AGRI-FOOD AND BIOSCIENCES INSTITUTE
Agriculture Branch, Hillsborough

College of Agriculture, Food and Rural Enterprise
Greenmount Campus, Antrim

GrassCheck: Grass Growth Monitoring and Forecasting

End of Project Report to AgriSearch

March 2008

Department of Agriculture and Rural Development

GRASSCHECK: GRASS GROWTH MONITORING AND FORECASTING

End of Project Report to AgriSearch

March 2008

Report prepared by Andrew Dale

Project team – P.D. Barrett*, A.J. Dale, N. Moore, A.S. Laidlaw, C.S.Mayne

*left project team December 2004

CONTENTS

OVERALL SUMMARY

This report summarises the data from three years of grass growth and quality monitoring within the DARD and AgriSearch funded GrassCheck project. The importance of monitoring grass growth is clearly evident by the variations in growth recorded during this project, with growth during early June being 46% above (2005) and 24% below (2006) average during 2005 and 2006, respectively. The monitoring of grass quality indicated that the highest crude protein and metabolisable energy contents were achieved in early season (March and April). Across years the quality monitoring also identified the large range that is possible in grass quality during the season, with average monthly crude protein content having a range in excess of 7% DM in each year. The average monthly metabolisable energy content had a range of 1.4MJ/kgDM in 2004, and 1.5MJ/kgDM in 2005 and 2006. As an extra aid for grassland managers, a grass growth model has been integrated into this project to provide forecasted grass growth up to two weeks ahead. The actual growth, predicted growth and grass quality data are used weekly to produce a bulletin for release to the farming press. This bulletin is produced jointly by AFBI, Hillsborough and CAFRE, Greenmount, staff during the growing season. In addition to the presentation of the data, the bulletin also includes management notes relating to grassland decisions that need to be taken during the grazing season.

Predicted growth generally correlated well with actual growth levels, with the one week prediction being 87% accurate during the 2005 growing season. During the project, grass growth was also monitored at reduced fertiliser nitrogen inputs and from three sites across Northern Ireland. The reduced fertiliser N plots provided a valuable dataset for growth curves under a reduced nutrient input, which is vitally important given the recent decline in fertiliser N use at farm level. The regional variations identified across the three on-farm sites also provided further evidence of the range in herbage production achieved across Northern Ireland.

INTRODUCTION

Following the completion of the original GrassCheck project (1999-2002), the format was modified and the project was re-launched for a further three-year period (2004-

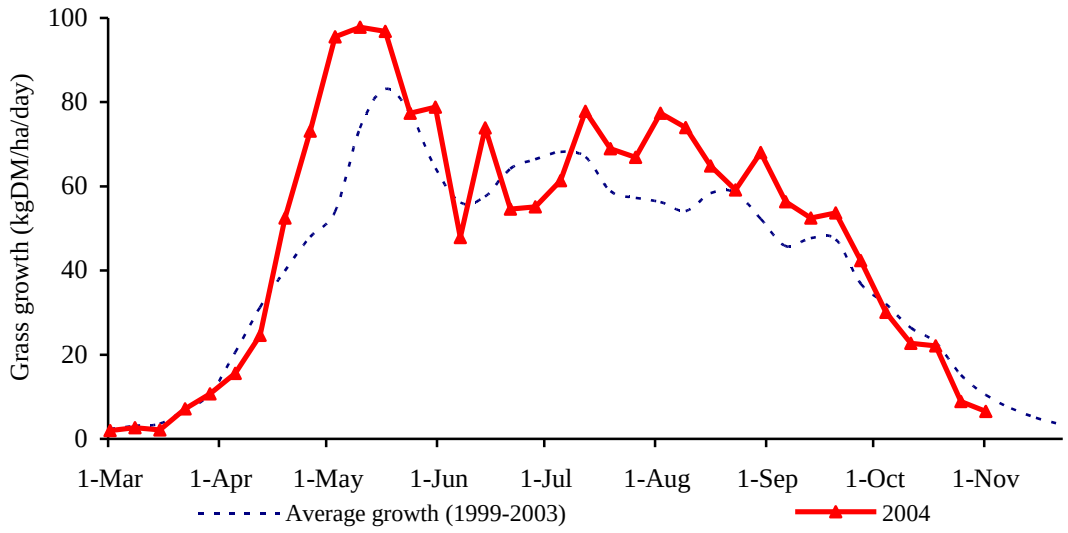
2006). The new project included predictions for grass growth up to two weeks ahead, and the monitoring of three on-farm sites and plots with reduced fertiliser N inputs (2005 and 2006). The project included grass growth from three full growing seasons, and each of these seasons will be summarised individually within this report.

SEASON 1. 2004

During the 2004 growing season, information for the average growth curve was generated from 5 sites including Hillsborough (Barn Field, Garden Field, White Hill), Greenmount (Far Field) and Crossnacreevy (Well Hollow). The 2004 season was an excellent year for grass production (Figure 1), with an average total herbage production across the sites of 12.5tDM/ha, compared to the four-year average (over the period 1999-2003) of 11.1tDM/ha.

