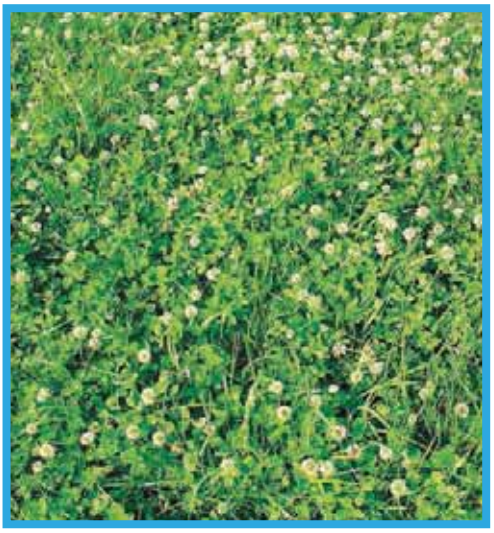
Improving the Welsh Dairy Supply Chain

GRASS VALUE

What is the value of grass?

Project Report



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GRASS VALUE

A Welsh version of this report is available on request.

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Contents

Acknowledgements

The project was led by John Owen and his team of dedicated recorders Matthew Rogers, Dafydd Morris and Lesley Griffith, who walked approximately 6,000 miles, taking around 40,000 field grass cover measurements over the three years of the project.

The project could not have happened without the cooperation and commitment of the twelve project farmers (listed on the map overleaf).

Other key individuals and organisations involved in the project included:

- Kingshay - analysed the data and prepared this report (www.kingshay.com).
- AgriNet - Grassland Management Software (www.agrinet.ie).
- Cled Richards, Agri Angels & Farm Consultancy Group - grass utilisation (www.fcgagric.com).
- Chris Duller - soil health and sward quality assessment.
- Staff from The Royal Veterinary College and the Welsh Regional Veterinary Centre at Gelli Aur - cow health.
- Kingshay Dairy Manager - herd performance (www.dairymanager.net).
- DairyCo Milkbench+ - financial benchmarking (www.dairyco.org.uk).

Introduction

In Wales we are blessed with some of the most favourable climates for growing grass in the whole of the UK. It means we can grow grass very efficiently and it makes economic sense to optimise the use of that grass.

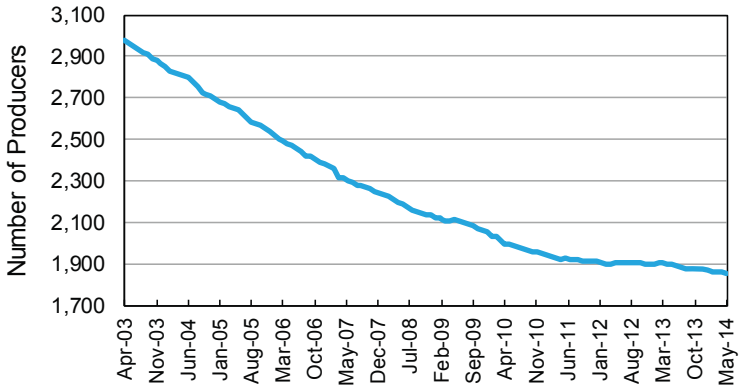
Dairy farmer numbers in Wales have been falling since the sixties, but there has been a rapid decline in recent years, the main reason for this has been the downward pressure on milk price and an increase in the cost of production. It is interesting to see that with the recent improvement in price how the rate of decline has slowed down. As a general comment Wales has always received a lower milk price than areas in England that are closer to the higher density population areas, so making the most of grass to keep production costs down is clearly a priority.

Milk from forage used to be a more common benchmark of performance and still has a very close correlation with profitability on forage based systems. The reason for the reduced interest in milk from forage as a performance indicator has been the increase in high input systems where milk from forage is not considered to be the right benchmark of performance. However on grazing and high forage systems 4,000 litres+ per cow of milk from forage is achievable.

The Grass Value project was set up to record grassland production and utilisation on dairy farms in Wales and to inform dairy farmers of the advantages of efficiently utilising the grass, so that they can gain a competitive advantage in the market. It was important that we selected a good cross section of farms across Wales, representing a range of different climatic conditions, altitude, soil types and production systems, including two organic farms.

We set a benchmark in the first year of recording in 2011, endured the wettest summer in 100 years in 2012 and the coldest and latest Spring for grass growth in 2013. Year 2 and 3 were very difficult seasons to manage and really challenged all farmers involved,

Figure 1 Welsh Producer Numbers

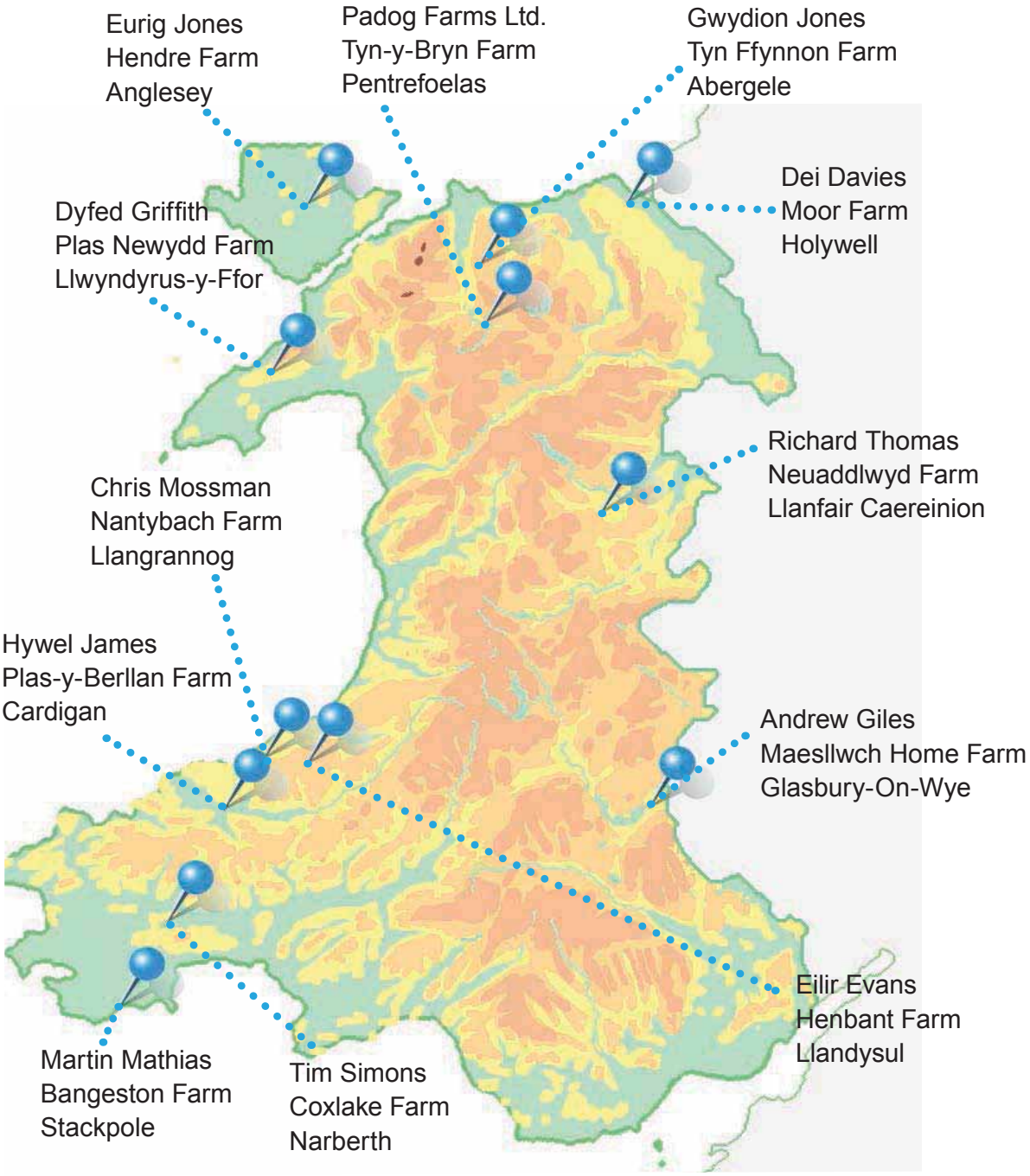


but conditions did highlight what is possible to achieve under the most difficult circumstances, if you have the right farm infrastructure and grassland management skills.

At this point I would like to thank all the farmers involved for their persistence and endurance in remaining involved in the project for the three years. I hope they found the project rewarding and that their involvement and experience has helped them to develop their skills and improve their farm output. I would also like to thank our dedicated team of recorders, Matthew Rogers and Dafydd Morris who have been with us from the start of the project, and Lesley Griffith who joined us in 2013, without their commitment and continuity we would not have been able to verify the outcomes of this report. Between them and myself, we have walked approximately 6,000 miles, taken around 40,000 field grass cover measurements and worn out several plate meters. I believe that this has been the most comprehensive commercial grass and performance recording programme ever carried out on farms in Wales and hope that other farmers will benefit from the results highlighted in this report.

John Owen, Project Officer

FIGURE 2 PARTICIPATING FARMERS



Project farms were selected from all the main milk producing areas in Wales, with a focus on producers that were keen to make good use of quality grass. The farms covered a range of rainfall and soil types and included a mixture of Spring and Autumn calving herds and two organic herds.

Any Welsh producer that wishes to increase the value that grass contributes to their herd performance and profitability, should be able to relate to one or more of these project farms in terms of location, size and system.

The main section of this report refers to the overall results from these twelve project farms. Further details on each individual farm and their specific findings can be found from page 36.

Summary

The purpose of the Grass Value project was to identify best practice from high performing farms, to be able to recommend methods for improving grassland management and utilisation on dairy farms across Wales. The weather conditions encountered in each of the three years were very different and at times challenging. For the project, this proved beneficial as it allowed the monitoring of grass growth and utilisation to be evaluated against management practices in the different growing conditions.

The summary of herd performance (Table 1) shows that the highest herd output was in 2011, where most project farms experienced less extreme weather than in the following two years.

The project farms averaged 37 weeks or 260 days grazing per year, with the highest achieving in excess of 290 days of full grazing in a year.

Table 1 Herd Performance

	2011	2012	2013	3 Year Average
Herd size	245	263	279	263
Replacement rate [1]	21%	25%	17%	21%
Yield per cow (litres) [2]	6,205	5,993	6,048	6,078
Litres per ha [2]	16,852	17,692	19,333	18,003
Milk solids per cow (kg)	453	437	442	444
Purchased feed per cow (kg) [3]	1,047	1,223	1,498	1,262
Yield from forage per cow (litres)	4,070	3,446	3,065	3,511
per hectare (l)	11,053	10,173	9,797	10,341
Stocking rate (cows per ha) [4]	2.72	2.95	3.20	2.96
Annual rainfall (mm)	936	1,251	1,037	1,075
Grazing weeks	38	35	39	37
Inorganic nitrogen (kg per ha)	209	211	224	214
Net Margin as % of output	33%	34%	27%	31%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

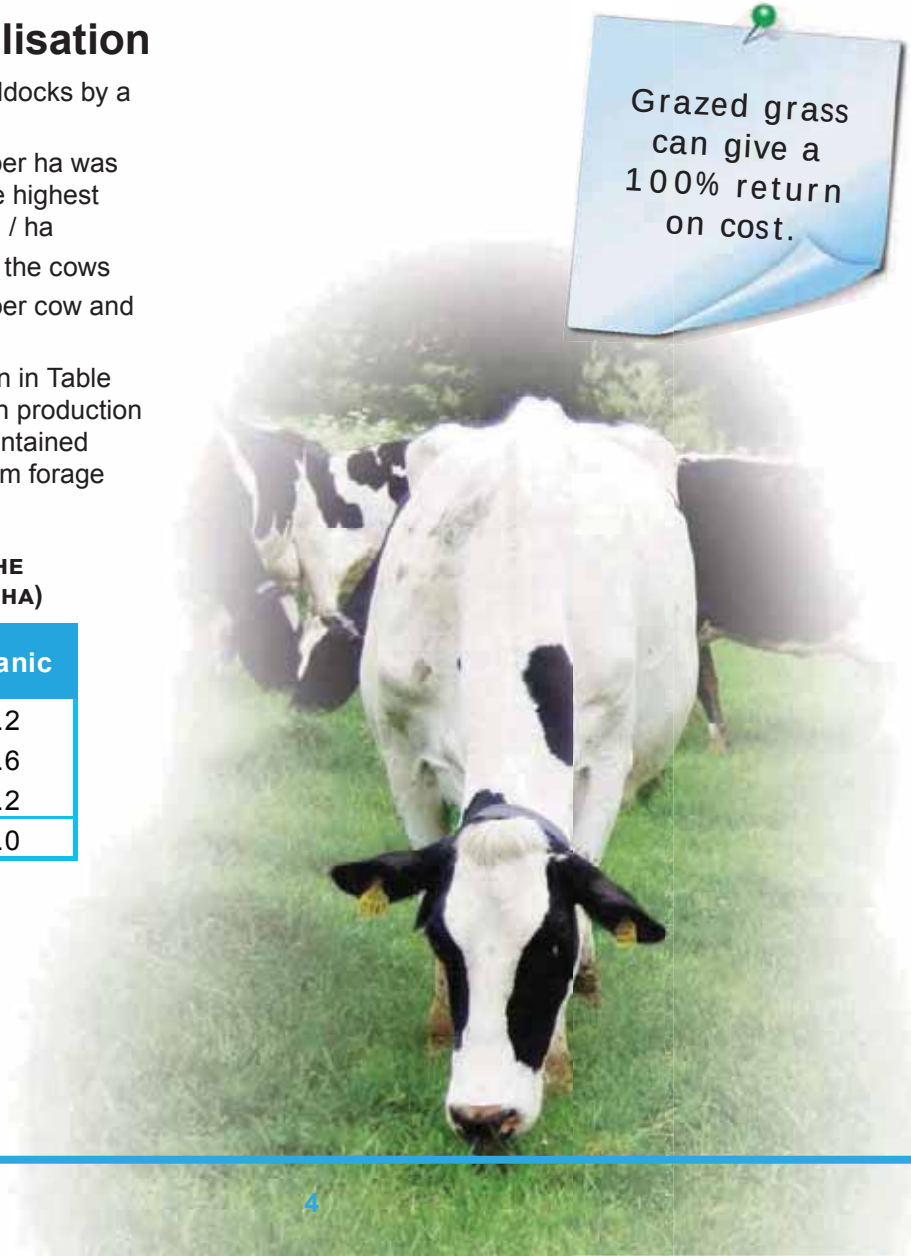
Grass Production and Utilisation

Weekly grass cover was recorded in all paddocks by a team of technicians:

- On average, 10.4 tonnes DM of grass per ha was grown on the twelve project farms. The highest yielding farm averaged 12.3 tonnes DM / ha
- 84% of the grass grown was utilised by the cows
- Milk from forage averaged 3,511 litres per cow and 10,341 litres per ha
- The variation from year to year is shown in Table 2. The cold Spring of 2013 impacted on production and whilst total output per cow was maintained through extra supplementation, milk from forage fell.

Table 2 Average Grass Grown on the Project Farms (tonnes DM / ha)

Year	Non-organic	Organic
2011	11.8	8.2
2012	10.8	8.6
2013	10.2	7.2
Average	10.9	8.0



The Value of Grass

Well managed grass has a production cost of £97 per tonne DM and a value of £197 per tonne DM - a 100% return on cost. This compares very favourably to conserved forages.

Achieving value from grass is not just the focus of block calving, low input herds. All but the highest yielding herds have potential to exploit well managed grazed grass and improve herd profitability.

