (Figure 6). This reduced April's contribution to the total annual yield from 13% to 6%, and a total deficit of 1t DM/ha was evident after the first 10 weeks of the season compared to the long term average.

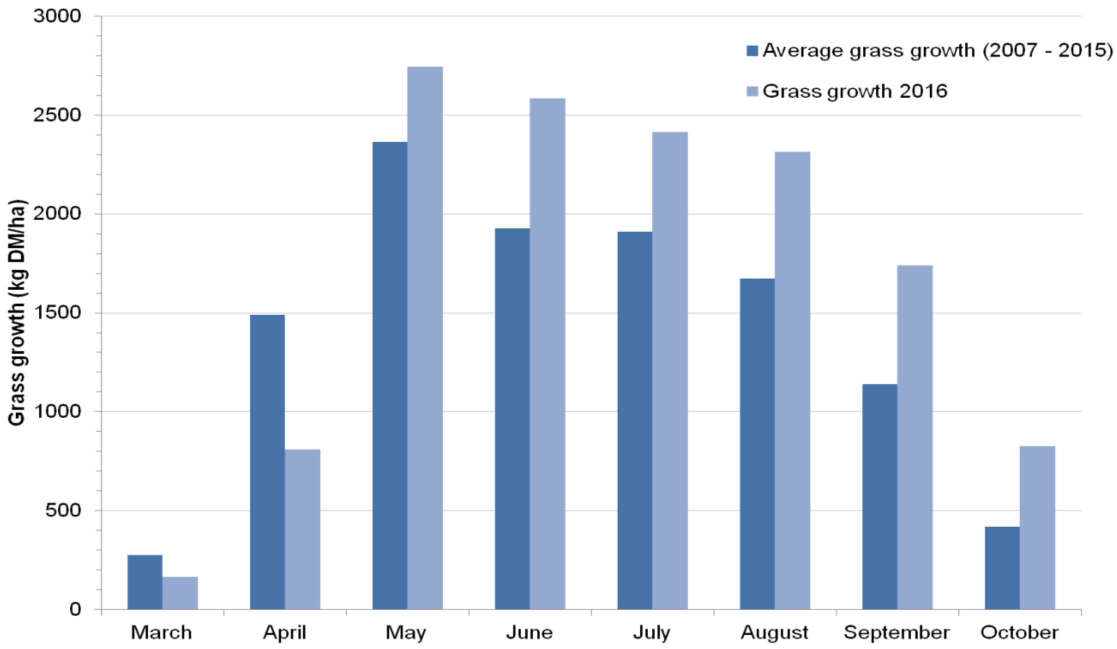

Figure 6. Measured monthly grass production (kg DM/ha) for the 2016 growing season and average grass growth for 2007 - 2015 from the Greenmount and Hillsborough sites.

At the beginning of May, grass growth rates averaged 37.5kg DM/ha/d, 35kg DM/ha/d below expected for this time of year. Following this an increase in temperature facilitated an upturn in grass growth rates. This 'spring flush' was greater than normal with growth rates climbing to a peak of 115 kg DM/ha/day on 23 May. Growth was enhanced by the late spring with swards entering their annual reproductive phase much later than normal.

The reproductive phase is typically triggered primarily by photoperiod (day length); however the timing can also be influenced by temperature and precipitation. This was evident in spring 2016, where low temperatures inhibited the initiation of the reproductive phase by 3 weeks. This phase is often associated with rapid growth, not of new leaf, but of existing plant matter, causing a large increase in grass herbage mass but also a subsequent decline in grass quality. Consequently the sudden high peak in grass growth rates witnessed in late May 2016 presented substantial challenges for managing both grass quality and herbage mass.

Following this, grass growth rates were volatile from mid-May to the end of July, however grass growth remained high, averaging 80kg DM/ha/d during the summer months. Total grass production during this time was 7312kg DM/ha, which was1802kg DM/ha greater than the long-term average. The typical soil moisture deficit usually evident at this time of year did not appear in the east of the Province, facilitating the high grass growth evident on the Greenmount and Hillsborough sites.

Although the Hillsborough and Greenmount sites during the 2016 summer months anecdotally appeared to provide a reasonable representation for grass growth in the eastern half of the Province, actual weather conditions (Figure 4) and consequently grass growth conditions in the western counties were very different from that measured on the

GrassCheck sites. However, only limited grass growth measurement data is publically available for other parts of Northern Ireland out with the Grasscheck 6 project and hence it is impossible to quantify the scale of this difference.