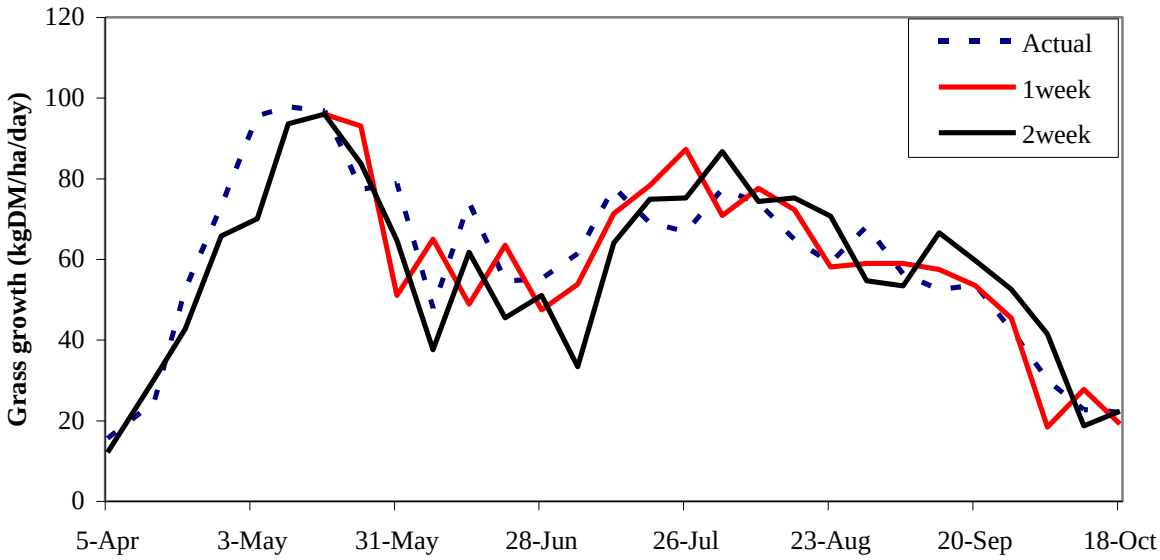
The season began with around average grass growth through March and early April, but growth increased rapidly to well above average through late April and reached a high peak in May. A period of dry weather through May and into June then lead to a decline in growth, resulting in below average production in late June. A return to showery weather in late June saw growth rates increase into July, and growth remained above average from mid-July through until late September.

Figure 1. Average grass growth throughout 2004 compared to four year average.



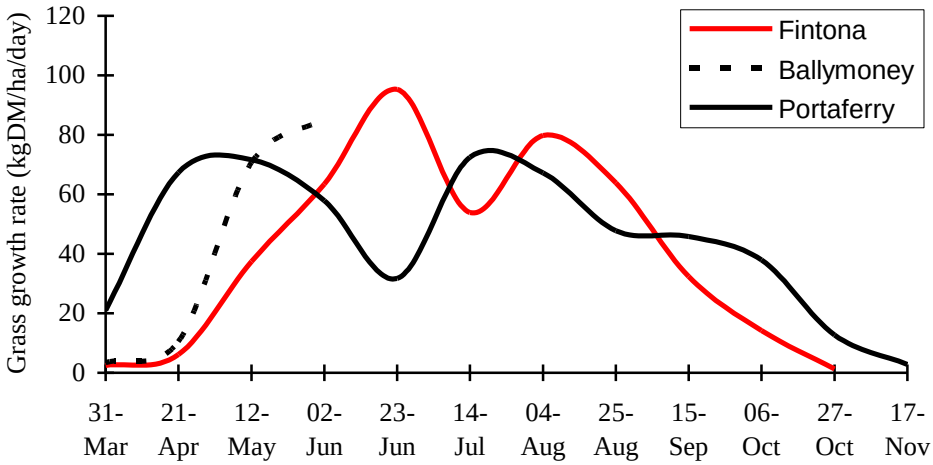
The 2004 season was the first year in which the growth prediction model was evaluated, and from the start of May until mid-October the one and two week predictions were published weekly in the press. The two week prediction identified the increase in production in early season (Figure 2), and reached a similar peak to the actual production recorded. The model over-estimated the reduction in growth during the dry spell in June, and under predicted the increase in growth following the rain. The one and two week predictions were relatively close to the actual recorded in late season.

Figure 2. One and two week prediction against average growth during 2004.



The three on-farm sites were located in Fintona, Portaferry and Ballymoney, and at each location one series of plots (3 strips) was harvested once every 3 weeks. Unfortunately, due to a bio-security issue, the measurements could not be carried out on the Ballymoney farm after 2nd June. Figure 3 indicates the grass production from the farms measured. The earlier and later growth potential of the farm in Portaferry is evident from the graph, with the effect of the dry weather through May also shown by a reduction in growth. The farm in Fintona however showed no decline in growth through the dry weather, and actually achieved peak production at this time. Total herbage production in Fintona was 9.4tDM/ha, with 11.3tDM/ha achieved in Portaferry.

Figure 3. Grass growth from the on-farm sites during 2004.



Grass quality was also monitored on a weekly basis throughout the growing season by near infrared reflectance spectroscopy (NIRS). A sample was taken from each of the core sites cut weekly, and Table 1 summarises the average monthly grass quality throughout 2004. The dry matter (DM) content of the grass peaked in June, with April grass also having a relatively high DM. The highest crude protein (CP) and predicted metabolisable energy (ME) concentrations were recorded in April, with the lowest values occurring in August. The water-soluble carbohydrate (WSC) content of herbage peaked in July, whereas the acid detergent fibre (ADF) content of the herbage peaked in August.

Table 1. Average grass quality during 2004.