Figure 3 Link between Grass Utilised and Net Margin (annual results)

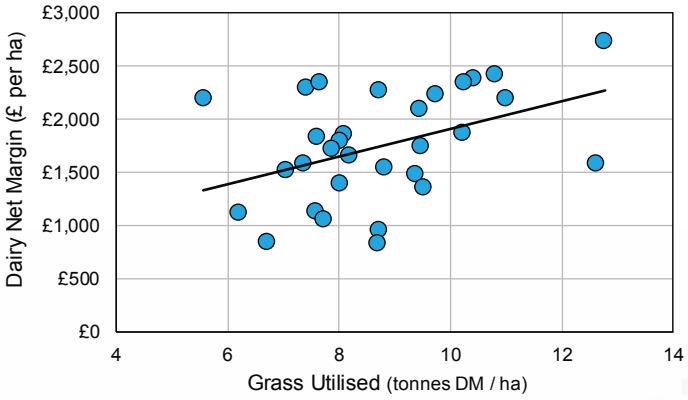
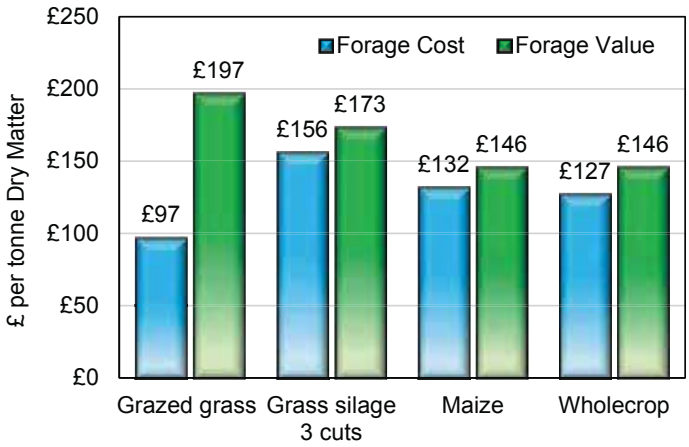


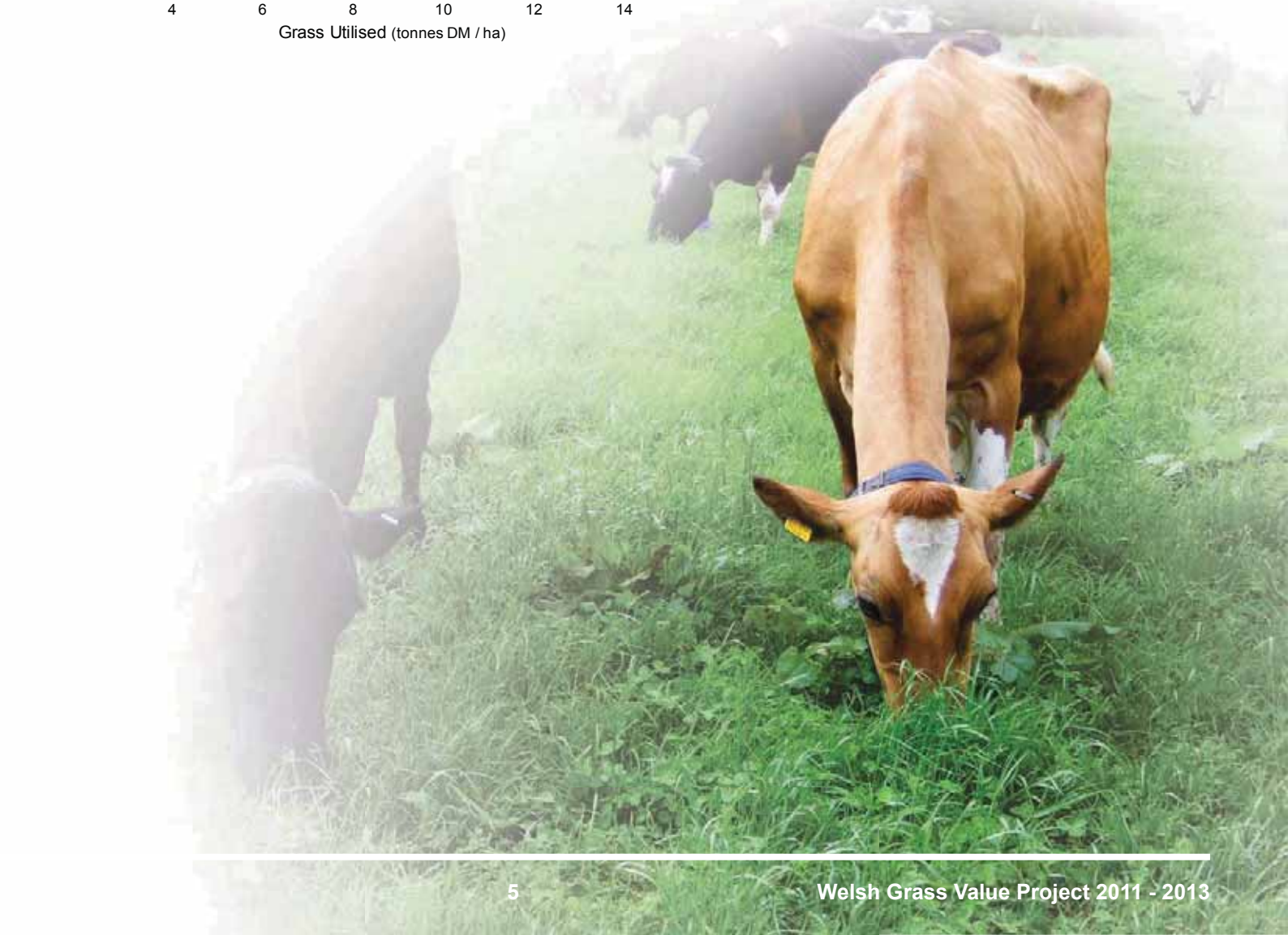
Figure 4 Forage Cost and Value



Impact of Grass Utilisation on Farm Net Margin

The full economic income and costs were evaluated on each farm.

Project farms that utilised more grass per hectare, produced more milk from forage per hectare and tended to have a higher net margin.



Key Management Points from the Project Farms:

Soils

Good physical soil structure, correct chemical and mineral balance and abundant biological activity is the key to soil health and grass growth. Issues such as compaction can reduce grass production and utilisation by over 1 tonne DM / ha.

Swards

- Well-managed, long-established permanent pastures can have a high ryegrass content and be as productive as many younger leys
- Rotational grazing opens up a sward and helps to encourage ryegrass growth
- Poor swards with less than 50% ryegrass content produced 25% less grass
- Swards with a high proportion of weed grasses recorded 14% less production
- Under organic management, swards with a high clover content produced 19% more grass than those with a low clover level. A sward with 30% clover can fix up to 200kg N / ha
- Within conventional non-organic swards, clover can reduce sward productivity.

Grass grows grass

The project farmers grazing higher covers produced more grass:

- Grazing a sward at too high a cover will increase wastage and reduce utilisation
- Grazing at too low a cover will mean potential growth is sacrificed.

Importance of measuring grass growth

Accurate measuring and recording of grass helps to keep control of grazing management and ensure supplements are used cost effectively. On all project farms there was a range in paddock performance, with the poorest 10% of paddocks typically growing half the grass of the 10% best performing paddocks on an individual farm. The project farmers used their records to cost effectively target improvements at under-performing paddocks.

Utilisation

Good paddock access is vital. 90% of paddocks on the project farms had good track access.

The right cow for the system

Ideally, the right cow needs to efficiently produce quality milk, whilst maintaining body condition, and is able to walk long distances and most importantly, get back in calf. Target 1 kg milk solids per kg of live-weight.

Flexibility

All the project farms had a flexible approach to grassland management.

This detailed study of these twelve project farms has clearly shown that focusing on producing the optimum dry matter yield of grass per hectare, combined with effective grassland management, results in high levels of grass utilisation, a good proportion of milk from forage, low feed costs and healthy profits –

TRUE VALUE FROM GRASS.

The Project

Throughout the three year project, detailed recordings were made of twelve project farms which were already utilising grass efficiently. This report gives the findings from the project and highlights the management policies and skills that are needed to take advantage of the value of grass under the favourable growing conditions throughout Wales.

Grass Recording

Accurate recording of grass production and utilisation was the key focus of the project.

Each week throughout the growing season the team of project technicians recorded the grass cover within each individual paddock, on each of the twelve project farms. Paddock covers were assessed with a rising plate meter and then recorded within the AgriNet Grassland Management Software program: www.agrinet.ie.

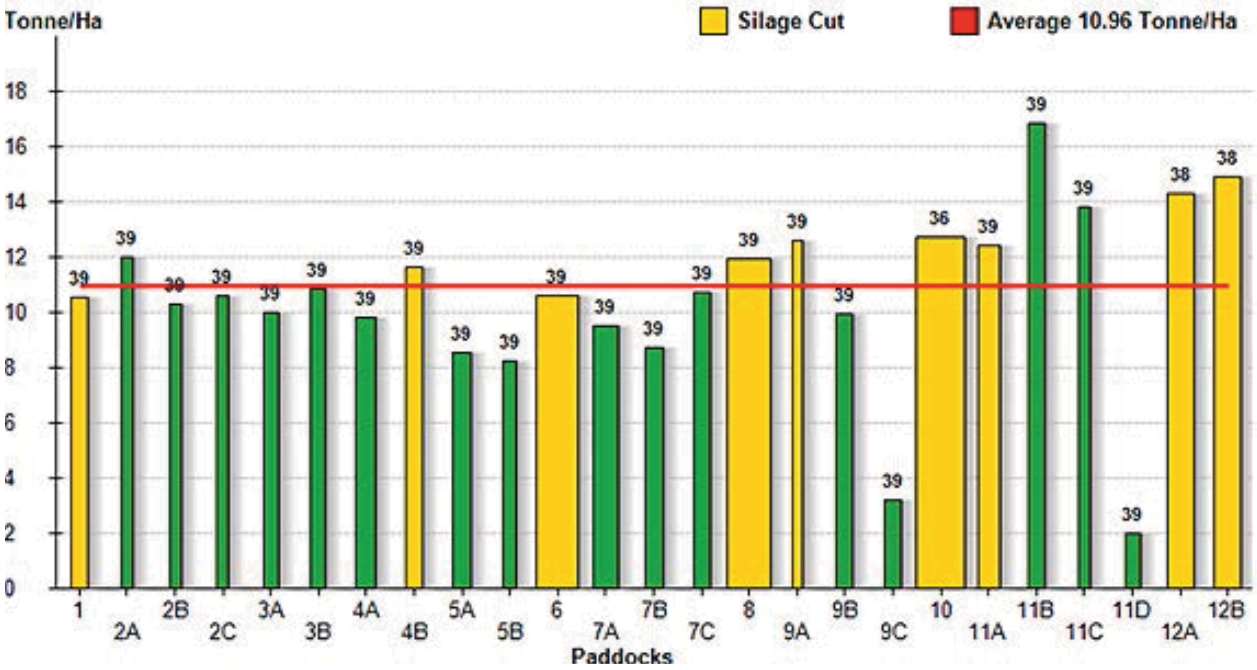
The program allows farmers to set a budget for the season, input weekly recordings to allow the calculation of average farm cover and growth, shows a visual grass wedge highlighting the forward supply of grass, plus allows seasonal and annual performance of paddocks to be compared.

Within the program, project farmers could also compare their grass production to others in the group week-on-week.

Grass Utilisation

The level of grass utilisation on each project farm was evaluated by taking into account the energy requirements for cow maintenance and milk production, less energy from imports of purchased feed and conserved forages from off the grazing platform.

Figure 5 Example Paddock Evaluation from AgriNet



Sward Quality and Soil Structure

Independent soil and grassland specialist Chris Duller carried out a detailed soil health and sward quality assessment on each paddock at the start of the project. Chris then re-visited the project farms in 2013 to carry out further evaluations, particularly focussing on under-performing paddocks and those that suffered poor grazing conditions during the wet Summer in 2012.

TABLE 3 SWARD EVALUATIONS

Positive Observations

	None / Very low (score 0)	Low (score 1)	Moderate (score 2)	High (score 3)
%ryegrass	Less than 30%	30-50%	50-70%	70%+
%clover	No clover	Less than 5%	5-15%	More than 15%
Sward density	More than 20% bare ground	20-10% bare ground	10-5% bare ground	Less than 5% bare ground
Rooting	Few roots below 5cm	Some roots extending below 5cm – not very dense	Good roots extending into subsoil – fair density	Excellent deep roots and high density
Earthworm activity	No earthworms or signs of activity	Less than 5 worms – small signs of activity	5-10 worms – worm channels and casts evident	More than 10 worms – lots of signs of activity

Negative Observations

	None (score 0)	Low (score 1)	Moderate (score 2)	High (score 3)
Weed grasses	Less than 30%	30-50%	50-70%	70%+
Broad leaf weeds	None	0-10%	10-20%	Above 20%
Soil structure	No signs of damage	Slight signs of compaction	Strong signs of compaction and temporary waterlogging	Large blocky structures, clear compaction layers

The sward evaluations carried out are summarised in the table above and each farm report included recommendations on actions required.

A soil chemical analysis was also carried out on each paddock evaluating pH, phosphorous (P), potassium (K) and magnesium (Mg) status.

Cow Health

To evaluate key aspects of cow health through the course of the project, Royal Veterinary College staff and students from the Welsh Regional Veterinary Centre at Gelli Aur visited all the project farms to assess cow body condition score (BCS) and mobility.

Herd Performance

Monthly herd performance was recorded within Kingshay Dairy Manager costings: www.dairymanager.net.
To allow clear comparisons between project herds within the analysis and in this report, milk yields have been converted to a standard litre (4% butterfat and 3.3% protein). Purchased feed use has been converted to an 86% dry matter equivalent.

Herd Profitability

The DairyCo Milkbench+ system was used to evaluate herd profitability each year. To allow comparisons between the herds in this project, external impacts were removed by:

- Applying a standard milk pricing formula
- Using a standard purchased feed cost per tonne
- Calculating a replacement cost for herd maintenance.

The Value of Grass

The choice of forages and purchased feeds fed on any dairy farm will depend on a number of inter-locking factors including:

- Herd production objectives
- Cow requirements
- Farm conditions and constraints
- Agronomy skills
- Crop growing costs.