Grass growth rates remained high during September and October with growth rates averaging 42.9kg DM/ha/day and total herbage 164% of expected measuring 2566kg DM/ha. This was a result of above average temperatures (+1.0ºC) in both months. In addition lower cumulative rainfall rates, accounting for the 43% less of cumulative rainfall than the expected during October (Table 2), facilitated an extended grazing period. For farmers this provided an opportunity to utilise late season grass and reduce winter feeding costs.

5.4 Grass growth forecasts

The GrazeGro model was employed to inform seven (7d) and fourteen (14d) day predictions of grass growth rates throughout the 2016 grazing season. Despite the high variability observed in growth rates throughout the 2016 season, strong correlations were exhibited with measured growth rates for both the 7d (0.955, standard error of the difference (SED) = 3.823) and 14d (0.941, SED = 3.552) published forecasts (Table 3).

Table 3. Mean measured and forecasted grass growth rates (kg DM/ha). Standard deviation (SD) and standard error of the difference (SED)

	Actual	**7d forecast**	**14d forecast**
Mean (SD)	66.2 (32.0)	59.6	57.0
Difference with actual measurements		-6.6	-9.2
Correlation		0.955	0.941
SED		3.823	3.552

Across the season, grass growth rates were under-predicted by 6.6 and 9.2kg DM/ha/day, for the 7d and 14d, respectively; however this was more prevalent once growth rates exceeded 60kg/DM/ha/d (Figures 7 and 8).

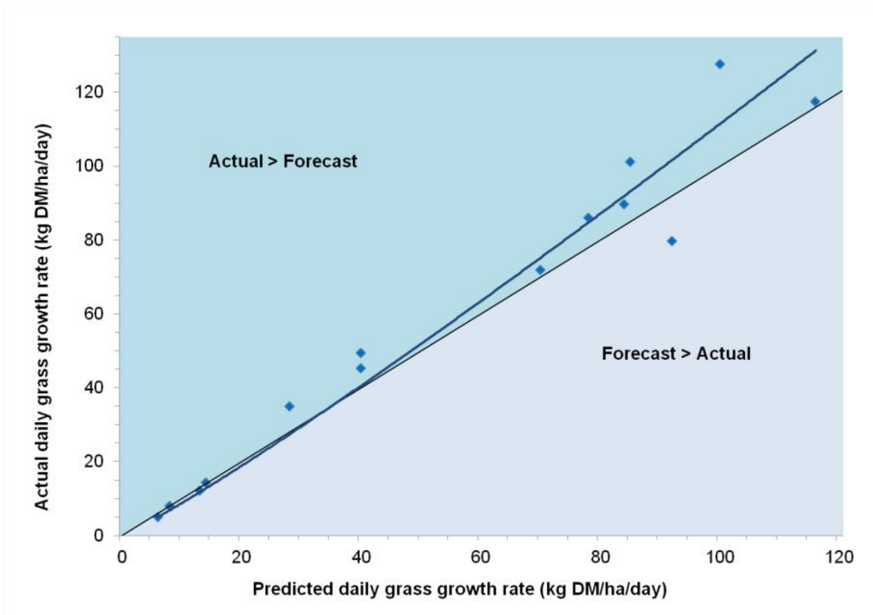

Figure 7. Relationship between actual grass growth rates observed during the 2016 growing season and published forecast grass growth rates based on a seven day forecast period