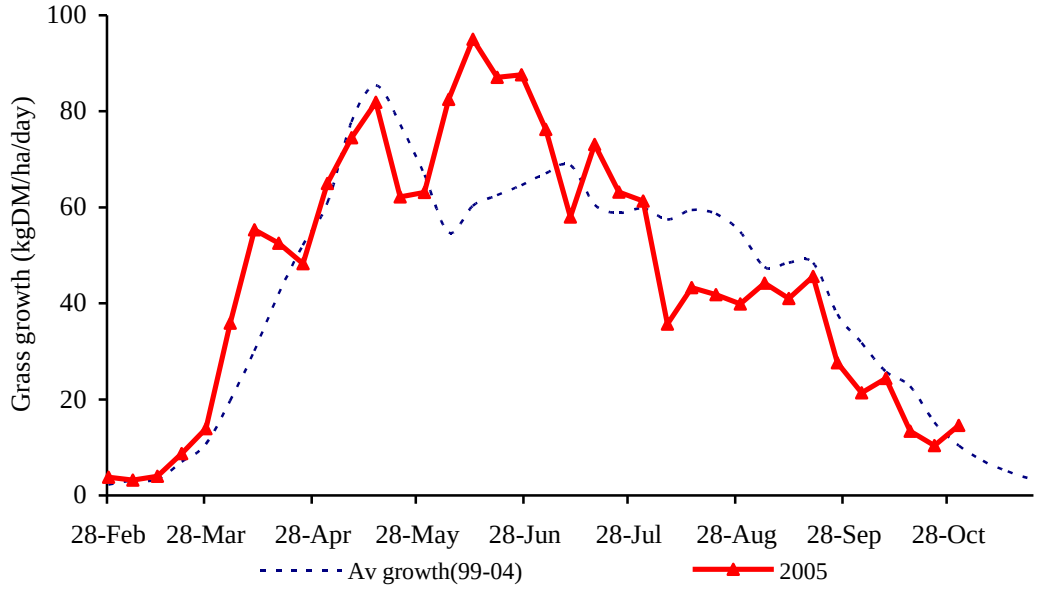
	DM (%)	**CP (%DM)**	**WSC (%DM)**	**ADF (%DM)**	**ME (MJ/kgDM)**
April	19.1	23.3	16.7	21.8	12.2
May	16.4	19.5	15.6	26.0	11.4
June	20.6	18.2	17.6	25.4	11.5
July	17.1	16.3	18.0	27.7	11.1
August	15.9	15.5	13.7	29.4	10.8
September	14.4	19.2	9.5	28.4	11.0
October	16.4	20.5	12.6	26.3	11.3

SEASON 2. 2005

The main information for the growth curve during 2005 was collected from six sites spread between Hillsborough (Barn Field, Garden Field and White Hill), Greenmount (Doctors and Far Field) and Crossnacreevy (Well Hollow). These main sites retained a fertiliser input of 360kgN/ha, and the White Hill and Doctors sites also contained a series of plots with a reduced fertiliser input of 250kgN/ha. The plots across all fertiliser levels were harvested at the same time, but the information collected from the reduced fertiliser input was omitted from the weekly bulletin released to the farming press. Total herbage production in 2005 across the sites was 11.6 tDM/ha, with the five-year average (1999-2004) being 11.1 tDM/ha.

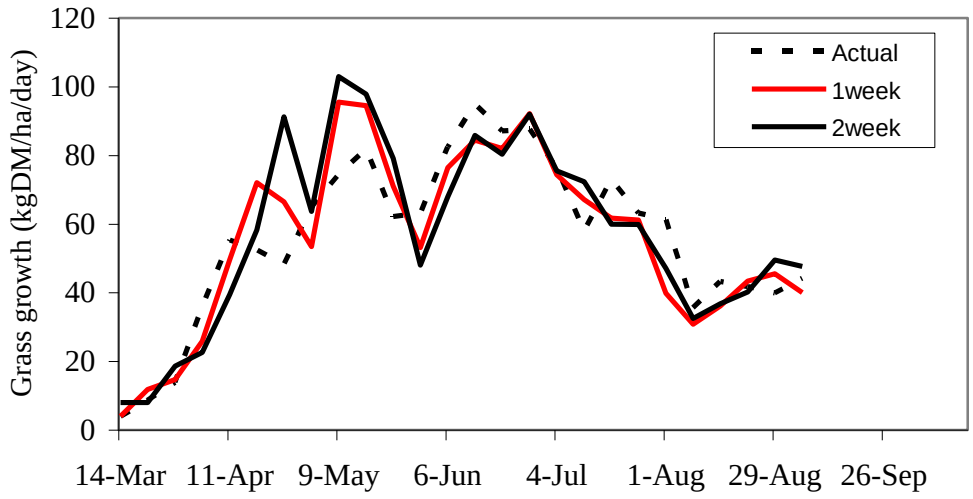
The 2005 growing season began with a period of higher than average rapidly increasing growth in late March/early April. However, growth rates declined in early April returning to around average throughout April and early May. There then followed a period of high grass growth during late May and July, only falling below average for a short period in late June. The sustained period of dry weather during the summer led to a reduction in grass growth from late July, remaining below average until late October.

Figure 4. Mean grass growth throughout 2005 compared to five year average.