Figure 6 Forage Choice

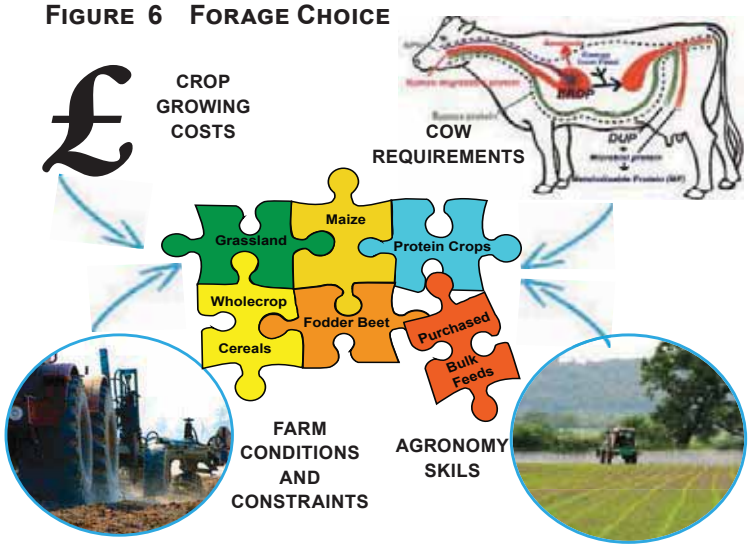
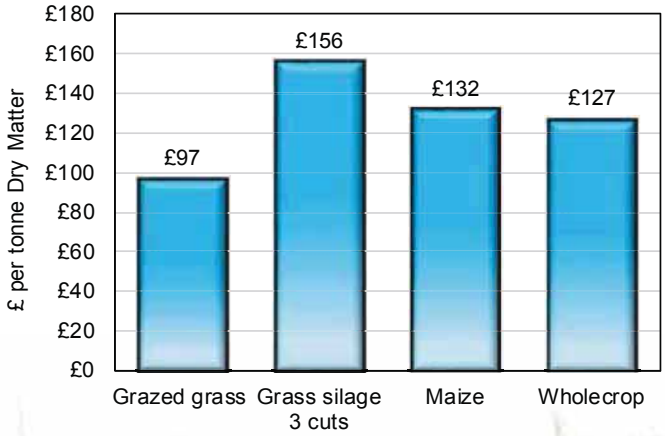


Figure 7 Forage Production Costs per Tonne of Dry Matter

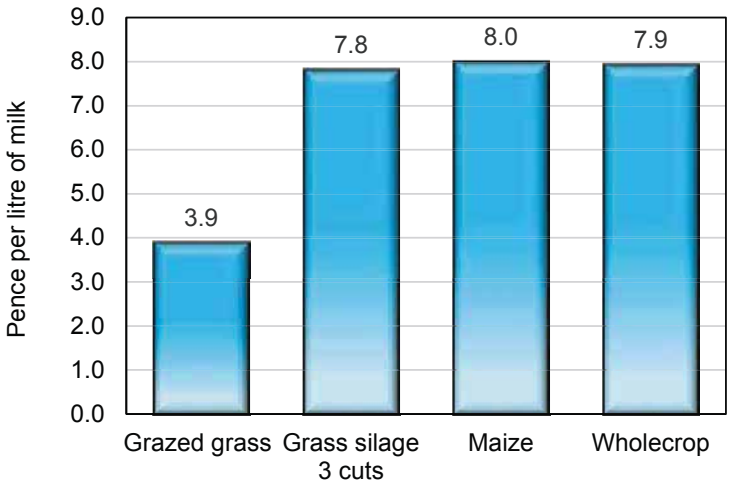


Many areas of Wales offer an ideal climate for high yields of grass to be grown, and with good utilisation at grazing, is relatively cheap feed.

Evaluating the full production costs of each forage, including establishment, growing, harvesting costs, plus overheads including land rent and storage, highlights the differences between forages.

With growing conditions typical of those found on the project farms, well managed grazed grass has a production cost of £97 per tonne of dry matter, over 25% less than other forages (Figure 7).

Figure 8 Forage Production Costs per Litre of Milk



Expressing the forage costs in terms of the cost to produce a litre of milk (Figure 8) allows the different forage, energy and protein characteristics to be taken into account.

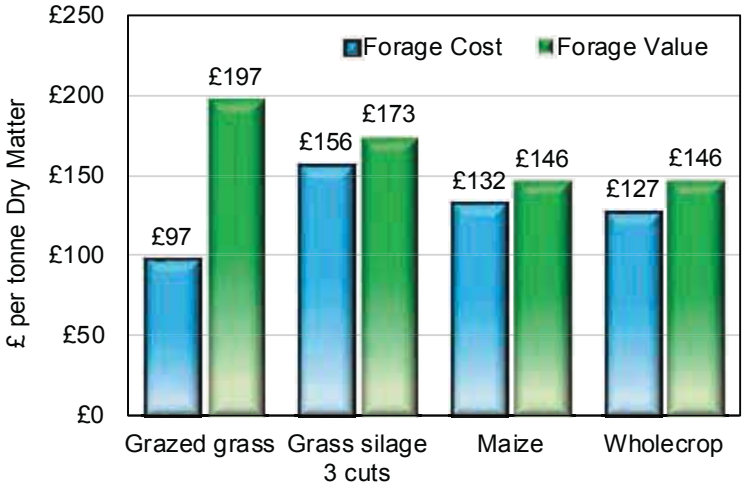
On this basis grazed grass can be grown for 50% of the costs of conserved forages. These costs are based on the yields and utilisation of grass achieved by the farmers in this project.

Well managed grazed grass can be grown for 50% of the cost of conserved forages.

The feed value of forages can be evaluated relative to purchased energy and protein feeds. The below graph shows the forage cost and value relative to purchased wheat and soya.

Grazed grass with a cost of £97 per tonne DM and a value of £197 / t DM, gives a margin of £100 per tonne of dry matter or a 100% return – much higher than other forages.

Figure 9 Forage Cost and Value



It's how you manage it

Simply growing grass does not mean it will be cheap and cost effective – it needs to be grown and utilised efficiently.

Even within this project, which evaluated farmers who were focused on efficient grass production and utilisation, there was a range of £109 per tonne of dry matter in growing costs, between the best and the worst paddocks across all the project farms. (Figure 10)

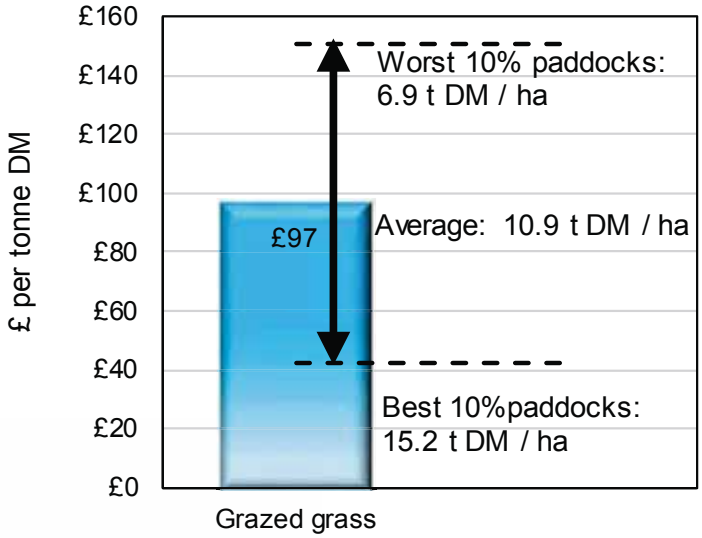
Managing grass to optimise yield and quality can cost more, but this higher cost is more than compensated by the extra yield and lower cost per tonne.

A place in most systems?

The variable growth rate of grass and relatively low dry matter in wet conditions means that it is not suited to all systems and higher yielding cows will need appropriate supplementation.

Achieving value from grass is not just the focus of block calving, low input herds. All but the highest yielding herds have potential to exploit well managed grazed grass and improve herd profitability. Many herds with yields up to 9,000 litres per cow achieve a proportion of their yield from forage, with a good share of this from grazing. With the right infrastructure and effective management, grazed grass can replace more expensive conserved forages without compromising yield, leading to increases in herd profitability.

Figure 10 Range in Production Cost of Grazed Grass (non organic farms)



The difference between best and worst paddocks is valued at £109 per tonne DM or £404 per ha.

Achieving the Value

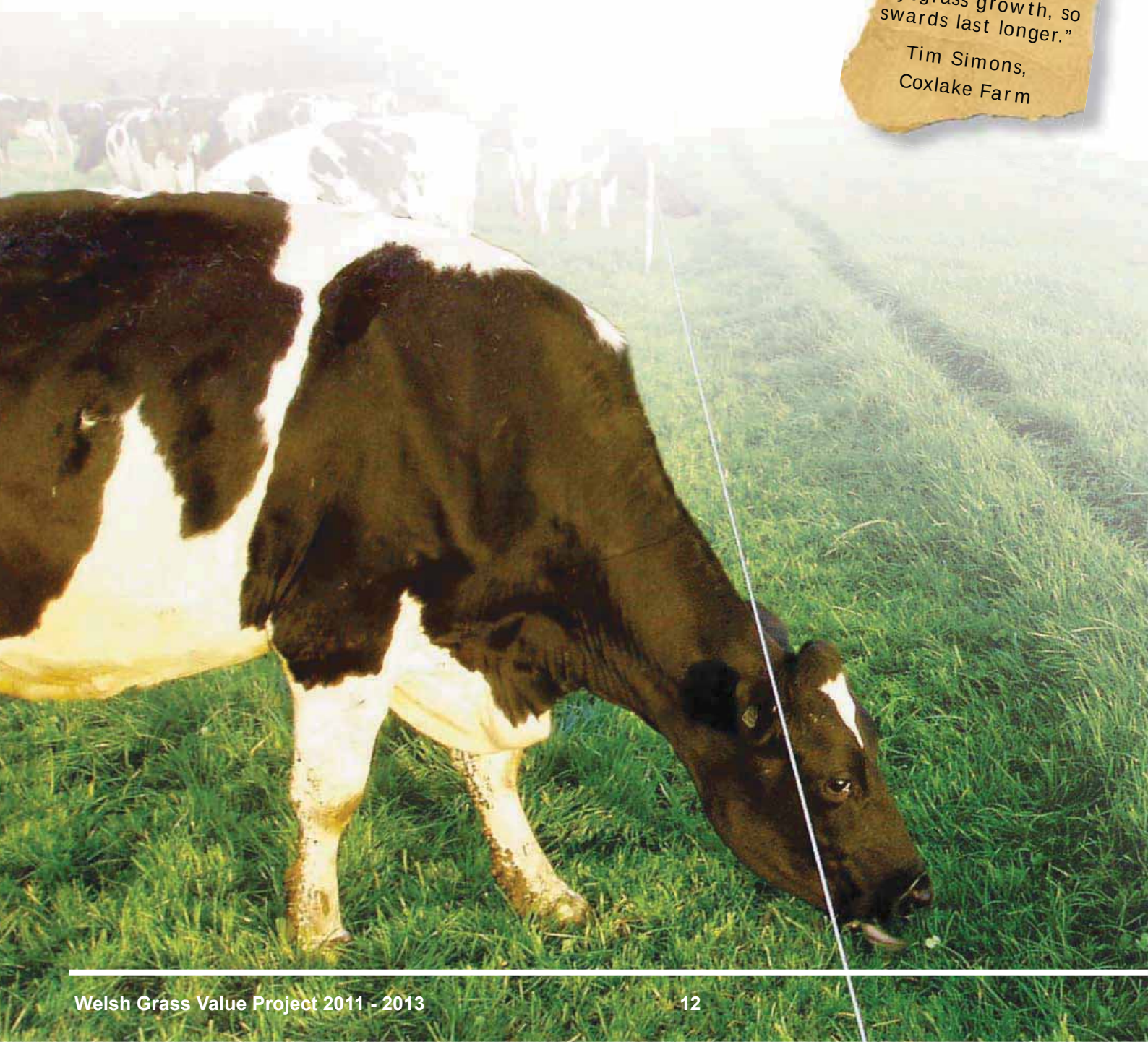
A key purpose of the Grass Value Project has been to highlight the link between effective production and utilisation of grass and farm profit. The wealth of grass recordings and farm data collected has shown that to get the greatest value from grass, everything has to be right from the ground up. The key is for an individual farmer to apply their management skills to make the most of the farm resources available to them.

To highlight the key findings from the project, the results are presented to follow the natural process from the soil resource, through the species grown, to the nutrients fed, to the grass produced and the management to ensure effective utilisation, to cost efficient milk production and the resulting business profitability.

Soil → Grass species → Nutrients → Production → Utilisation → Milk production → **Profit**

"Rotational grazing encourages ryegrass growth, so swards last longer."

Tim Simons, Coxlake Farm



Soil as a Living System

Soil is the greatest natural resource of any farm and sustains the sward physically, chemically and biologically. A healthy soil will be alive with microbiological life - how it is managed impacts on sward productivity and subsequently livestock performance and health.

Target:

Good physical soil structure

Correct chemical and mineral balance

Abundant biological activity.

The crop growing capability is determined by soil moisture. The limiting factors for crop growth are infiltration rate (drainage), water-holding capacity, soil structure, compaction and rainfall. The twelve project farms covered a range of soil types, from peat, to heavy clays to light loams, sharing different challenges of low or excessive rainfall, and at times, unseasonal temperatures.

The grass growth was evaluated relative to soil type. To limit the impact of different nitrogen regimes, paddocks receiving 200 to 300 kg nitrogen per hectare were compared and the results are shown in Figure 11.

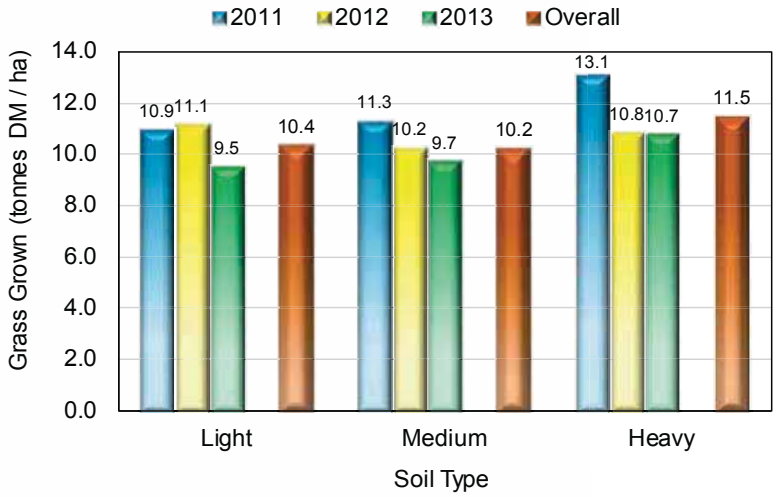
Over the three year period heavy soils produced just over 1 tonne more DM / ha compared to medium or light soils.

Within this average:

- Early Spring and Autumn grass growth was relatively similar across the soil types
- Grass growth was less on lighter soils during the drier Summer of 2011, but greater in the wet Summer of 2012
- All soils suffered restricted growth during the cold Spring of 2013 and improved production later in the year didn't make up for this loss.

These results show that although soil type has a significant influence on grass production, as would be expected, the management of that soil is a key factor.

Figure 11 Grass Production relative to Soil Type
Paddocks receiving 200 to 300 kg N / ha



Evaluating Soil Condition

Dig 50 cm x 50 cm (1½ sq. ft.) soil pit and assess how well the soil is working.

