



afbi Agri-Food and Biosciences Institute

The Application of NIRS for Commercial Forage Analysis

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4x4 of the Alltech FEI World



Outline of talk

- Introduction
- Weather
- Farming
- History of forage analysis in Northern Ireland
- Hillsborough Feeding Information System (HFIS)
- Enhancing analytical reports with feeding models
- Ensuring the accuracy of the service
- Service delivery
- Staffing the service
- Costing the service
- Future developments

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Introduction

The Agri-Food and Biosciences Institute was formed in April 2006 from the amalgamation of the Agricultural Research Institute of Northern Ireland and the Science Service of the Department of Agriculture and Rural Development

It is one of the world's leading providers of scientific research and services to government and commercial organisations.

The 800 strong multi-disciplined workforce possess a unique breadth of scientific ability and facilities in the fields of :-

- Agriculture
- Animal Health & Diagnostics
- Food
- Environment
- Biosciences

We offer facilities to both the private and public sectors worldwide.

Weather in Northern Ireland

- 54°North
- Rainfall between 30 & 48 inches/year
- Gulf stream has a major effect on our climate
- Prevailing winds from the southwest
- Coldest in January & February (4 - 7C)
- Hottest in July & August (14 - 16 C)
- Driest in May & June

Farming in Northern Ireland (1)

- Climate is ideal for grass growth
- Growing season of 280 to 320 days/year
- Primary pasture is perennial ryegrass
- 8.5 million tonnes grass silage/year
- Most farmers operate a 2 or 3 cut system
- Most silage is wilted for 24 - 48 hrs
- Yields range from 10 - 15 tonnes DM/ha in a 3 cut system

Farming in Northern Ireland (2)

- Maize & whole crop silages of increasing importance
- Nearly 3000 ha of maize last year
- 12 - 14 tonnes DM/ha @ 25 - 30% starch

The Hillsborough Feeding Information System

based at AFBI Hillsborough

Mission statement

“To supply a fast, accurate and affordable forage analysis service to the farming industry based on robust scientific research from AFBI Hillsborough.”

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- ◆ AFBI Hillsborough achieved certification in ISO 9001 in 2006
- ◆ Analytical Services Laboratory at AFBI Hillsborough also achieved UKAS Accreditation i.e. BS17025 for a number of tests including fat, protein, lactose, casein & urea in milk
- ◆ We are working to extend this UKAS Accreditation to cover the HFIS forage service

What is the Hillsborough Feeding Information System?

- *The HFIS is:-*
 - An innovative commercial forage analysis service based on high quality, peer-reviewed research
 - Embraces new techniques and methods to reduce costs and speed up analysis time
 - It provides a cost neutral service which is available to
 - research teams
 - commercial firms
 - individuals

Forage analysis background

- Forage analysis is an essential tool in formulating ruminant diets
- Animal performance depends on the quality of the forage and the amount that the animal will consume
 - **The later is the major driver**
- In 1992, we commenced a 2 year study to determine the intake potential of grass silage using farm silages from throughout N.I.
- 136 silages were chosen on the basis of dry matter, ammonia, metabolisable energy & pH.
- All silages were analyzed by wet chemistry and NIRS
- Intakes and digestibility were measured through 192 beef and dairy animals
- Metabolisable energy was measured using sheep.



Forage analysis background

- From the wet chemistry and NIRS scans, robust calibrations were created for the prediction of chemical parameters
- Similarly, calibrations were formed for the biological parameters i.e. ME and intake potential as measured in the animal experiment, also the degradability of dry matter and protein
- Using the research database created at Hillsborough, animal performance models were created for dairy milk production, liveweight gains for beef and lambs at different levels of concentrate feeding. Concentrate requirements for suckler cattle and breeding ewes were also modelled.