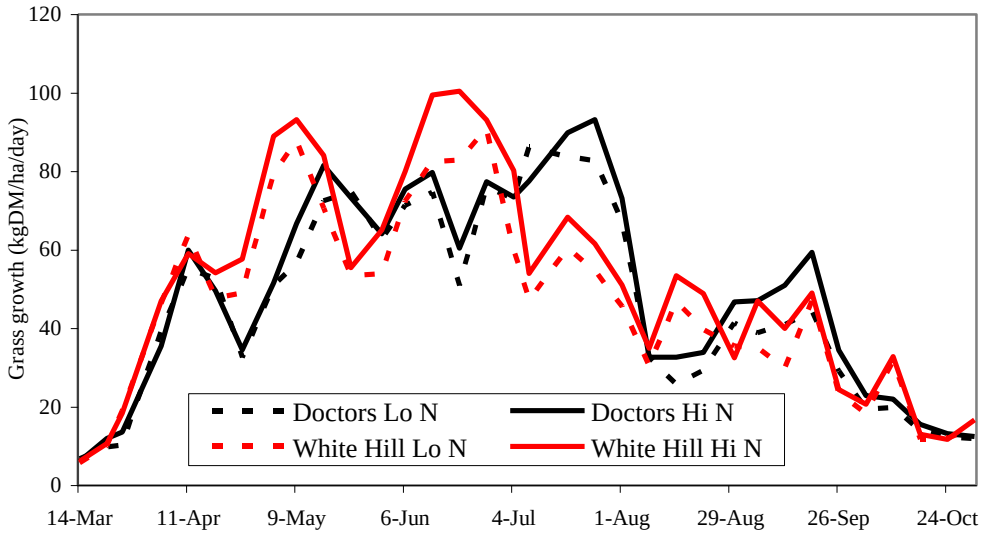
The one and two week predictions were published from the beginning of the season in 2005 (Figure 5). Despite an underestimation of growth during the early season and an overestimation of peak growth in May, the model successfully predicted the above average growth through June and also managed to track the declining growth through July and August. Over the whole season the one week prediction had an r^2 of 0.87, with the two week prediction at 0.81.

Figure 5. One and two week prediction against average growth during 2005.



Although not published in the farming press, the reduced N plots were harvested throughout 2005 in order to gain an insight into growth patterns at lower N levels, particularly relevant given the recent declining trend in fertiliser N use on Northern Ireland livestock farms. The growth curves produced from the 360 and 250kgN/ha fertiliser inputs on the two sites are shown in Figure 6, with the pattern of fertiliser applications provided in Appendix 1 for both fertiliser levels. Both fertiliser treatments resulted in similar growth in early season, however the lower N input caused a reduction in growth through mid and late season on each site. The total herbage production for the high and low N input at Doctors was 11.7 and 10.8tDM/ha respectively, with the White Hill high and low N production totalling 12.3 and 10.9tDM/ha. This equates to mean DM production responses to N fertiliser of 8.2 and 12.7kg DM/kg N fertiliser, respectively.

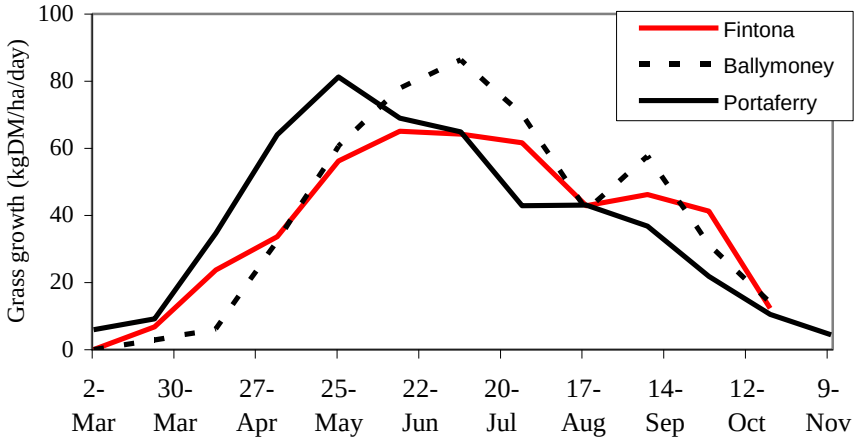
Figure 6. Herbage production on the 360 (Hi N) and 250kgN/ha (Lo N) plots at the Doctors and White Hill sites.



The onfarm sites again demonstrated the variability of growth across Northern Ireland with grass growth in Ballymoney and Fintona being lower than Portaferry throughout April and May (Figure 7). The earlier growth potential of Portaferry was reflected in a grass growth of 35kg DM/ha/day during late March and early April, and continuing to increase through April and May. During this period the growth at Ballymoney and Fintona was similar, but 50% lower than Portaferry, and 25% lower during mid and late May. However, during early June the difference in grass growth between the farms reduced, with growth at Ballymoney and Fintona continuing to increase, while the growth at Portaferry declined. Grass growth remained high at Ballymoney and constant at Fintona throughout June and July, with the dry weather reducing grass growth in Portaferry, particularly during mid July.

Although grass growth improved in late August and early September in Ballymoney and Fintona, it continued to decline in Portaferry. Grass growth subsequently declined during mid and late September in Ballymoney, with growth in Fintona remaining high. It dropped quickly in October across all farms, with Portaferry achieving the lowest growth from mid August until the end of the season. Despite growth being restricted in Portaferry throughout the second half of the growing season, total herbage production was highest in Portaferry at 10.3tDM/ha. Total herbage production in Ballymoney was 10.1tDM/ha, with Fintona producing 9.5tDM/ha.

Figure 7. Grass growth during 2005 across the on farm sites.



The average quality of the fresh herbage samples analysed weekly throughout the year by NIRS are presented in Table 2. The highest DM, CP and ME were all recorded in March, with the CP values declining through the spring/summer and then increasing again towards the end of the season. The ADF peaked in June, with the average monthly WSC in May and August reaching 15% or above

Table 2. Average monthly grass quality throughout 2005.