TABLE 4 ASSESSING SOIL CONDITION

	What to look for	Importance
Soil Temperature	The soil ideally should be relatively warm to the touch	If the soil is warm it indicates that air is penetrating, allowing plant growth to start earlier in the Spring and extend later into the Autumn
Soil Moisture	The soil should not be waterlogged or dehydrated	For efficient transfer of nutrients it is important that there is the right amount of moisture in the soil. Too much and the soil becomes anaerobic, too little and there is not enough moisture for the transfer of nutrients
Soil Aroma	Pleasant "earthy" smell	Indicates that the microbial soil system is working well
Soil Compaction	Open crumb structure with a variety of aggregate size	Compaction reduces the number of pore spaces in the soil available for air, moisture and roots. This will affect rooting depth, nutrient transfer and earthworm population
Soil Organic Matter	All plant organic material digested, with no material left from previous years	Plant organic material, such as maize stubble left from previous years, indicates that the soil is not cycling nutrients efficiently
Grass Root Mat	Well dispersed roots down through the soil profile	Indicates good soil structure, allowing roots to freely go down through the soil for moisture and nutrient extraction Shallow rooting indicates compaction or a lack of soil structure
Clover Root Nodules	Multiple pinkish white nodules on the roots	Shows that clover is fixing nitrogen efficiently
Surface Moss	Lack of moss	Moss indicates soil capping and poor nutrient cycling

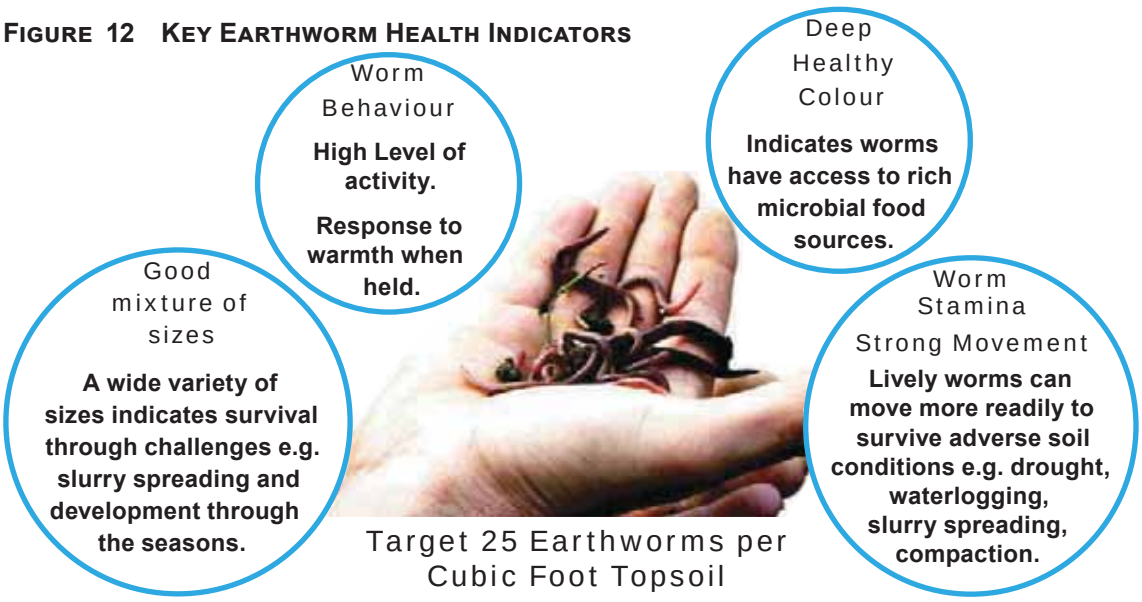
Earthworm Activity

Soil has one of the most diverse and complex biological communities with different groups of organisms that perform key roles in nutrient cycling, suppression of plant pathogens, decomposition of organic residues, degradation of pollutants and the maintenance of soil structure. Earthworms are the most visible of these organisms and a good indicator of soil quality, plus they also help to aid the recovery of a damaged sward.

When digging a hole in suitable conditions, in a healthy soil expect to find 25 worms in a cubic foot of soil.

Paddocks were assessed for worm activity but no link was found with grass production. This was partly due to the earthworms being less visible during winter assessments where soils were cold and low activity would be expected.

FIGURE 12 KEY EARTHWORM HEALTH INDICATORS



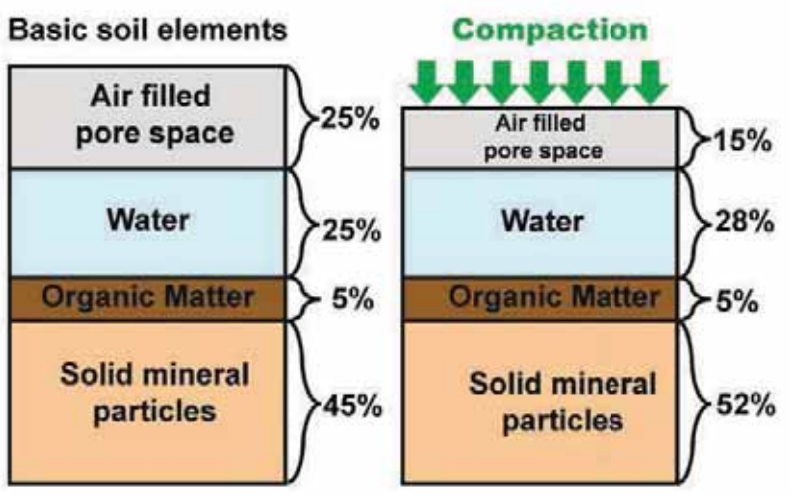
Compaction

From a soil physics viewpoint, soil consists of solid mineral particles, organic matter (OM), water and pore spaces filled with air and gases. To maximise plant productivity and nutrient content the soil needs to provide adequate air movement and water. The ideal distribution of these portions is generally accepted as 50% solid, 25% water and 25% air.

Compaction is the reduction of the total pore volume which can either contain water or air. Compacting soil reduces air-filled pore space only. This initially results in a higher percentage of water in the total soil volume (see Figure 13) which causes a number of physical and biological consequences:

- It affects the balance of oxygen and water in the soil which can reduce microbial activity and plant nutrient uptake
- It causes reduced air movement which limits biological activity
- There is less soil water storage capacity
- Root penetration is reduced
- Drainage is reduced.

Figure 13 Soil Compaction



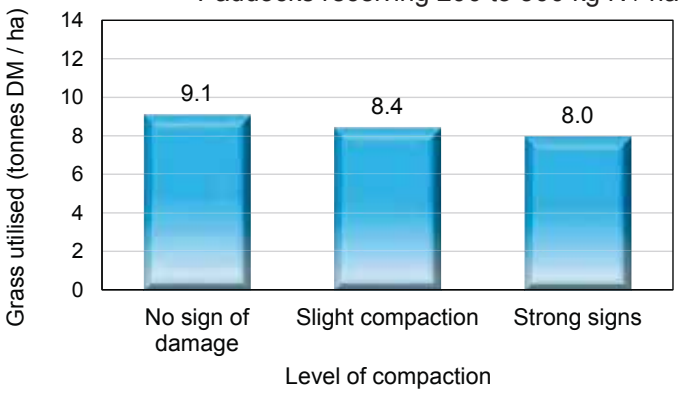
Soil compaction is either seen as surface compaction from trampling and poaching from grazing cattle in wet conditions or at a high stocking density, or deeper compaction from tracking or heavy machinery.

Paddocks were assessed for signs of soil compaction between one and two times during the project. Swards with a higher level of compaction had lower grass production and less of the grass grown was utilised. Figure 14 shows the impact of compaction on grass utilisation. This difference was more pronounced during the Summer. This highlights the issue of soil compaction not just limiting grass production, but causing paddocks to be less free draining, reducing utilisation. Paddocks with compaction also tended to have a lower proportion of perennial ryegrass in the sward and a higher weed infestation.

No link between compaction and earthworm activity was found although other research has shown double the earthworm burrows in soils without compaction relative to those with signs of compaction.

Following the poor grazing conditions during 2012, several of the heavier land project farms had paddocks showing increased signs of compaction. With relatively favourable weather conditions post Spring 2013, many soil structural problems had an opportunity to recover on their own but some required some sort of remediation to maintain sward productivity. It is key to assess the point of compaction to select whether sward aeration, sward lifting or subsoiling is the most appropriate remediation method.

Figure 14 Grass Utilised Relative to Soil Compaction
Paddocks receiving 200 to 300 kg N / ha



"We out-winter on our light land farm and then re-seed but the grass recording has shown relatively poor growth from these re-seeds. We now focus more on improving soil health."

Martin Mathias, Bangaston Farm

Nutrients Important For Plant Growth

Three of the major elements; carbon, oxygen and hydrogen are obtained by the plant from the air and water in the soil and in the atmosphere. For all practical purposes the supply of these essential major elements is inexhaustible unless conditions are dry. Plants must obtain the remainder of the essential nutrients from the soil. Whilst there are a whole host of essential nutrients the key elements are nitrogen (N), phosphorous (P) and potassium (K).

For healthy grass growth, the soil chemical nutrient status and pH needs to be determined by analysis, before any amendments are made.

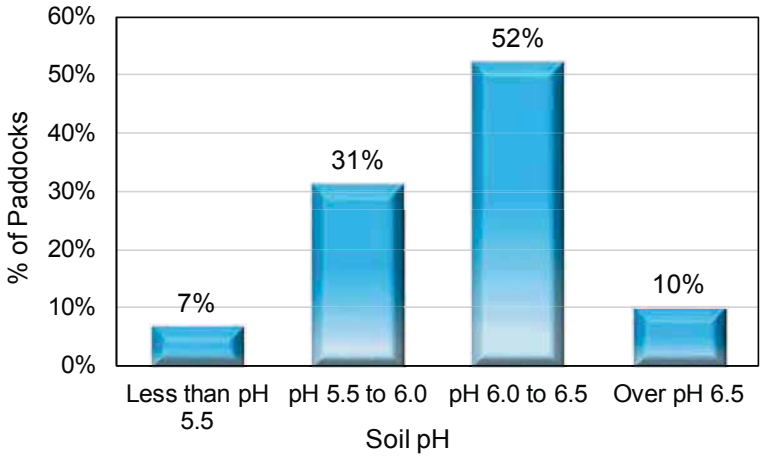
Soil pH

The soil pH (alkalinity or acidity) has a significant impact on the plant's ability to take up nutrients, which will affect grass growth and potentially, forage quality.

Incorrect pH affects nutrient availability:

- High pH - manganese, iron and boron are less available
- Low pH - calcium, magnesium and molybdenum are less available
  - aluminium, iron and zinc are more available
  - Lower uptake of applied nutrients, particularly phosphorous
- Essential soil micro-organisms i.e. nitrifying bacteria are inhibited at lower pH.

Figure 15 Soil pH



All the paddocks recorded in the study were analysed for pH. 38% had a suboptimal pH below 6.0, which although an improvement relative to the national position, highlights the potential for higher yields.

Evaluating grass production from the low pH paddocks did not identify a production loss, but other research has shown a 9% loss in dry matter production in swards with a pH of less than 5.5 (Table 5).

Table 5 DM Losses in Grass due to Low pH

Soil pH	<4.5	4.5-5.0	5.0-5.5	5.5-6.0	6.0-6.5
Loss %	13%	12%	9%	4%	0%

Source: Defra

Grass needs a pH above 6.0 while clover will only thrive soils with a pH above 6.5.

Nutrient Applications

Matching nutrient application to crop requirements is essential to the farm's productivity, profitability and environmental health, so that over applications (leading to losses to the environment or residual build-up of P and K indices) as well as under applications (leading to reduced grass production), are avoided. Even at optimum levels, when P is 100% available to the plant, only 60% will be taken up by the crop, resulting in inevitable P index residuals being stored in the soil. Soil sampling is therefore essential so that pH and indices are corrected to achieve maximum efficiency and productivity. Grass takes up nutrients in order of its requirements N > K > Na > Mg > Ca.

The first N application of inorganic fertiliser of the season, where you can achieve between 90 – 100% efficiency, is when the soil temperature at 10 cm (4") depth reaches and remains at 5 to 6ºC.

The average artificial nitrogen use on the non-organic project farms was 255 kg / ha.

Evaluating the nitrogen response on the project farms highlights the large variability in grass production relative to the level of N applied, (Figure 16). Significant variability was seen across all farms.

To evaluate performance within farms, the grass production of each paddock in each year was evaluated against the farm average for that year. The paddock production could then be assessed relative to the farm average and then corresponding impacts evaluated.

There was a clear correlation, with the best paddocks giving a greater response to the N applied (Figure 16).

P and K soil reserves are also critical to plant growth, with P particularly necessary for the development of new roots and K for its key role in the transport of sugars and other carbohydrates in the plant.

Of the paddocks recorded within the project, 91% had optimal P and 96% had optimal K levels.

Figure 16 Grass Response to Nitrogen Application Total bag and manure N
(annual results of non-organic farms)

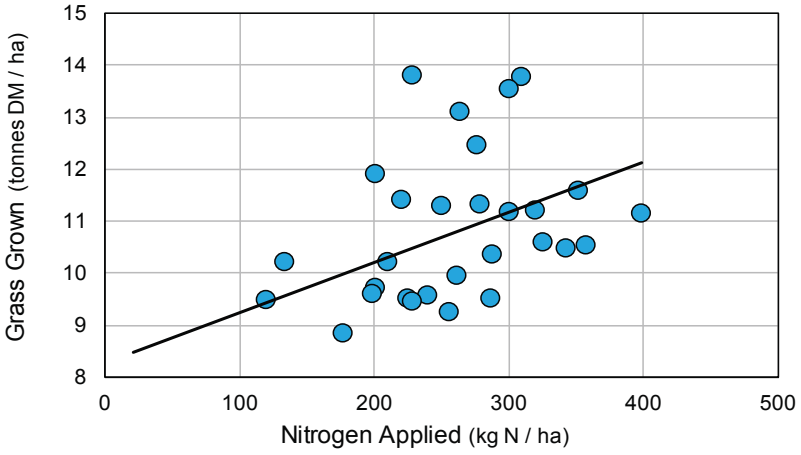
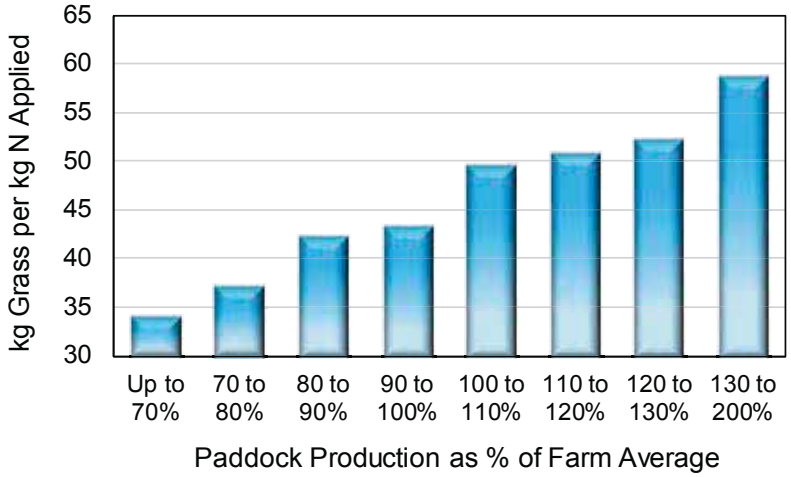


Figure 17 Grass Response to Nitrogen Application (total bag and manure N)

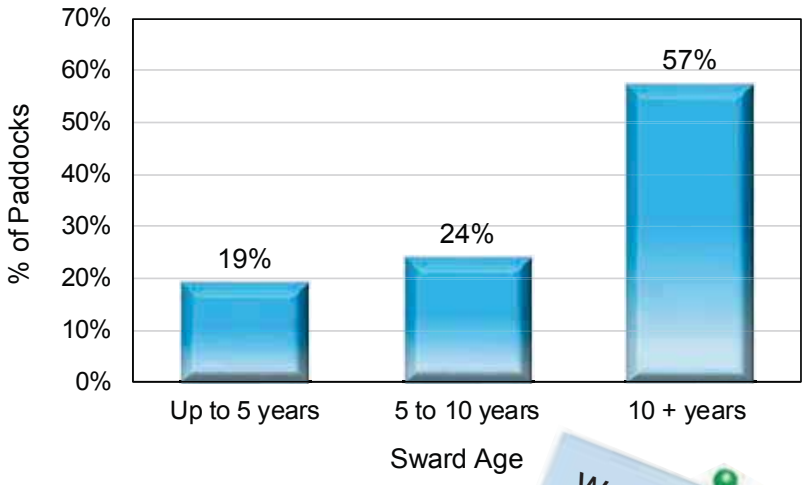


Sward Quality

To achieve high levels of milk from grazing and forage, grass quality is vital. Many farmers expect to re-seed paddocks as a matter of course after they are a certain age. Whilst that may be beneficial when part of an arable rotation, the detailed recordings from this project show that with the right management, long established permanent pastures can have a high ryegrass content and be as productive as many younger leys.

Figure 18 shows the majority of paddocks recorded within the project were 10 years or older. Little difference in the recorded grass grown or utilised could be found when evaluating by age of sward.