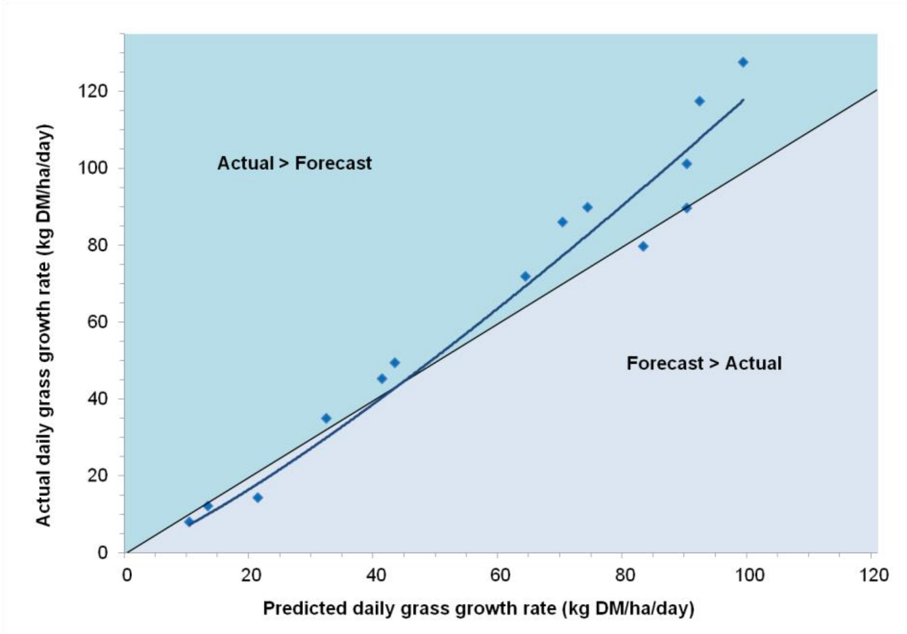

Figure 8. Relationship between actual grass growth rates observed during the 2016 growing season and published forecast grass growth rates based on a 14 day forecast period

5.5 Grass measurement technique

The RPM technique for estimate herbage yield was compared with the harvested herbage yields from the plots (Figure 9). The RPM method used to estimate the herbage yield explained the 62% of the variability of herbage mass measured by the cut and weigh method. The correlation between the RPM and cut and weigh methods in the 2016 dataset is lower than previously reported in similar studies using GrassCheck data (Dale, 2015). The difference in the measurement methods is most likely a function of the exceptionally high herbage yields recorded during 2016 which is thought to have affected the grass growing cycle and impacted on sward structure.

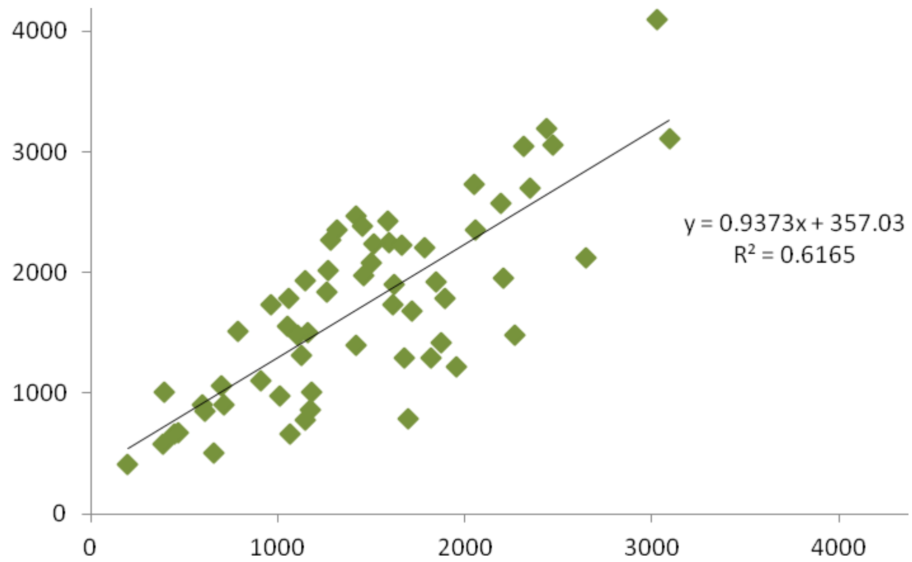

Figure 9. Linear correlation between the cut and weight grass yield measurements (axis x) and the plate meter reading (axis y)

5.5 Grass quality

Grass quality over the 2016 season remained relatively consistent with the 2007 – 2015 long term averages, reflecting a nutrient profile of vegetative grass growth found on managed swards under moderate – high rates of nitrogen fertiliser inputs (Table 4).

Table 4. Grass quality characteristics observed from the GrassCheck plots throughout the 2016 grass growth season as compared with the 2007 – 2015 average.

	2007 - 2015		**2016**	
	Mean	**SD***	**Mean**	**SD***
Dry matter (%)	17.5	2.90	15.6	2.70
Metabolisable energy (MJ/kg DM)	11.7	0.50	11.5	0.80
Crude protein (%)	19.6	3.30	19.5	2.90
Acid detergent fibre (%)	26.7	2.60	27.6	2.70
Water soluble carbohydrates (%)	14.4	3.50	12.5	3.60

*SD = Standard deviation

5.5.1 Dry matter content

Grass dry matter content during the 2016 study period, was 1.9% lower than the long term average, at 15.6%. This was particularly evident during June and July with dry matter contents remaining at least 2.0% lower than expected for this time of year (Figure 10). This reduction in dry matter content was most likely driven by above average rainfall levels during this time (Figure 2) which encouraged higher grass water contents and inhibited soil moisture deficits which typically appear during this time of year. Lower dry matter contents of grass can invariably have significant bearings on animal performance. From a practical perspective, a cow eating 85kg of fresh grass per day would suffer a significant drop in energy intake from consuming a grass of 1.5% lower dry matter content. Without changes in supplementation this is typically equivalent to a loss of 2.6kg milk per day.