A history of the HFIS (1)

- August 1996 - HFIS service started for grass silage (Intake, DM, pH, ME, CP, NH₃, LA, LA(%TA), ADF, NDF, D value, protein a & b) Reports with feeding table predictions in 4 days .
- Spring 1997 - Pilot service on grass for ensiling and grass for monitoring (DM, CP, WSC, ME, ADF, BC, NO₃)
- Spring 1998 - Full grass service offered with 24 hour service for monitoring and 4 hour service for ensiling grass
- Autumn 1998 - protein rate coefficient added (c)
- Autumn 1999 - maize and whole crop silage service in 10 days (DM, ash, CP, pH, NH₃, ME, starch)
- Autumn 2000 - Feed into Milk intake value used for dairy model

A history of the HFIS (2)

- August 2003 - solubility of dry matter and protein with a, b, & c
- August 2004 - expanded the service to incorporate the French Protein System quoting pdia, pdin, pdie, ufl & ufv
- August 2005 - calibration range extended wider range of DM
- August 2005 - soluble sugars and oil added
- August 2005 - new capping ranges for ME and intake introduced
- September 2006 - new report style for grass silage and complete integration into LIMS
- August 2006 - haylage reports available
- Spring 2007 - new grass report launched
- October 2007 - new methodology and report style extended to cover maize silage with additional parameters NDF, NCGD within 4 days

In total, we predict or model 82 values for each silage

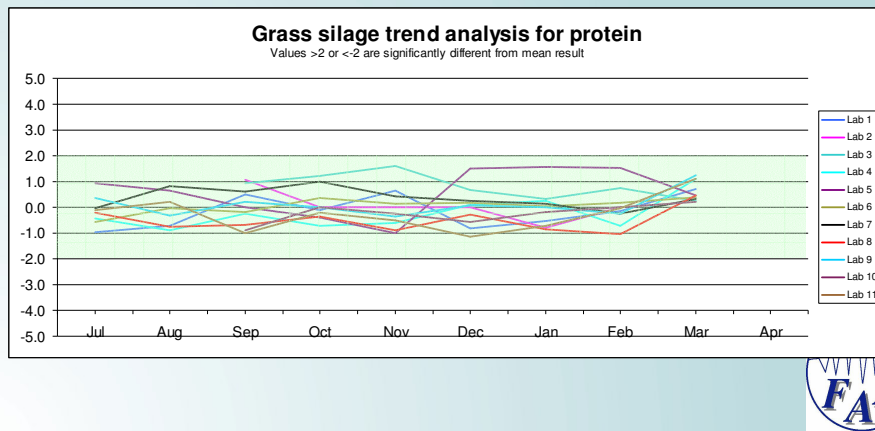
The FAA Group -what does it do? Setup and routine procedures

Routine procedures

- Daily testing of a known sample
- Ring Tests
 - 20 silages sent to each lab
 - Grass silage - April and November
 - Maize silage - January
 - Wet chemistry compared against master instrument NIRS prediction
 - Master instrument NIRS prediction compared against each labs NIRS prediction



The FAA Group - what does it do? - Monthly drift test



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What can we analyse?

At present, we routinely analyse:-

- Grass silage
- Maize silage
- Whole crop silage
- Haylage
- Grass for ensiling
- Grass for grazing

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The HFIS service in 2006/7

- Feeding reports requested
 - 90% Dairy
 - 14% Growing cattle
 - 5% Suckler cattle
 - 2% Sheep and lambs
- Prepaid postal service
 - 17% of total (or 28% of NI silages)
- Sample source
 - 60:40 Northern Ireland / Republic of Ireland
- Sample numbers (15,000/y)

Grass silage	70%
Maize silage	8%
Whole crop silage	6%
Grass	14%
Others	2%

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Enhancing the analytical reports

- Analytical reports have been enhanced with predicted animal performance reports
- Models were developed in-house by production specialists based on local research work
- Models are based primarily on intake and energy
- Available reports for
 - dairy cows
 - growing cattle
 - suckler cows
 - breeding sheep
 - growing lambs