Figure 18 Sward Age



Well managed permanent pastures can be as productive as many younger leys.

Coxlake Farm achieved one of the highest levels of grass production in the project, while having swards that are all over ten years old.

Whilst this is not a detailed study of the benefits of re-seeding, it does show that with good rotational grazing management the productivity of swards can be maintained.

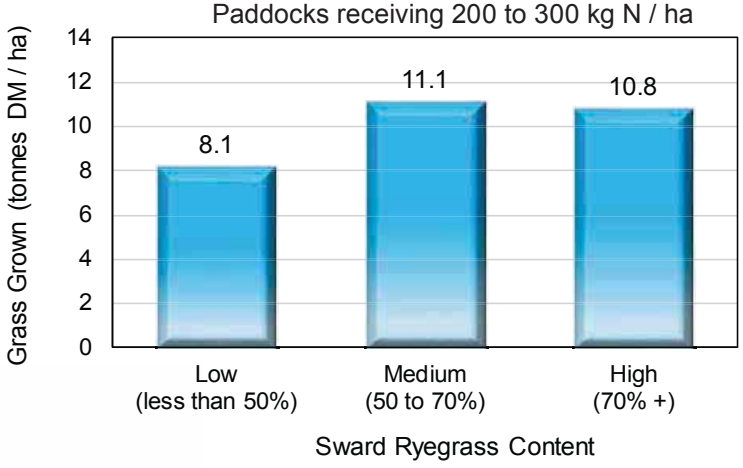
Sward Ryegrass Content

Consider reseeding / oversowing paddocks with less than 50% ryegrass content.

Paddocks were evaluated for the content of perennial ryegrass as a proportion of the sward, compared to other less responsive grasses. To remove the impact of different nitrogen regimes, the grass production of paddocks receiving 200 to 300 kg N per ha was evaluated. Figure 19 shows that swards with less than 50% ryegrass produced 25% less grass.

To accommodate herd expansion at Nantybach Farm, neighbouring permanent pastures were taken on that had previously been grazed by sheep. The grass production on this land was increased through nitrogen applications and rotational grazing, without the need to re-seed. The rotational grazing helped to open up the sward, promoting ryegrass growth and improving sward composition.

Figure 19 Grass Grown Relative to Sward Ryegrass Content
Paddocks receiving 200 to 300 kg N / ha



Rotational grazing opens out the sward and helps to encourage ryegrass growth.

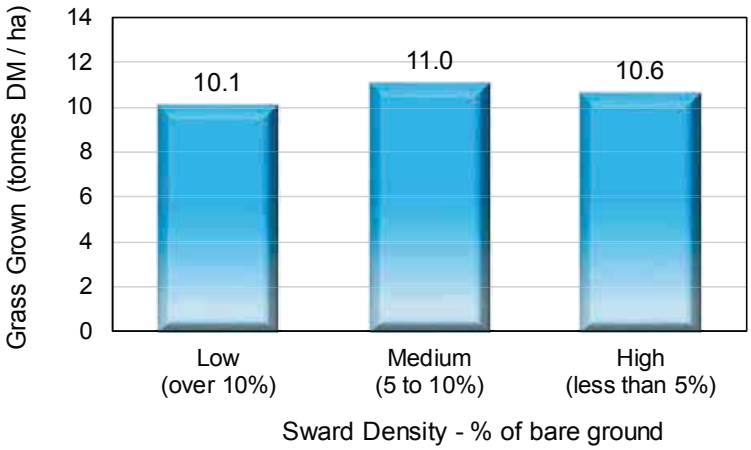
Sward Density

Denser swards will be more productive, capturing more of the available sunlight, give less opportunity for weeds to establish and have improved stock carrying capacity.

Paddocks were assessed for sward density by evaluating the proportion of bare ground. Assessing the results, there was a slight tendency for more open swards to be less productive but the majority of the paddocks assessed were medium to high density.

Swards with a higher density tended to have a higher ryegrass content, less weeds and a higher clover content.

Figure 20 Grass Grown relative to Sward Density
Paddocks receiving 200 to 300 kg N / ha



Weed Grasses

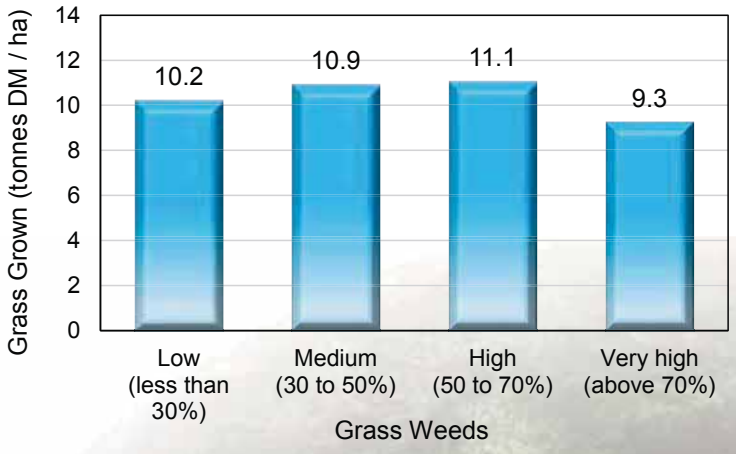
Swards were assessed for the level of weed grasses and broad leaved weeds.

Swards with a high proportion of weed grasses recorded 14% less grass production than those with a lower proportion.

The level of broad weed infestation was also assessed but the majority of paddocks did not have levels high enough to impact on grass production.

Establishing and maintaining a clean sward, supplying optimum nutrients and rotational grazing will help to maintain a denser sward.

Figure 21 Grass Grown relative to Weed Grasses
Paddocks receiving 200 to 300 kg N / ha



Selecting Grass Mixtures for Reseeding

Where reseeding was required, the majority of the project farmers selected mixtures with late heading perennial ryegrass varieties. Some chose off-the-shelf mixtures, whilst others specified individual grass varieties most suited to their system.

A seed mixture designed specifically for grazing should include varieties selected for characteristics such as sward density and, particularly for Spring calving herds, early season growth.

Whichever mixtures are chosen, ensure that varieties are in the Recommended Grass and Clover Lists: www.dairyco.org.uk/rgcl.

Clover in Swards

White clover increases sward palatability, digestibility and protein levels. When this legume makes up about 30% of the established sward it is able to fix up to 200kg N/ha, reducing the need for bought in nitrogen fertiliser. White clover is essential in organic swards to fix nitrogen but in conventional swards can complicate the sward management and if levels are too high, reduce sward productivity.

Figure 22 Grass Grown relative to Clover Content in Non-Organic Swards
Paddocks receiving 200 to 300 kg N / ha

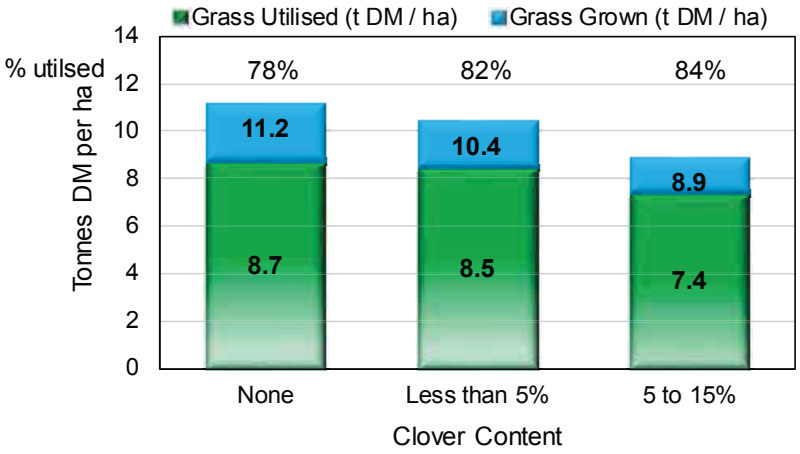
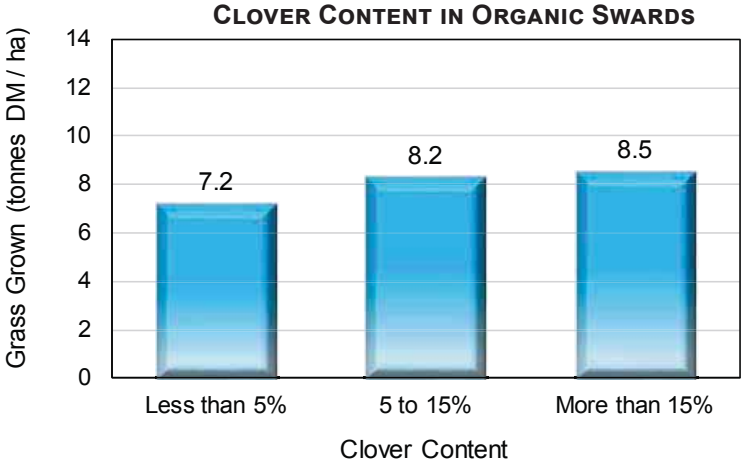


Figure 23 Grass Grown relative to Clover Content in Organic Swards



Clover in Organic Swards

Clover is an essential component of an organic sward.

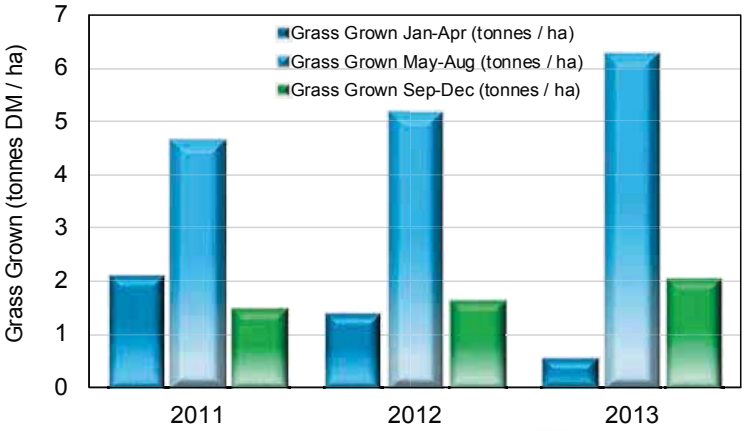
Swards with a high clover content produced 19% more grass than those with less than 5% clover (Figure 23). In addition, the high clover swards had a greater ryegrass content, less weeds, less compaction and a greater worm population.

The high clover swards were also found in more of the paddocks with an optimum soil pH.

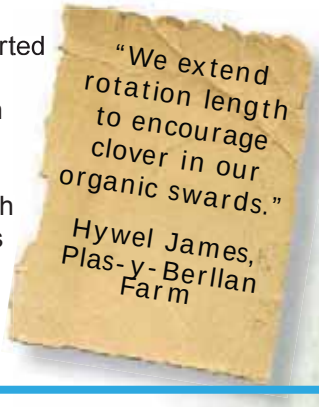
Clover in Non organic (conventional) Swards

In conventional swards, those paddocks with a higher clover content tended to have lower grass production but that grass was better utilised (Figure 22). Overall the amount of grass utilised from the high clover paddocks was 14% lower but other factors influenced this result, including the fact that a greater proportion of the high clover content paddocks had a sub-optimal pH.

Figure 24 Grass Grown at Maesllwch Home Farm



In 2013 Maesllwch Home Farm reverted from organic back to conventional. Fertiliser was applied from May, with a seasonal total of 178 kg / ha N applied. Both the mid-season and Autumn grass growth responded with an extra 1.8 tonnes DM / ha of grass grown, compared to the mid-season and Autumn growth in 2011 / 2012.

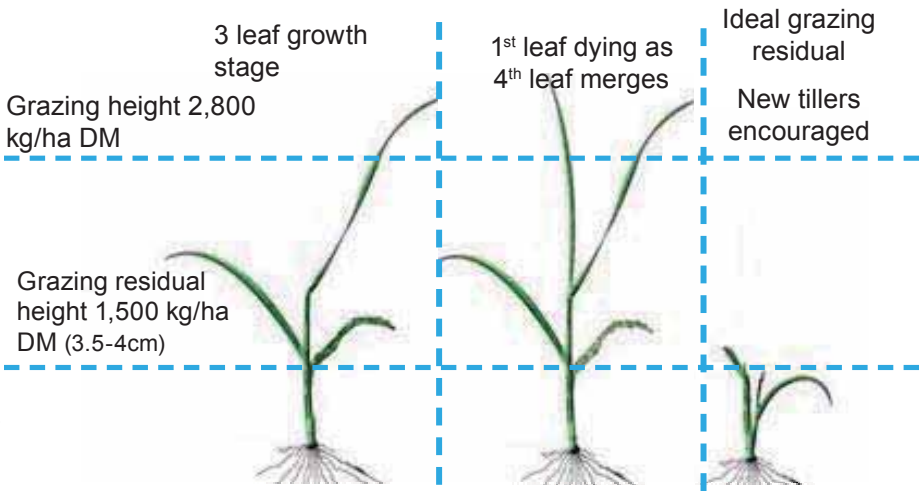


Factors affecting grass growth

To achieve high yielding swards and good utilisation, swards must be grazed at the correct time. Implementing grazing management strategies that coordinate grazing with grass growth stages can stimulate increased herbage production by up to 45%. Rotational grazing suits the growth habit of perennial ryegrass.

Ryegrass shoots have only 3 living leaves at any one time; one recently emerged and actively growing, one fully developed and one senescing, starting from the leaf tip. As a fourth leaf emerges the first leaf desiccates and dies. This produces continuous turnover of plant tissue within a sward.

Figure 25 Grass Growth Stages



Aim to graze at three leaves to maximise grass quality.

Grass plants produce tillers (shoots) which in turn produce leaves. This process is influenced by the frequency of defoliation as the removal of existing tillers encourages the germination of new ones. Continuous grazing systems encourage a succession of tillers, producing a dense population of young tillers. Rotationally grazed grass has less tillers which are generally older but have higher growth rates.

Grazing and plant reserves

The amount of leaf area capable of conducting photosynthesis that remains after defoliation affects the quantity of herbage produced. Severely defoliated plants depend on stored carbohydrates for new plant growth which restricts growth rates whilst new photosynthetic material is produced.

Plants with sufficient leaf area remaining after defoliation utilise only small amounts of stored carbohydrates for development of new leaf tissue and newly produced photosynthesis are allocated to areas of active growth. Grazing at three live leaves is essential, it defines rotation length and ensures optimal grass quality.

Aim to leave swards with approximately 1,500 kg DM / ha after grazing.

Grass Budgeting and Monitoring

Effective grass budgeting and monitoring will help to graze swards at the optimum time. Weekly monitoring of the grazing platform with a plate meter or other effective method, creates a weekly wedge to identify grass availability for the current grazing rotation (i.e. 21 days).

Understanding the typical grass growth curve is the key to weekly management of grass. The main challenge is the uneven grass supply throughout the year. This, in combination with yearly weather variations, makes it important to monitor grass growth at least weekly and adapt plans accordingly.

The 'pasture wedge' is a simple method used to interpret this data. A profile of the kg DM / ha in each paddock, from highest to lowest visually illustrates the current and forward grass supply on the farm. A line is superimposed onto the graph calculated from the intended herd demand, rotation length and grazing residual.