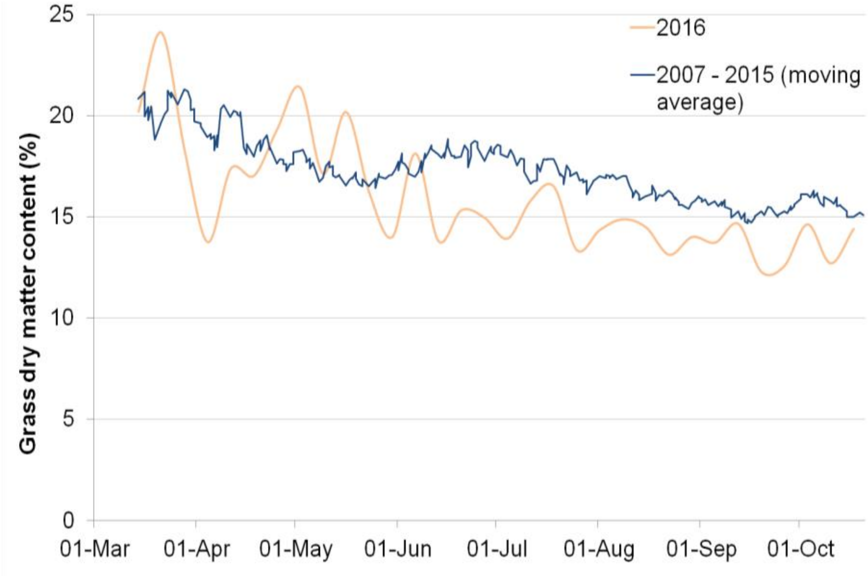

Figure 10. Mean grass dry matter content observed from the GrassCheck plots during the 2016 growing season, compared with the long term average (2007 to 2015)

5.5.2 Metabolisable energy content

In the current study grass ME ranged between 11.1 to 12.1 MJ/kg DM, averaging 11.5MJ/kg DM indicating the highly digestibility of the sward throughout the study period (Table 4). As expected small reductions in ME content in late May and June were observed, coinciding with higher plant ADF values. This reflected increases in sward maturity driven by a rapid jump in grass growth rates as swards entering the reproductive period (Figure 11).

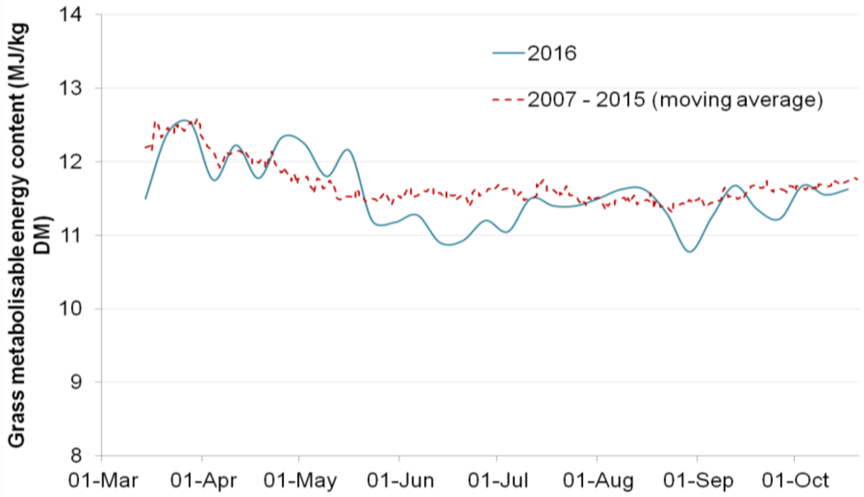

Figure 11. Mean grass metabolisable energy content observed from the GrassCheck plots during the 2016 growing season, compared with the long term average (2007 to 2015)

5.5.3 Crude protein content

Grass crude protein content averaged 19.5% during the 2016 season on the GrassCheck plots, comparable to the long term average (Table 4). Grass crude protein content was lower than expected during the spring period, mostly likely as a result of below average soil temperatures, restricting soil nitrogen mineralisation processes (Figure 12). This likely impacted grass protein contents in March, April and much of May. During late spring as plants enter their reproductive phase, growth in new leaf will slow and crude protein concentrations will fall, particularly when sharp increases are evident in grass growth as experienced in mid-May 2016. Grass crude protein content fell from 21.9% to 15.1% during the period 9 May to 23 May. Increases in grass crude protein content were evident during the late summer and early autumn period of 2016, in line with typical seasonal trends and most likely aided by high soil temperatures experienced during the autumn, facilitating high levels of soil nitrogen mineralisation.