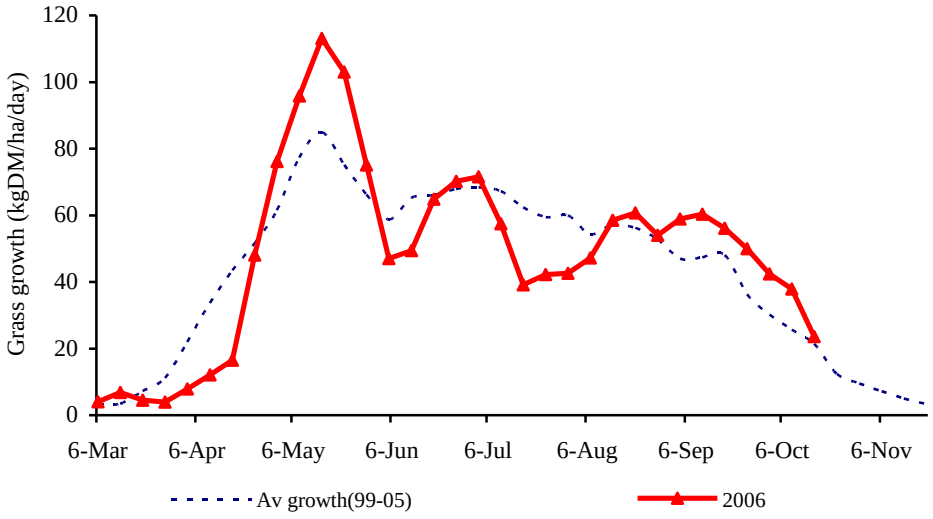
	DM (%)	**CP (%DM)**	**WSC (%DM)**	**ADF (%DM)**	**ME (MJ/kgDM)**
March	19.7	23.7	13.2	23.1	11.9
April	16.2	21.7	14.5	26.5	11.3
May	14.8	18.9	15.0	29.1	10.8
June	15.7	16.3	14.7	31.4	10.4
July	16.0	16.8	14.7	31.2	10.4
August	17.5	17.9	15.3	29.5	10.7
September	15.9	19.2	11.1	29.1	10.8
October	15.3	21.4	8.7	26.9	10.6

SEASON 3. 2006

The core sites during 2006 were reduced to 5 including Hillsborough (Garden Field and White Hill), Greenmount (Doctors and Roundhill) and Crossnacreevy (Well Hollow). The standard fertiliser N used within the published graph was retained as 360kgN/ha, with a 250kgN/ha series of plots included at the White Hill, Doctors and Roundhill sites. Total herbage production during 2006 at 360kgN/ha was 11.5tDM/ha, compared to the six year average (1999-2005) of 11.3tDM/ha.

The 2006 season began with a prolonged period of cold and wet weather during March and early April, which delayed early season growth (Figure 8). By the third week in April growth was over 60% below average, with spring growth in 2006 being one of the slowest since 1999. Despite wet conditions continuing into late April and May, there was a rapid improvement in temperatures from mid-April, with the average air temperature recorded at Crossnacreevy being 2.5^{o}C higher during the second half of the month compared to the first half. This rise in temperature resulted in a dramatic improvement in grass growth, with growth up to average levels by late April. By mid-May grass growth had increased to one of the highest peaks recorded since 1999, with this peak being over 30% higher than average. By late May grass growth had returned to around average, and a settled period of weather into early June improved grazing conditions.

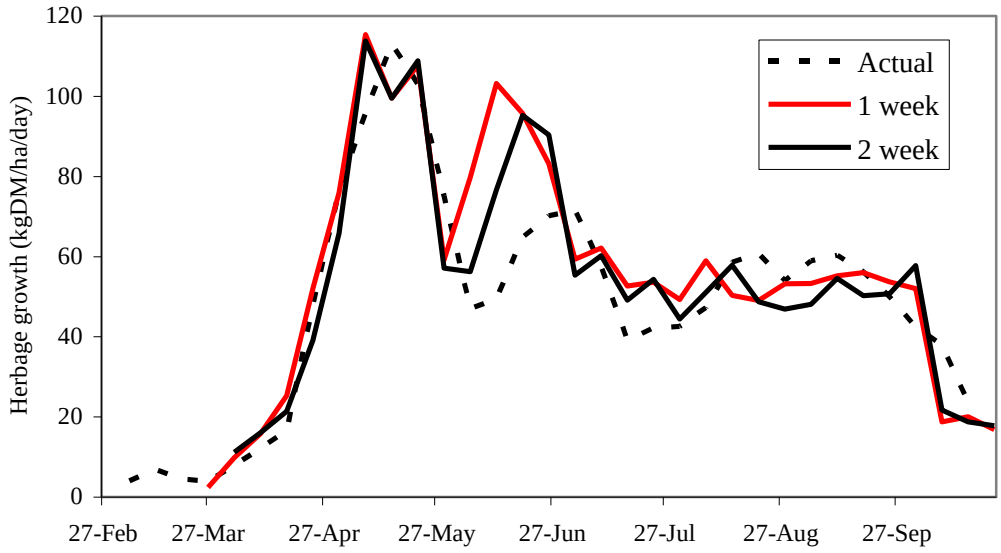
Figure 8. Mean grass growth throughout 2006 compared to six-year average.



The change to drier weather through June and July then had a dramatic impact on grass growth. During this 60 day period there were almost 40 days with no rainfall recorded at Crossnacreevy, with only 4.3 inches (109mm) of rainfall recorded over this period. The site at Crossnacreevy is susceptible to moisture deficit, and growth actually dropped to a low of 33kgDM/ha/day in mid-July, where it remained until mid-August. Growth around mid-July was 37% below average.