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The dairy model

- Initially based on the 1992/4 silage intake work but updated in 2000 with the advent of the FAA consortium and the FiM dairy based SIP
- Silage intake is a factor of DM, digestibility, soluble protein, fibre components and residual sugars
- Prediction of intake has a high R² value
- The dairy model is based on intake, ME, and level of conc. feeding
- Milk yields are based on lookup tables constructed from
 - assumed maintenance levels
 - ME of a standard concentrate
 - silage ME
 - intake value

(All based on a standard cow, 585 kg, 2nd lactation, CS = 2.5, average genetic merit, zero energy balance, and in week 12 of lactation)

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The growing cattle model

- Based on the 1992/4 silage intake work
- Performance predictions of intake and LWG for 300 & 500 kg steers
- Uses the original HFIS intake value
- Model assesses:-
 - ME intake from concentrate level of feeding
 - Silage DMI based on concentrate feeding level
 - Total MEI
 - Incorporates a standard maintenance factor and ME efficiency factor for weight gain
 - Energy content of the gain is related back to the EBW and thus LWG

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Other models

- Suckler cows predicting weight of concentrate to sustain body weight in pregnancy, early & late lactation - also potential LWG where silage alone exceeds maintenance
- Breeding sheep predicting concentrate required to maintain body weight in 4 x 2 week steps prior to lambing. Covers singles, twins and triplets for both lowland and hill breeds.
- Growing lambs predicting silage intake and potential LWG at 4 levels of concentrate feeding.

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Service accuracy

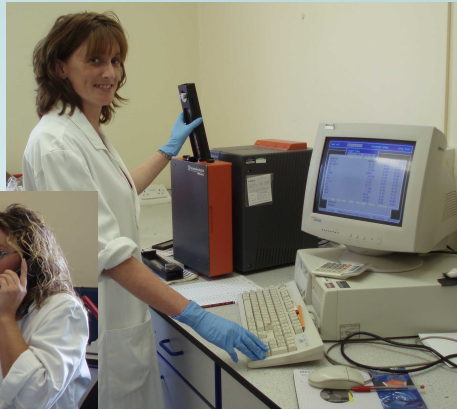
- Quality control is an integral part of the HFIS service
- We follow similar rules to normal research samples
- Daily QC sample scan through each instrument for 52 weeks
- We put 1 sample in 20/50/100 through rigorous quality control depending on sample type
- In addition to the FAA ring tests and monthly bias check samples
- We are in the process of submitting an application to expand the scope of our UKAS accreditation to forage analysis by NIRS - a first in the UK

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Service delivery

- The best turn round times of any silage laboratory in the UK & Ireland
- In 2006/7 this was < 3 days and in 2007/8 < 2½ days
- Service was enhanced to include automated e-mailing of results
- Cheap postal service covers approx. ⅓ of all NI samples
- From this year we offer a personalised summary by return



Grass silage (typical values in 2007)

	2007	2007
	1st cut	2 nd cut
Intake (g/kg W ^{0.75})	90	84
Dry matter (%)	24.5	22.5
pH	4.0	4.0
Metabolisable energy (MJ/kg DM)	10.8	10.3
Crude protein (% DM)	12.2	11.8
Ammonia N (% total N)	9.2	9.0
Lactic acid (% DM)	7.6	8.0
D- value (% DM)	67	64

Future developments

- A direct measure of ME of grazing grass
- Mineral analysis of forages by NIRS
- A full wet analysis service
- An integrated approach for data handling

In conclusion

- In the mid 90s silage analysis had a very poor press
- We have worked successfully for over the past 12 years to promote silage analysis and the need for it
- The techniques perfected at Hillsborough are now regarded as the benchmark methods
- The Hillsborough Feeding Information System is well regarded by the whole of the industry in Ireland for:-
 - the accuracy of the predictions
 - the quality of the service
 - the extent of the service
 - the speed of the service
 - it's independence