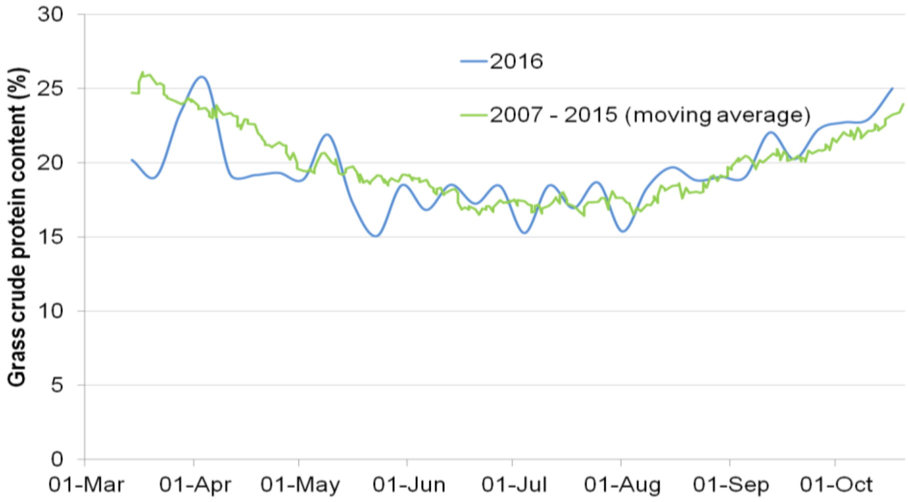

Figure 12. Mean grass crude protein content observed from the GrassCheck plots during the 2016 growing season, compared with the long term average (2007 to 2015)

5.5.4 Acid detergent fibre content

The acid detergent fibre content ranged from 24.3 to 30.3% during the 2016 season, averaging 27.6%, reflective of perennial ryegrass swards managed predominantly in a vegetative state (Table 4). Some increases in acid detergent fibre content were evident in late May and June, reflecting changes in crop maturity as plants entered the reproductive phase (Figure 13).

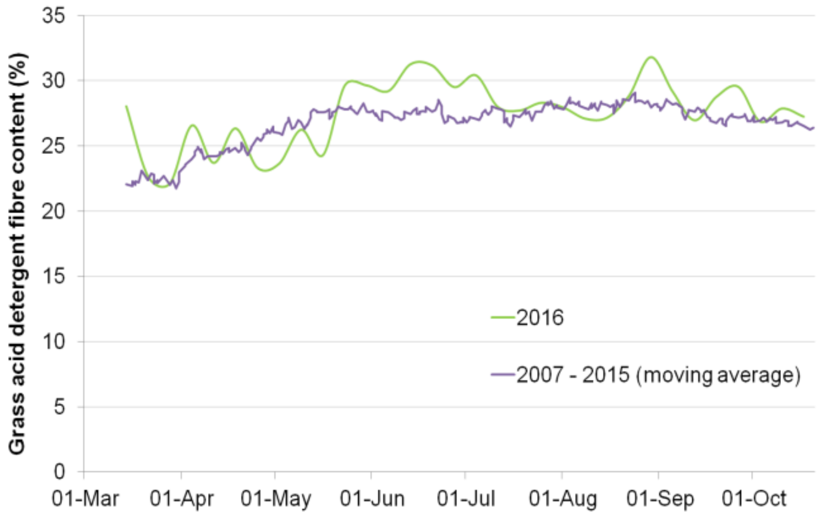

Figure 13. Mean grass acid detergent fibre content observed from the GrassCheck plots during the 2016 growing season, compared with the long term average (2007 to 2015)

5.5.5 Water soluble carbohydrate content

Water soluble carbohydrate concentrations averaged 12.5% during the 2016 season, 1.9% lower than the long term average (Table 2). Below average solar radiation levels during the summer months was most likely the contributing factor to the lower water soluble carbohydrate levels evident in the Grasscheck samples from the beginning of June onwards (Figure 14). During the months of June, July and August of 2016 there were 46, 30 and 4 hours of sun less than the long term average for the Province (2005 to 2015).