The scarcity of grass through July and August was quickly compensated for in early September, as the well publicised mild temperatures throughout September 2006 kept grass growth well above average. Growth remained above average from mid-August until early October, with growth being 40-50% higher than average at times during this period.

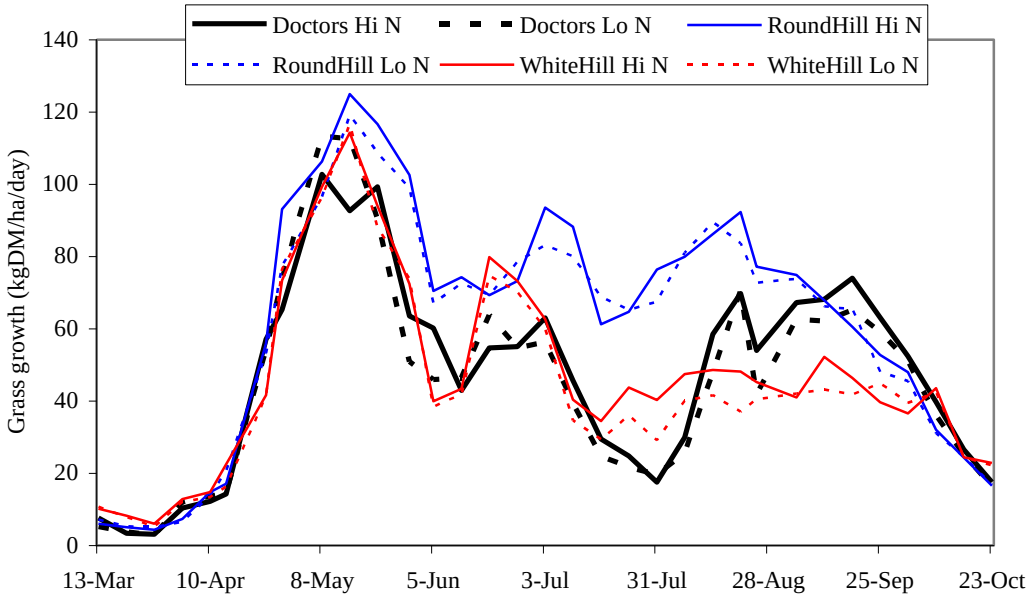
Figure 9. One and two week prediction against average growth during 2006.



Due to the erratic nature of grass growth, 2006 was the most problematic year for the model and grass growth prediction. Overall, the r^2 of the one week prediction was 0.72, with the two week prediction having an r^2 of 0.76. The growth model did follow growth well through early season, and identified the peak production. However, the decline in growth in mid-season was not reflected by the model. A specific reason for this discrepancy in mid-season is difficult to pin-point, although potential hypotheses are:-

1. The restriction on growth in early season actually impacted on tiller development, which is a major driver of mid-season grass growth
2. There is a tendency for a period of reduced growth following a very high peak of growth, and this year's peak was one of the highest recorded within GrassCheck and so at the outer limits of the dataset used to create the model

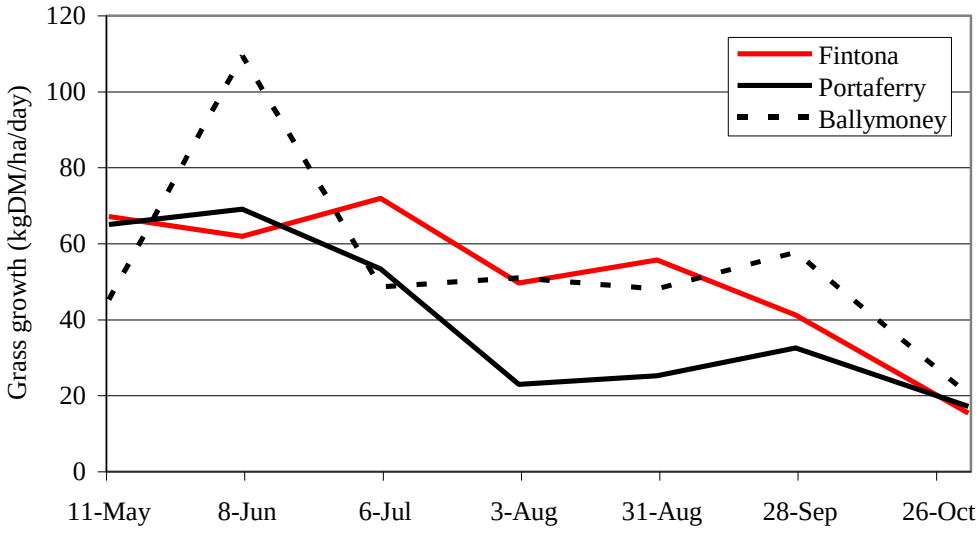
Figure 10. Herbage production at WhiteHill, Doctors and Roundhill at two levels of fertiliser N input.



Throughout 2006, the reduced N series of plots were harvested simultaneously with the normal N series at three sites (Figure 10). The pattern of herbage production was similar between fertiliser treatments with total herbage production being lower with reduced fertiliser N inputs. Total herbage production at the 360kgN/ha level at Doctors, Roundhill and WhiteHill was 11.0, 14.4 and 10.9tDM/ha, with the respective

production at the reduced fertiliser input being 10.6, 13.9 and 10.2tDM/ha, giving DM production responses of 3.6, 4.5 and 6.4 kgDM/kg additional N applied.

Figure 11. Grass growth on the three on-farm sites during 2006.