Figure 26 Typical Grass Growth

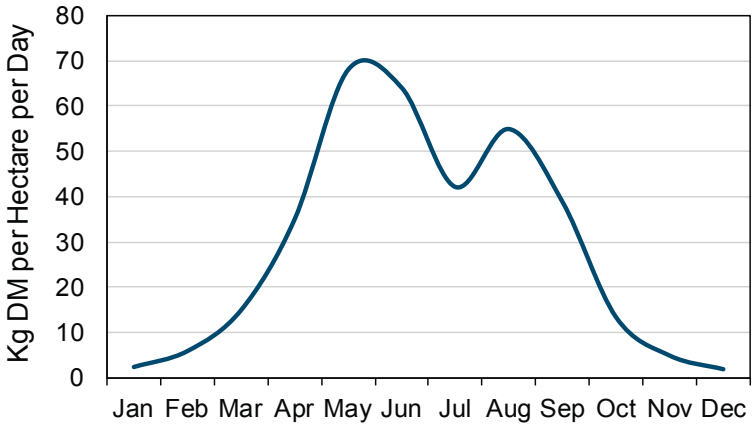
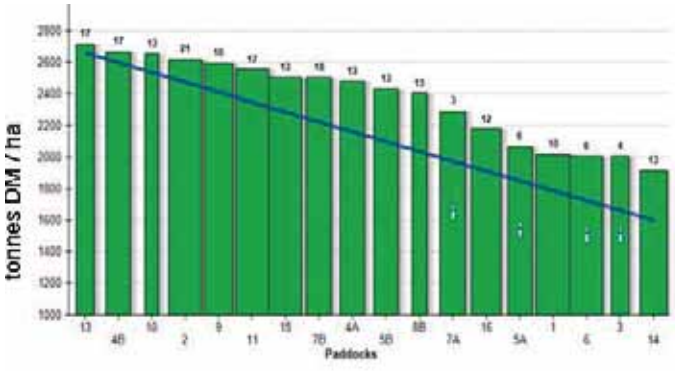
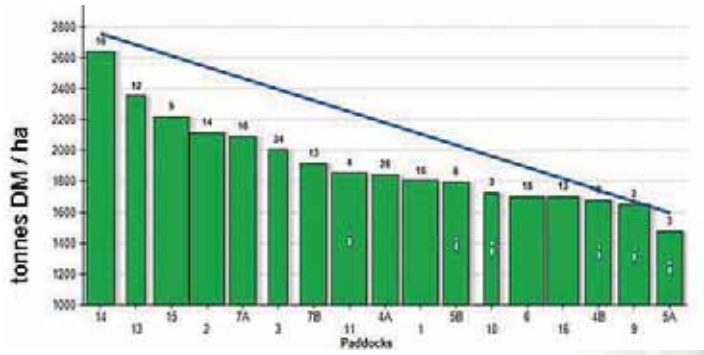


Figure 27 Example Grass Growth Charts from Bangeston Farm

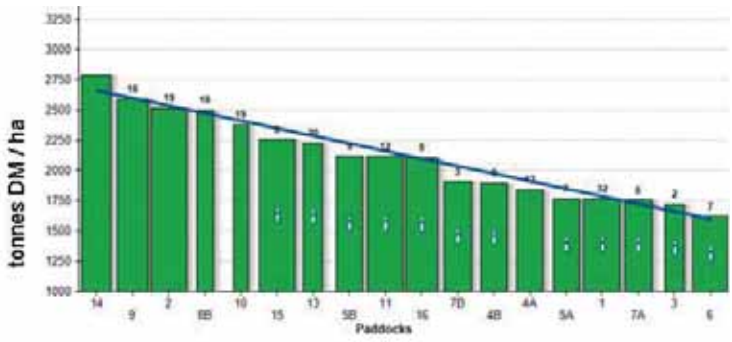
Surplus Building Up - Growth greater than feed demand



Shortfall Ahead - Growth less than feed demand



Ideal Farm Cover - Growth matched to feed demand



The Importance of Monitoring

The project has shown the value of plate metering to accurately measure grass covers alongside the use an efficient recording system. Some farmers may be tempted to save time by visually assessing covers as an alternative, but this risks losing control at peak grass growth. Some of the project farmers plate meter twice a week during periods of peak growth.

There are other recording options such as weighing grass cut from a quadrant square and future technology such as drones may further advance grass measuring.

Continuing to measure and record grass growth accurately helps to keep control of grazing management and ensures that supplements are used cost effectively.

With any recording method, don't dismiss the value of walking the farm each week and assessing the overall condition of the paddocks and the farm in general.

Managing Grass Cover throughout the Season

Average farm cover at turnout should be approximately 2,000 to 2,200 kg DM / ha, depending on mean calving date – an earlier calving date equates to higher animal demand and the need for a higher opening cover. The table below gives a guide to the average farm cover required through the grazing season.

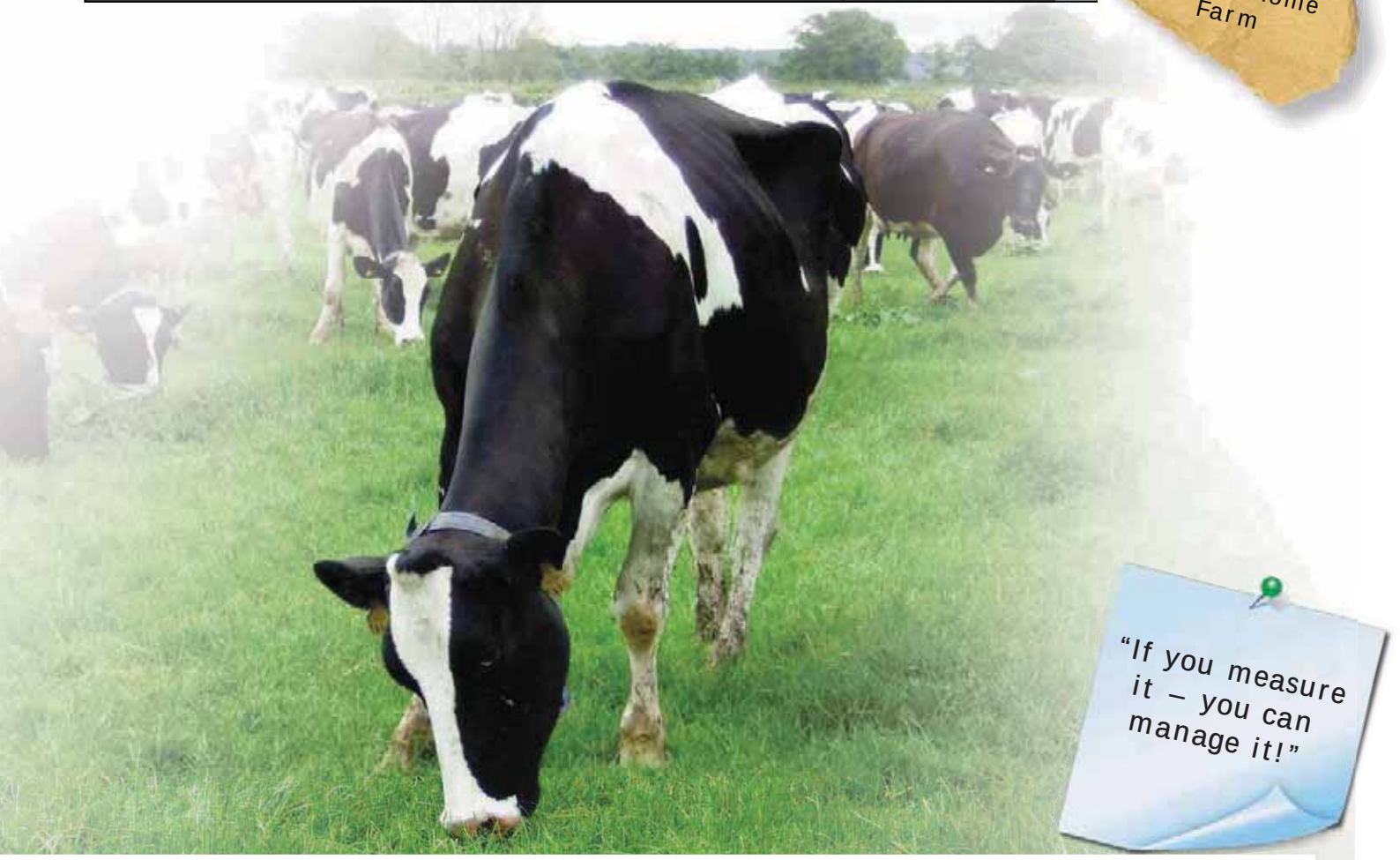
Average farm cover ***- is the average tonnes dry matter per hectare across the grazing platform i.e. if grazing at 2,500 kg DM / ha, down to 1,500 kg DM / ha, then the average farm cover will be around 2,000 kg DM / ha.***

Table 6 Guide to Average Farm Cover and Rotation Lengths

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average grass cover (kg DM / ha)											
	2,100	2,000	1,900	2,200	2,200	2,300	2,300	2,600	2,400	2,000	
Guideline rotation length (days)											
-	80	60	21-28	18-21	18-21	18-21	25-30	35-40	80-100	-	-
				In dry summer months, extend to 40 days							

"The key to good grassland management is to Measure and React."

Andrew Giles, Maesllwch Home Farm



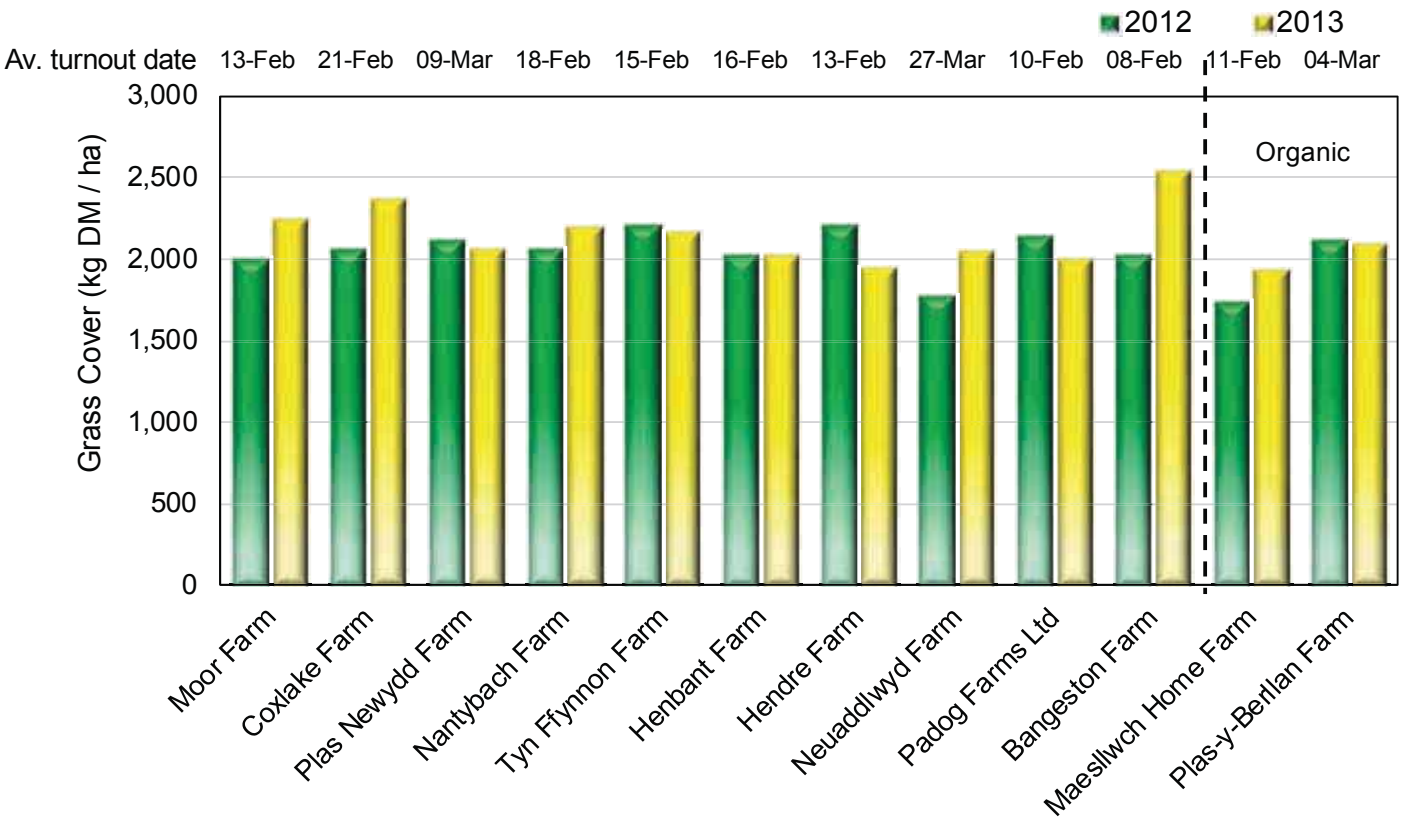
"If you measure it – you can manage it!"

Spring Turnout Management

A Spring grass budget (Spring rotation planner) can be used to give a guide to how much grass area should be allocated each day. The rotation length can start at as much as 75 days at turnout and then shorten to 21 days during peak growth in April / May.

The average turnout date of the project farms was 21st February. Opening farm covers on the project farms in 2012 and 2013 are shown in Figure 28.

Figure 28 Opening Farm Covers and Average Turnout Date on the Project Farms



Key points for turnout management from the project farms:

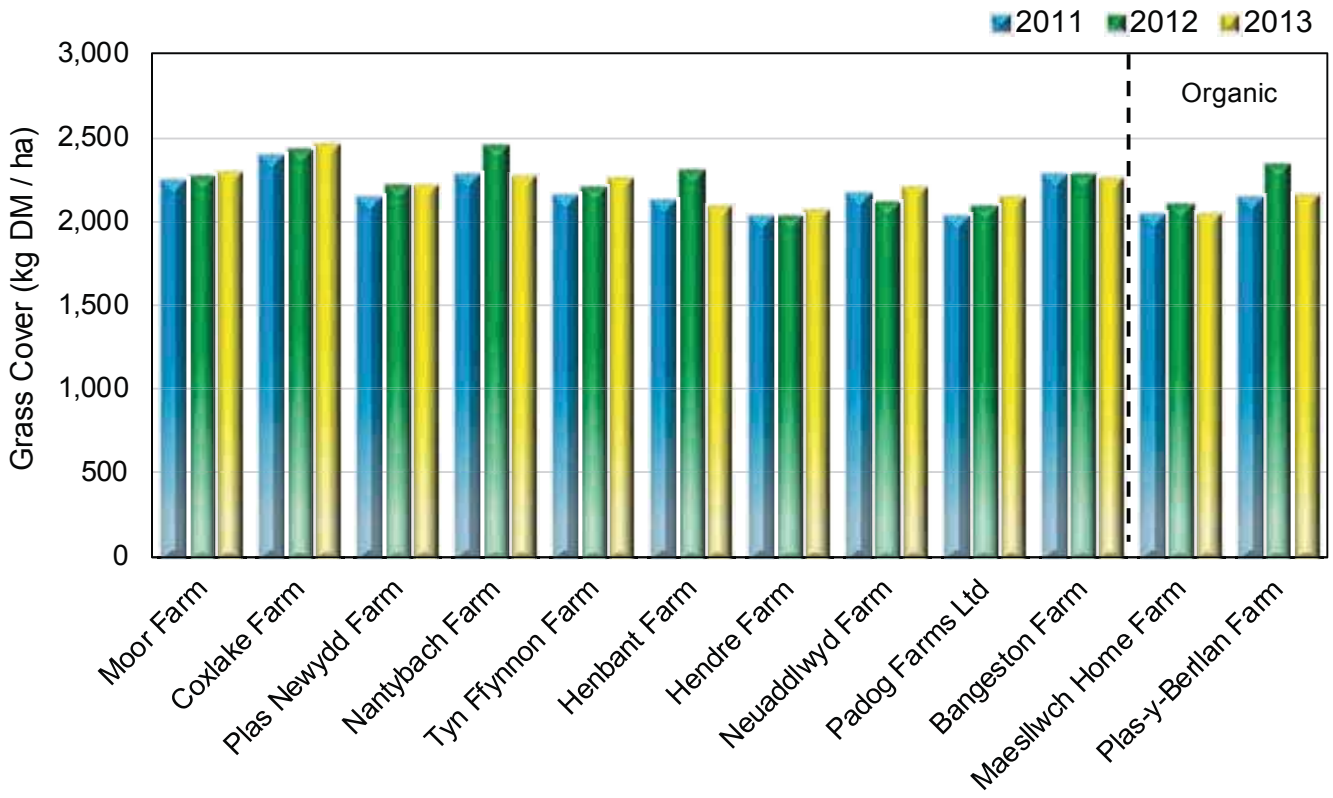
- All had a flexible approach and adapted to the conditions
- Many set the plan to graze the driest paddocks first
- All practiced on / off grazing when ground conditions were tender to prevent sward damage. Once cows have been grazing for about three hours they will have consumed the majority of their grass allocation. Housing or holding on a stand-off area until milking will avoid unnecessary sward damage. A fresh grass allocation can then be given after the next milking
- Some grazed by day only initially, others grazed day and night from turnout.