The impact of declining sunlight hours during the autumn period on water soluble carbohydrate levels was likely exacerbated by the high temperatures during this time. This most likely facilitated higher night time respiration depleting water soluble carbohydrate stores in plants.

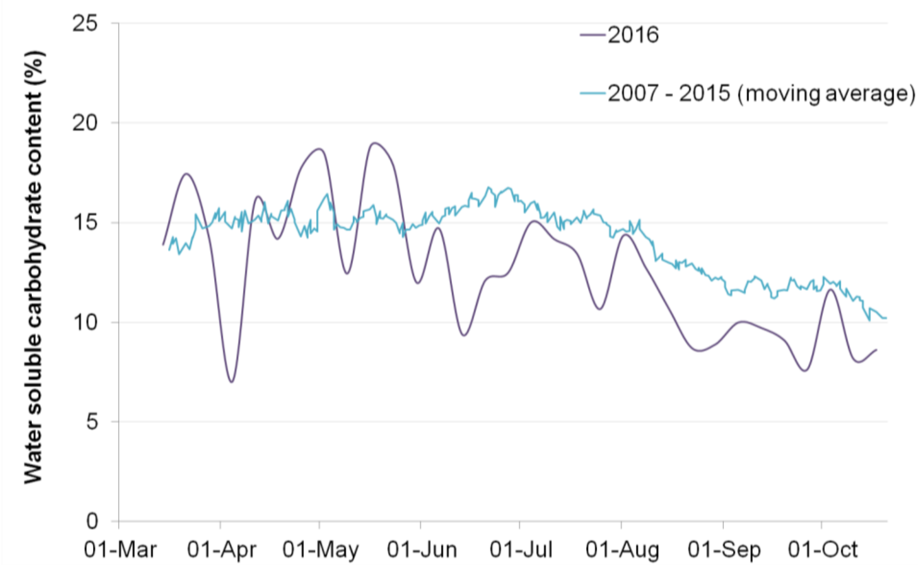

Figure 14. Mean water soluble carbohydrate content observed from the GrassCheck plots during the 2016 growing season, compared with the long term average (2007 to 2015)

6. Future Work

The GrassCheck 2016 project provided an excellent record of grass growth conditions on the Greenmount and Hillsborough sites which were deemed to be relatively reflective of conditions in the east of N.I. However, limited data was available for both climatic conditions and grass growth evident across the west of the Province. Given the range in growing season length, climatic conditions and soil types across N.I. there is a requirement to capture more detailed data from multiple sites across N.I. to provide a better understanding of potential and actual grass growth.

In addition, a comparison of grass measurement techniques for establishing grass yield suggested there is scope to consider alternative forms of measurement of grass cover. This could extend to newer precision technology forms of measurement which now starting to become commercially available.

7. Conclusions

The 2016 GrassCheck project was established to provide robust grass growth and quality data to farmers throughout the grazing season. Over the course of the year 30 GrassCheck bulletins were published on the AFBI and AgriSearch websites and in the farming press providing current grass growth and quality information, management notes and forecast grass growth rates. This information was provided through managed plots at CAFRE, Greenmount and AFBI, Hillsborough.

Analysis of grass growth rates, forecasts and quality throughout the season highlight:

- Good growth conditions facilitated high rates of grass production on both sites averaging 13.6t DM/ha, 2.4t DM/ha above average
- Growth rates were highly variable throughout the season. The growth curve was characterised by below average production in early spring, a delayed spring production peak, large swings in grass growth rates during the summer months and above average growth in autumn
- Grass crude protein, metabolisable energy and acid detergent fibre remained on average, comparable to the long term average however grass dry matter content and water soluble carbohydrate content was lower during the summer period
- Grass growth forecasts provided for both seven and 14 days were highly correlated with subsequent measured values for the Hillsborough site.
- More widespread data from multiple sites is required to reflect the variation in grass growth conditions across N.I.

8. Acknowledgements

The authors gratefully acknowledge the hard work and dedication of staff at the AFBI Dairy Unit and Hillsborough Feed Information System, and the CAFRE Greenmount Beef Unit and Advisory teams. Special thanks to Alistair Thompson and Stephen Clyde for plot management and data collection and Scott Laidlaw, Stephen Gilkinson and Alistair Boyle for grass growth forecasts and weekly publications. The study was funded by AgriSearch.