The three on-farm sites during 2006 were integrated into a larger on-farm project, and in order to facilitate further measurements, the cutting interval for the grass plots was lengthened to 4 weeks. The grass growth information collected from the three sites indicates that the site in Portaferry was adversely affected by the dry weather during mid-summer (Figure 11). The Ballymoney and Fintona sites were affected to a lesser extent, and total herbage production for Portaferry, Ballymoney and Fintona was 8.1, 10.1 and 10.3tDM/ha respectively for 2006. 2006 was the only year out of the three recorded that the Portaferry site had the lowest herbage production.

The monthly average analysis of the fresh herbage collected from each core site throughout the growing season indicates that the DM was highest in early season. The wet weather through May caused a reduction in herbage DM at this time, but the dry weather caused this to increase again to almost 20%DM in July. During this dry weather in June and July, individual sites actually recorded DM's above 24%DM in the fresh herbage. CP and ME peaked in March, whereas WSC and ADF peaked in April and October, respectively.

Table 3. Monthly average grass quality throughout 2006.

	DM (%)	CP (%DM)	WSC (%DM)	ADF (%DM)	ME (MJ/kgDM)
March	20.4	24.4	14.3	23.0	11.9
April	19.0	23.3	17.0	24.0	11.8
May	15.3	18.1	15.2	29.1	10.8
June	16.6	18.0	14.6	28.6	10.9
July	19.9	17.3	16.6	29.3	10.8
August	15.6	18.1	13.3	31.0	10.5
September	13.6	19.7	8.5	31.3	10.4
October	14.2	22.0	8.1	31.7	11.4

QUESTIONNAIRE

At the end of this three year project, a survey was conducted at the AgriSearch stand at the winter fair in December 2006 among visitors to the AgriSearch stand, and a copy of the questionnaire is shown in Appendix 2. A total of 39 responses were collected, and all responses indicated that farmers were aware of the GrassCheck project. The results are shown in Table 4, and 87% of the responses indicated that they used GrassCheck within decision making, and 97% wanted GrassCheck to continue. Suggested improvements included four asking for more regional information.

Twenty eight of the responses were from dairy farmers, with five mixed farms (dairy/beef/sheep). There were also 4 beef/sheep farmers, with 1 press and 1 trade representative filling in a questionnaire.

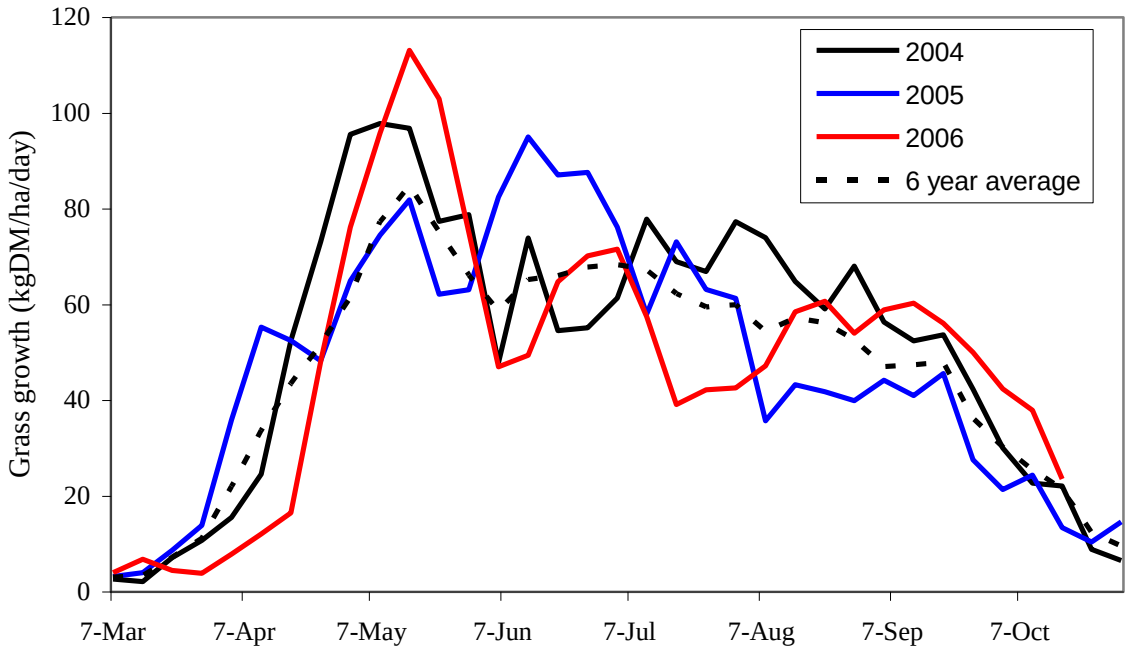
Table 4. Summary of results from questionnaire.

		Percentage (%)
Number surveyed	**39**	
Have used GrassCheck in decision making	**34**	**87**
Want to see GrassCheck continue	**38**	**97**
Would like bulletin via email	**22**	**56**
Suggestions		
Receiving bulletin via text message	**3**	
Retain bulletin in press only	**13**	
Use more regional data	**4**	
Would like training on use	**2**	

SUMMARY OF THREE YEARS (2004-2006)

Large variations in grass growth were observed between and within years during this project. During a six week period within a single growing season, growth was both over 60% below average and also over 30% above average. The variation between years is clearly evident from Figure 12, with growth equally variable in early, mid and late season. Early season growth in late March/early April was 30% below, 60% above and 60% below average during 2004, 2005 and 2006, respectively Early May is generally the period whenever grass growth peaks, and the growth at this stage was 30% higher than the average in 2006, and 15% higher in 2004. Grass growth in 2005 was around average in early May, however, peak production was achieved in early June. At this stage growth in 2005 was 45% above average, with growth in 2006 at this time being 25% below average. A dry summer through 2006 then reduced growth to around 40% below average in mid-July, with growth in 2004 and 2005 being 10 and 17% above average at this stage. Late season growth for 2006 was very good, with growth remaining above average from mid August right through until the end of the season. Growth in 2005 dropped well below average in early August and it remained below average, whereas 2004 had above average growth through July and August, only dropping below average in late-September.