As a general rule, aim to graze 30% of the milking platform in February, 70% in March and 100% by 'Magic Day' (when grass growth exceeds feed demand , typically in mid-April). Target farm grass cover in April should be around 1,900 kg DM / ha to ensure the entire platform is of the highest grass quality. The start of the second rotation should be the lowest cover of the year.

Mid-Season Management

During the main grazing season (from mid-April to August) it is essential to maintain pasture quality to maximise cow performance.

Figure 29 Average Farm Covers on the Project Farms



Key points for mid-season management from the project farms:

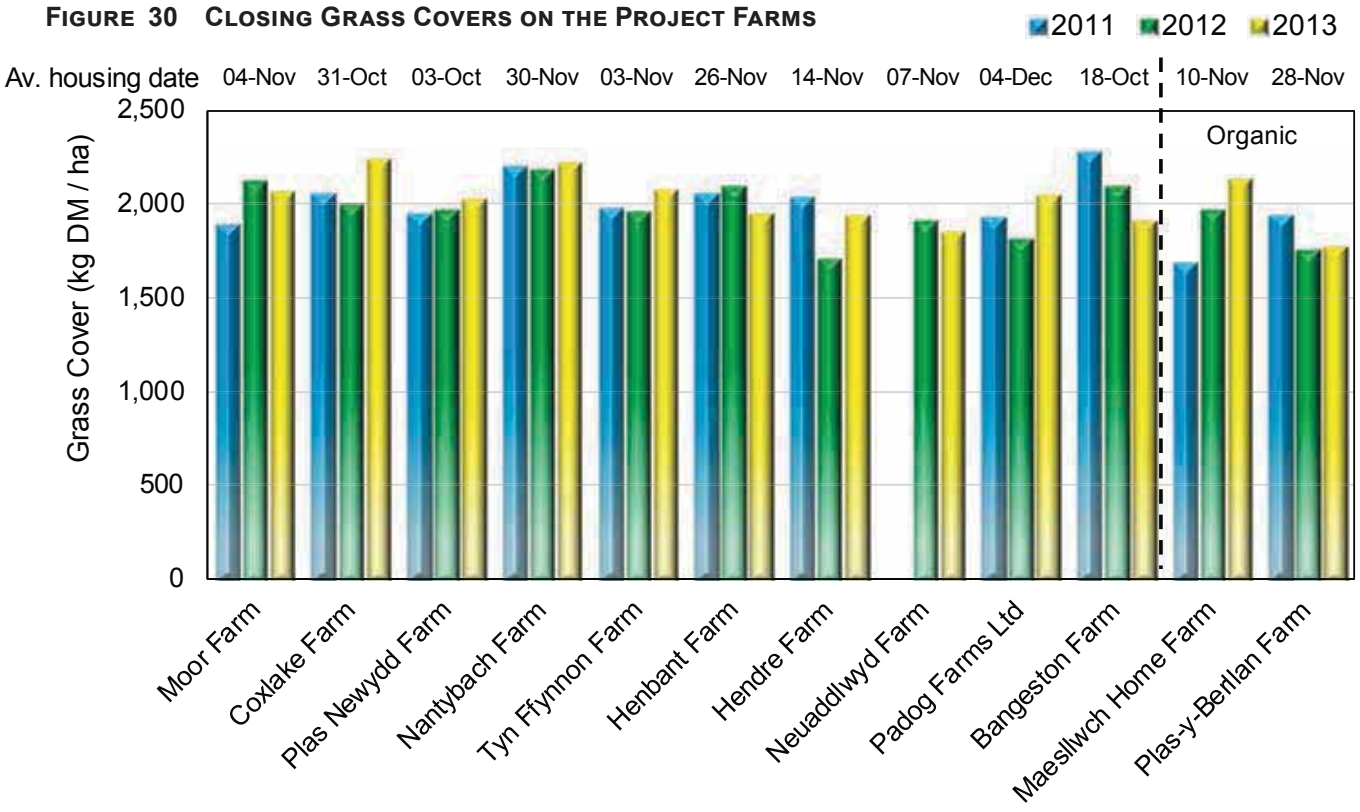
- Use the grass wedge to determine grass supply on the farm
- Target pre-grazing cover of 2,600 to 3,000 kg DM / ha. The project results show that if pre-grazing covers are slightly higher at 2,800 to 3,000 kg DM / ha, then more grass will be grown
- Some project farms increase grass cover during the breeding period
- Manage the paddock rotation relative to grass supply, but aim to avoid reducing below 18 days
- Maintain grazing residuals at 1,500 kg DM / ha in the early season and expect that this may have to increase to 1,700 kg DM / ha as the season progresses
- Where this becomes a challenge, pre-mow swards ahead of the cows. Aim to keep topping to a minimum
- Remove grass surpluses by shutting up paddocks for silage
- Mid-season quality can be improved by alternating paddocks that are grazed with those that are cut for silage or grazed by other stock (on a larger grazing platform)
- Extend the grazing platform (where possible) or offer buffer feeds or supplements when a grass shortfall is foreseen
- Supplement cows with ‘concentrate feed’ where milk production requirement is greater than what the grass can supply but aim to optimise grass intakes. Be flexible and adapt supplementation relative to weather and grass dry matter content.

Late Season Management

Key objectives of late season grazing management are to optimise the proportion of grazed grass in the diet for as long as ground conditions allow and to finish the grazing season with the desired farm grass cover, ensuring sufficient grass for early turnout the next Spring. Autumn calving herds require different management, particularly in late-season – see examples in the Project Farm Profiles.

Farms with a higher closing cover will have more grass available for early Spring grazing. This should be a particular priority for Spring calving herds.

FIGURE 30 CLOSING GRASS COVERS ON THE PROJECT FARMS



Key points for Autumn management from the project farms:

- Build average farm covers by increasing rotation length from September either by introducing more grassland into the rotation or by increasing supplementation
- Target a slightly higher pre-grazing cover but not greater than 3,500 kg DM / ha
- Aim to start the final rotation from 1st October. When Autumn grazing conditions are good, it may be tempting to extend the start of the final grazing round but this is often at the detriment of grass availability the following Spring. This is particularly crucial for Spring calvers
- Practice on / off grazing in wet weather.

"We aim for an average farm cover of 2,500 kg DM / ha at the end of August and then target a closing cover of 2,200 kg DM / ha."

Eurig Jones, Hendre Farm

Aim to start the final rotation from 1st October.

The weekly grass cover recordings have provided a wealth of data to evaluate. The seasonal and annual grass production from each paddock was evaluated, excluding those that did not have a full set of recordings for reasons such as re-seeding.

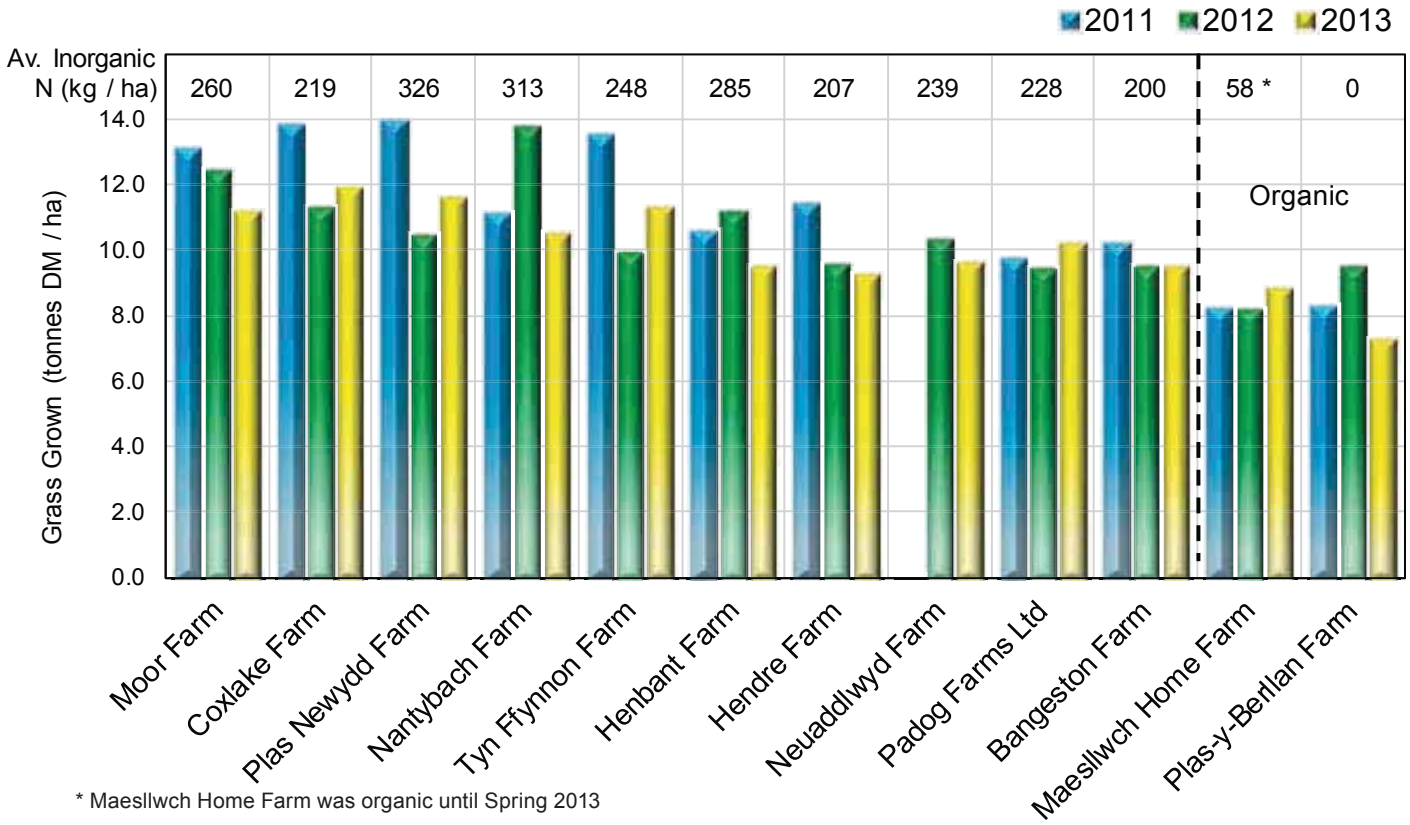
Over the three years of the project, the average grass production was 10.4 tonnes dry matter (DM) per ha, with 10.9 tonnes DM / ha grown on conventional farms and 8.0 tonnes DM / ha grown on organic farms.

Both the production potential of grass and the variability relative to seasonal weather, growing conditions and management practices is illustrated in Figure 31, showing the annual grass grown on each project farm.

Table 7 Average Grass Grown on the Project Farms (tonnes DM / ha)

Year	Non-organic	Organic
2011	11.8	8.2
2012	10.8	8.6
2013	10.2	7.2
Average	10.9	8.0

Figure 31 Annual Tonnes of Grass Grown on each Project Farm



* Maesllwch Home Farm was organic until Spring 2013

The range in grass production between farms can be related to growing conditions (site class) and inorganic fertiliser application in the figure above. The full range of grass production can be evaluated by analysing the individual paddock records across the twelve project farms. The top 10% performing paddocks grew 15.2 tonnes DM per ha of grass, whilst the lowest performing grew less than half this at only 6.9 tonnes DM per ha (excluding the organically managed farms).

Within the organically managed swards, the top 10% of paddocks grew 10.4 tonnes DM per ha, which compares favourably to the average conventional swards which received an average of 255kg nitrogen per ha. The lowest performing organic swards yielded 6.2 tonnes DM per ha.

"Measuring grass and seeing a visual grass wedge on AgriNet helps make better decisions."

Dei Davies, Moor Farm

Weather Conditions

The weather conditions encountered in each of the three years were very different and at times challenging, to say the least.

For the project, this proved beneficial as it allowed the monitoring of grass growth and utilisation to be evaluated against management practices in the different growing conditions.

The average annual rainfall over the three years was 1,070 mm (43 inches). Standing out as the most challenging, 2012 was the wettest year on record, with 1,241 mm (50 inches). This presented grass utilisation challenges, particularly to the heavy land project farms, although some of the drier farms recorded above average growth. Seasonal rainfall is shown in Figure 32.

The cold conditions in the Spring of 2013 were challenging for all farms, with grass growth significantly restricted.

Evaluating grass production relative to rainfall showed that the paddocks in the lower rainfall areas tended to grow more grass. This was influenced by a high proportion of those paddocks having a relatively heavier soil that retained moisture through the drier periods.

Figure 32 Seasonal Rainfall

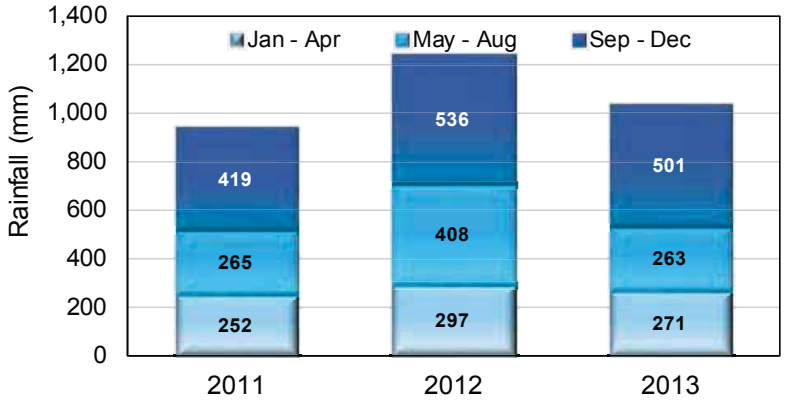
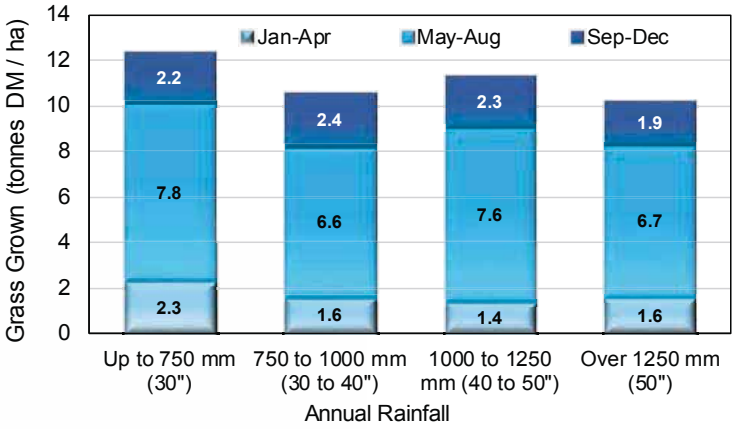


Figure 33 Grass Production relative Rainfall



"None of the farms grew as much grass as I'd have expected. This shows the value of accurate, consistent recording – never base your budgeting on hearsay!"