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Appendix 1

Table i: Soil pH, phosphorus (P) potassium (K), magnesium (Mg) and sulphur (S) from the two plot areas at Greenmount and the two plot areas at Hillsborough.

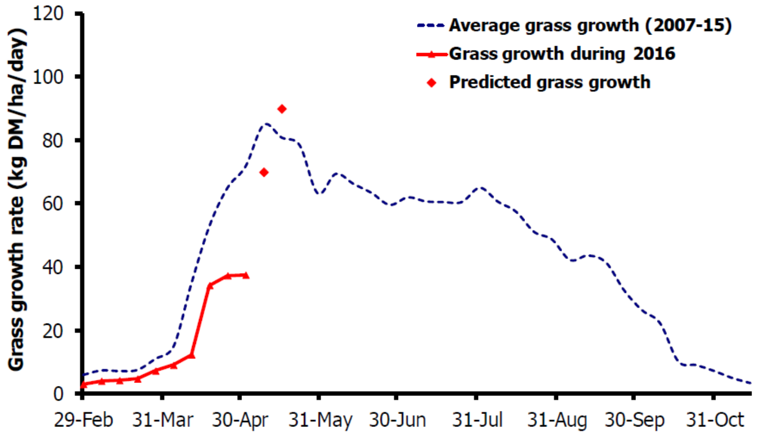
Site	pH	P		K		Mg		S	
		mg/l	index	mg/l	index	mg/l	index	mg/l	index
Greenmount A	6.43	42.6	3	700	5	695	7	15.01	4
Greenmount B	6.52	22.7	2	440	4	683	7	13.60	3
Hillsborough A	5.75	47.0	4	145	2	205	4	12.72	3
Hillsborough B	5.96	36.0	3	115	1	197	4	14.16	3

Appendix 2

Example of the weekly bulletin published on 2 May 2016.

GrassCheck

Week beginning 2 May 2016



Grass growth and quality measured from swards at Hillsborough and Greenmount

Grass Growth (kg DM/ha/day)*		
Previous 3 weeks	2 May	38
Predicted	9 May	70
	16 May	90

* 270 kg N/ha/year applied

Grass Quality	
Dry matter (%)	22.2
ME (MJ/kg DM)	12.3
Crude protein (%)	18.9
Sugars (% DM)	18.5

Management notes.

- The cold weather throughout late April has resulted in growth remaining well below average, and coupled with heavy and wintry showers, late April produced some really challenging grazing conditions.
- However, the weather outlook promises a steady increase in temperatures through early May and this is likely to result in an immediate response in growth.
- Walking the grazing platform regularly will be essential so that informed decisions can be made about adjusting levels of supplementation and closing areas for silage as grass supply improves.
- Keep fertiliser applications up to date and make the most of the surge in growth that will surely follow the expected rise in temperatures through early May.

cafre College of Agriculture, Food & Rural Enterprise

afbi Agri-Food and Biosciences Institute

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Appendix 3

Additional grass growth curves for 2016.

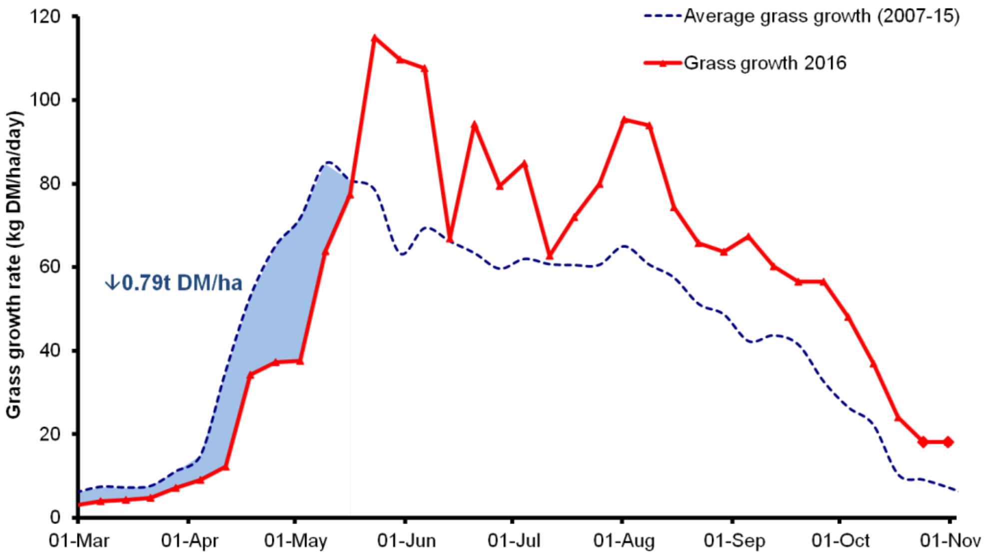

Figure X. Grass growth rates between March and mid-May 2016 were below the expected, on average 0.79 t DM/ha.