Figure 12. Grass growth across the three years compared to the 6 year average.



To develop the use of GrassCheck into a more complete information package, grass growth predictions were calculated through a grass growth model using forecasted weather details and actual historic weather and fertiliser N inputs. The prediction is therefore vulnerable to the variations in forecasted weather patterns, particularly rainfall and temperature. However, the growth predictions for one and two weeks ahead achieved an r^2 of 0.87 and 0.81 in 2005, and 0.76 was achieved by the two week prediction in 2006.

The GrassCheck grass plots have historically been managed under a fertiliser regime that applied 360kgN/ha annually, and it was recognised that this would no longer be appropriate given future legislation (Nitrates Directive) and also economics. Therefore, a second series of plots were established at a selection of the sites to enable plots to be cut with two levels of fertiliser applied for comparison. The fertiliser was reduced from 360 to 250kgN/ha, and the sites monitored through 2005 and 2006 showed little impact of fertiliser level on grass growth through early season. Overall, during 2005 the reduction in fertiliser reduced total herbage production by 8 and 11%, and in 2006 the reduction was 4, 3, and 6%.

The on farm sites have shown the differences that can occur within years in different regions, with 2004 data highlighting the earlier and later growth potential of the drier site in the east compared to the west. However, the drier site had a reduced growth rate during the summer months whenever soil moisture was limiting, whereas the heavier soils in the west had good growth. The earlier growth in the east was also evident in 2005, with the site in the east having the highest total herbage production in 2004 and 2005. In 2006 there was not such a clear early season advantage from the site in the east, and the dry summer severely reduced growth in the east compared to the north and west. The west had the highest total herbage production in 2006, with the east actually producing the least amount of grass overall.

INTERPRETATION OF INFORMATION COLLECTED

Following this three year project, the information collected has highlighted some key areas that should be considered in future projects. The regional variation highlighted by the on-farm sites has generated a lot of interest, and being able to monitor this variation in more detail should be a priority. A set of replicated plots cut weekly along with the core sites, would enable a more detailed growth curve to be measured, and identify short term fluctuations in growth. The fertiliser input used to measure actual growth rate must also be decreased from 360kgN/ha, especially given that this will be in excess of legislation from the beginning of 2007. During the duration of this project, there has been a growing interest in the reintroduction of clover into grassland swards, and the inclusion of clover into a future project should also be considered.

Appendix 1. Fertiliser nitrogen application pattern.

	360kgN/ha	250kgN/ha
Cut number - (Approximate time of year)	**N applied at each application**	
*Before first cut - (mid Feb)	35 (urea)	30 (urea)
After first cut - (early March)	35 (urea)	30 (urea)
After second cut - (Late March)	50	30
After third cut	40	30
After forth cut	40	30
After fifth cut - (Late May)	40	30
After sixth cut	30	30
After seventh cut	30	20
After eighth cut	30	20
After ninth cut - (Late Aug/early September)	30	0

* Applied to all three series in one blanket application

Appendix 2. Questionnaire completed at winter fair.

AgriSearch NI Farmer Funded Research **GrassCheck**

1 Have you used GrassCheck as an aid to decision-making on your farm, or in your business?

i. Yes ___ No ___

2 Would you like to see GrassCheck continue next season?

i. Yes ___ No ___

3 Would you like to receive the GrassCheck bulletin via e-mail when it is sent to the press?

i. Yes ___ No ___

4 Have you any suggestions for improving the usefulness of GrassCheck to you?

.....

.....

.....

5 Suggestions for research

.....

.....

.....

Name .....

Address.....

Postcode .....

Email address .....

Farmer- Dairy ..... Beef &/or Sheep ..... Other .....

Adviser ..... Trade ....

Appendix 3. Outputs from project.

Publications

P.D. Barrett, and A.S. Laidlaw (2005). GrassCheck: monitoring and predicting grass production in Northern Ireland. Proceedings of a satellite workshop of the XXth International Grassland Congress, July 2005, Cork, Ireland. pp. 213

Farmers meetings

GrassCheck results were presented at the summer meeting of the Ulster Grassland Society in the Clandeboye Hotel on the 7th June 2005

Press releases

Weekly GrassCheck growth bulletin in the farming press:

2004 from 5 April until 18 October

2005 from 21 March until 17 October

2006 from 20 March until 16 October

Articles released to farming press

(including United News, Irish Farmers Journal, Farming Life and Farm Week)

Date released	Article title
March 2004	GrassCheck – Grass growth prediction service launched
May 2004	AgriSearch GrassCheck - Progress this spring
August 2004	AgriSearch GrassCheck: The Season So Far
December 2004	GrassCheck end of first year success!
March 2005	AgriSearch GrassCheck returns for the New Season
August 2005	Early and mid season grass production across Northern Ireland
September 2005	Grass growth reduced by dry weather in August
November 2005	2005 grass growing season across Northern Ireland
March 2006	Meeting the grassland challenges in 2006 with GrassCheck
November 2006	The Highs and Lows of the 2006 Grass Growing Season

GrassCheck data was presented to a large number of visiting farmer groups and international visitors throughout the three years of the project