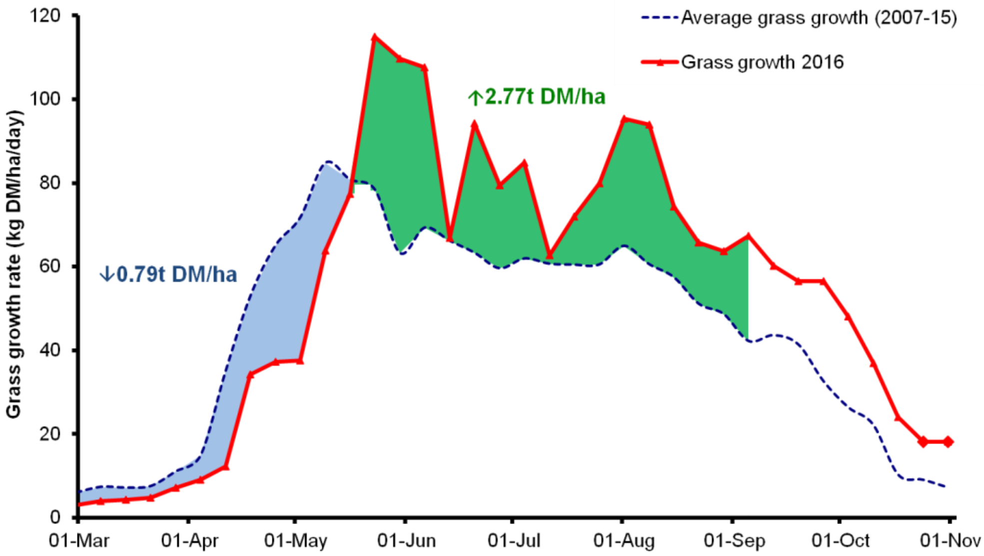

Figure Y. Grass growth rates picked between mid-May and September 2016. Growth rates were above the long term average growth rates, on average 2.77 t DM/ha more.

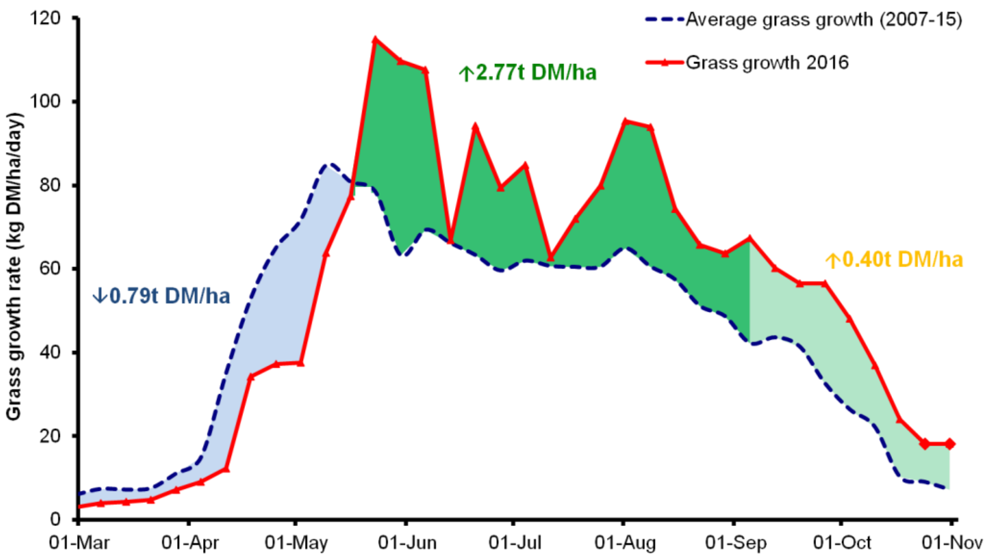

Figure Z. Grass growth rates between September and November 2016 remained higher than the long term average growth rates. Growth rates declined compared to the previous months, but still yielded 0.4 t DM/ha more than the expected for that time.