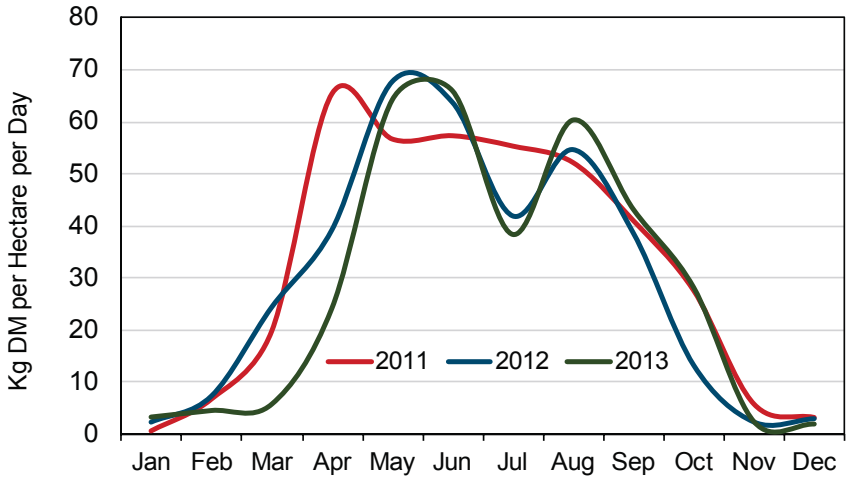
Chris Mossman, Nantybach Farm

Pattern of Grass Growth

The variable weather conditions certainly influenced the grass growth pattern over the three years. Figures 34 and 35 show the average project farm monthly growth curve in each of the three years on the non-organic and organic farms.

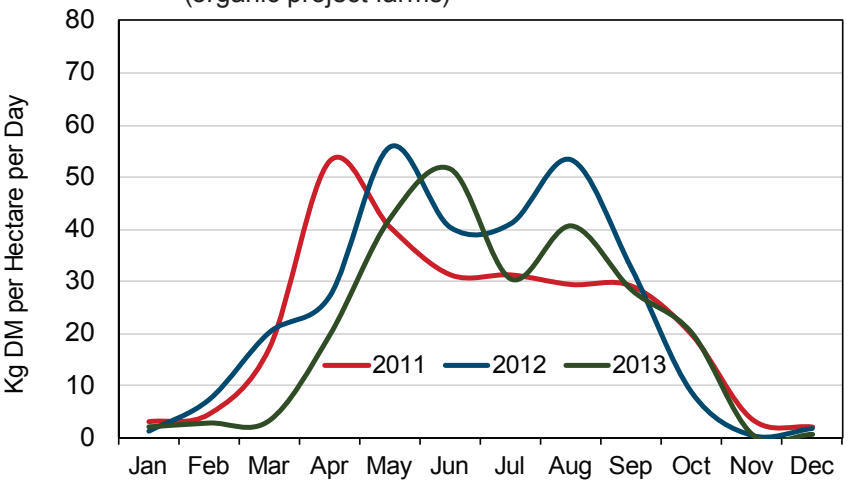
- In 2011 growth above 50 kg DM / ha / day was sustained through the summer
- The cold Spring of 2013 limited growth from February to May.

FIGURE 34 GRASS GROWTH CURVE
(non-organic project farms)



- Through the main growing season, growth on organic farms was typically 15 kg DM / ha / day less than on non-organic farms.

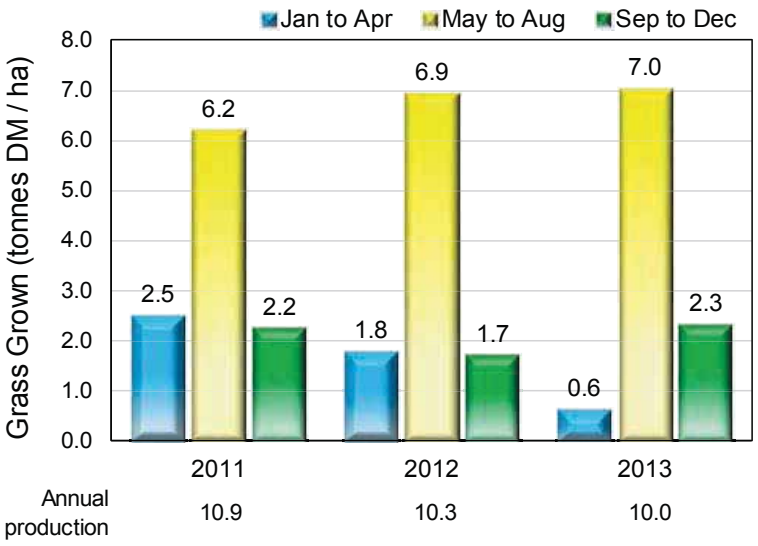
FIGURE 35 GRASS GROWTH CURVE
(organic project farms)



The seasonal variation in grass production over the three years is shown in Figure 36.

This highlights the impact of the cold Spring of 2013.

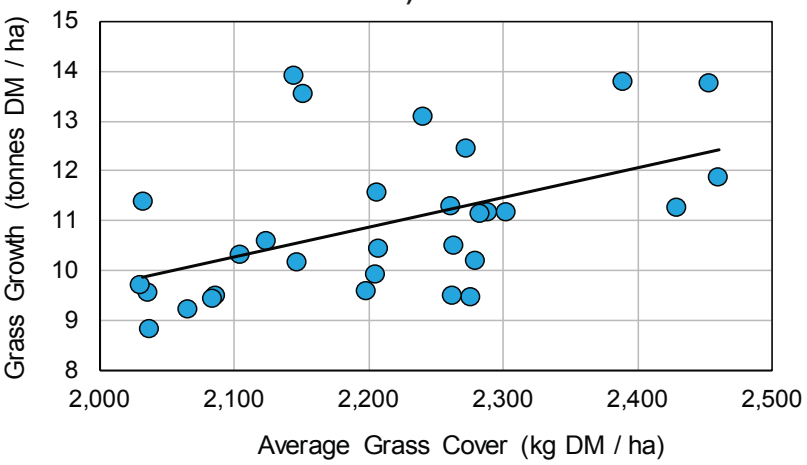
FIGURE 36 SEASONAL GRASS PRODUCTION OVER THE 3 YEARS



Grass Grows Grass

As swards bulk up and leaf area increases, the rate of grass growth increases. Whilst grazing a sward at too high a cover will increase wastage and reduce utilisation, grazing at too low a cover will mean potential growth is sacrificed. Project farms grazing swards at a higher cover tended to produce more grass (Figure 37).

Figure 37 Link between Grass Cover and Grass Growth(annual results of non-organic farms)



Length of Grazing Season

Effective cow tracks are essential for herds aiming to optimise grass utilisation and are one of the best investments that can be made on any farm aiming to improve production from grazing. Preventing five cases of lameness could pay for 50 metres of track.

When constructing tracks source suitable materials on-farm or locally. Most farmers in the project constructed tracks from shale or quarry stone. Other potential materials include sandstone river gravel or crushed rubble. At Coxlake Farm a layer of AstroTurf has been rolled on top of some of the stone tracks for the 2014 grazing season.

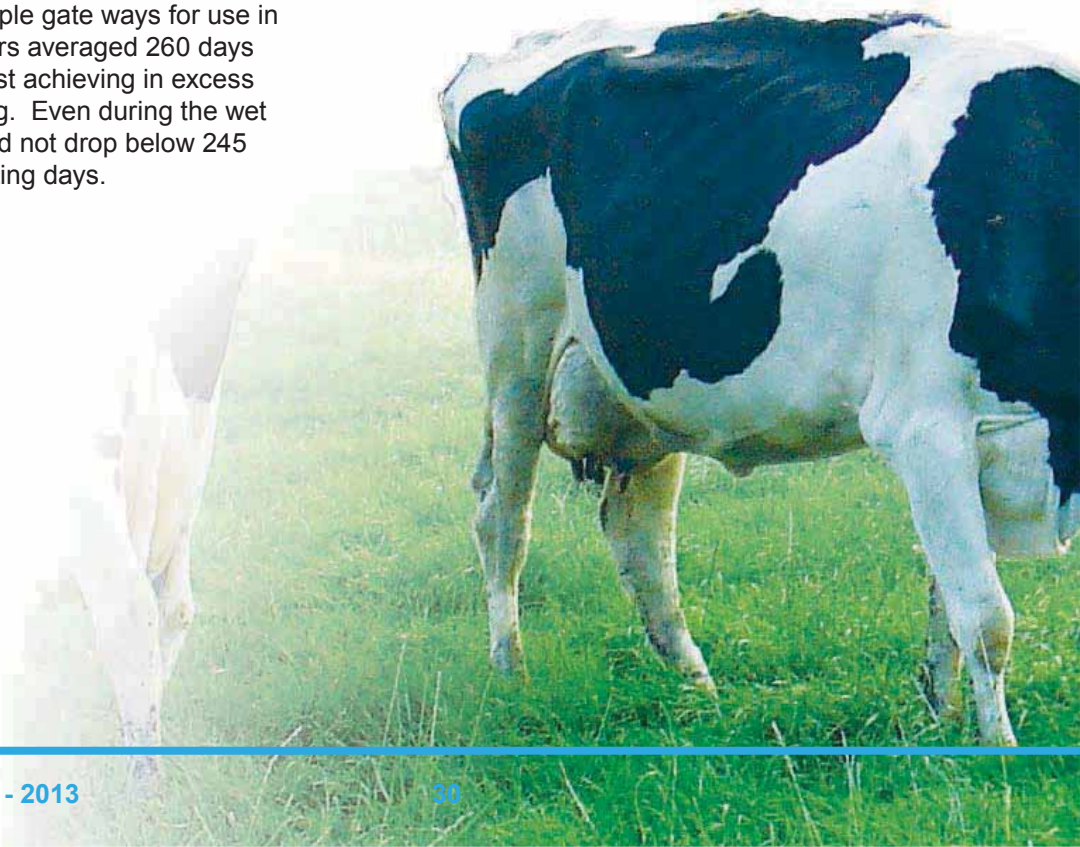
It is also important to consider the camber and width of the tracks and ideally they should be used for cows only and not tractors. As a general rule tracks should be a minimum of 3 metres (10 ft.) wide for 100 cows, then add 1 metre per 50 cows. The project farmers' track costs were generally around £10 per running metre.

90% of the paddocks had good track access, with flexible paddock sizes and multiple gate ways for use in wet weather. The project farmers averaged 260 days grazing per year, with the highest achieving in excess of 290 days a year of full grazing. Even during the wet summer of 2012, the average did not drop below 245 grazing days.

Grazing a sward at too high a cover will increase wastage and reduce utilisation. Grazing at too low a cover will mean potential growth is sacrificed.

"Our farm runs to 1,000 ft. and is quite exposed to the weather but recording grass growth and comparing to other farms has shown that we can grow and utilise grass well. There are no excuses!"

Gwydion Jones,
Tyn Ffynnon Farm



Grass Utilisation and Production from Forage

Once a high cover of quality grass has been grown, it must then be utilised effectively.

The proportion of grass grown that was utilised by the cows was on average 84% across the three years, with a dip in 2012 due to the wet conditions affecting the wetter project farms.

Grass utilisation was calculated for each individual project farm on an energy basis, taking into account the requirements for cow maintenance and milk output, less energy from imports of purchased feed and conserved forages from off the platform. Whilst a high level of recording was carried out throughout the project, it was still not possible to record all the grass production.

Figure 38 Grass Utilisation

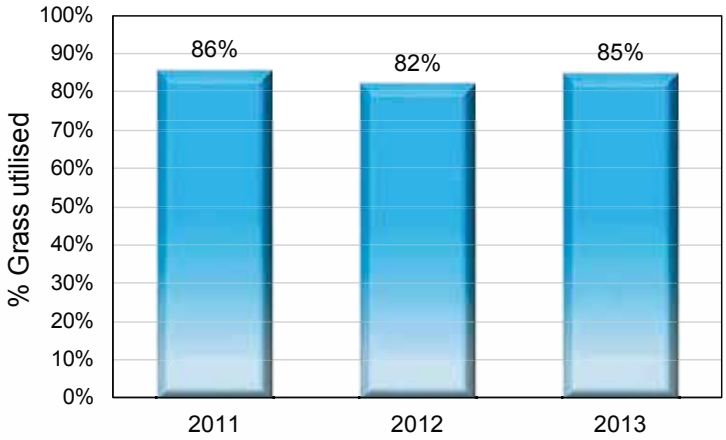
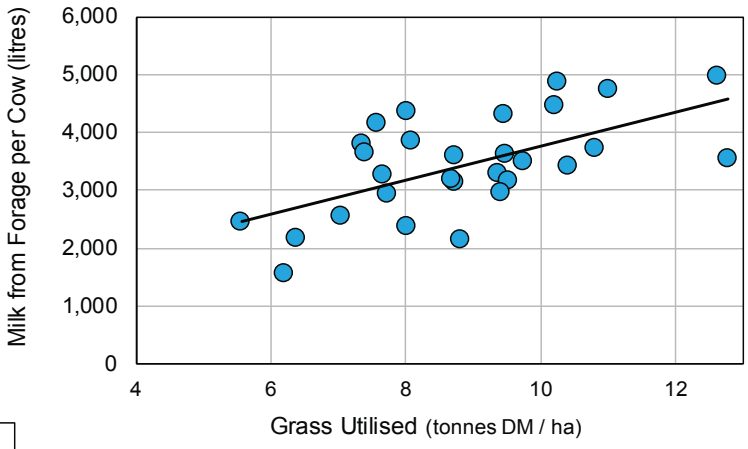


Figure 39 Impact of Grass Utilisation on Milk from Forage(annual performance of non-organic farms)



Without recording the pre and post grazing covers of every paddock, grass production will be under-recorded and this will then result in a higher calculated grass utilisation figure. In reality grass utilisation rates in excess of 85% would be rare, with a realistic rate being between 75 and 80%. Although the calculated grass utilisation rates in this report are high, they still provide very useful comparisons.

The close correlation between grass utilisation and milk from forage is clearly shown in Figure 39.

"We sold our high yielders and purchased crossbreds only four years ago. Comparing to other progressive farms within the project has increased our confidence in the value of grass – we've learnt a lot."

Dyfed Griffith, Plas Newydd Farm

High grass utilisation is essential for good milk from forage.

The Right Cow for the System

Most of the farmers in the project utilised cross breeding to develop a cow that suits their system. Some have been cross breeding for up to 15 years and within the Spring calving herds, New Zealand Friesian and Jersey based crosses were the most popular. A smaller, lighter cow will cause less sward damage during tender grazing conditions. The Autumn calvers had a greater Friesian and Scandinavian influence.

The target is to breed a cow which will produce 1 kg of milk solids per kg of live-weight (e.g. 450 kg milk solids from a 450 kg body weight cow) - the highest performing project farms were achieving this. The ideal dairy cow is one with the ability to efficiently produce quality milk whilst maintaining body condition, is able to walk long distances and most importantly get back in calf to allow a tight calving pattern to be maintained.

A tight calving pattern allows cows to be managed as one herd, matching the feed demand to grass availability. This is particularly important for Spring calving herds where calving is matched to the onset of grass growth, i.e. at the beginning of February, allowing feed demand to rise in line with grass growth.

Herd fertility was of upmost importance to all project farmers within the group, with the majority calving all cows within a 12 week period and achieving an average 6 week in-calf rate of 70%. The group had a 21% replacement rate (to maintain cow numbers).

"A robust cow is essential. Very pleased with our Scandinavians and their excellent health traits."

Richard Thomas, Neuaddlwyd Farm

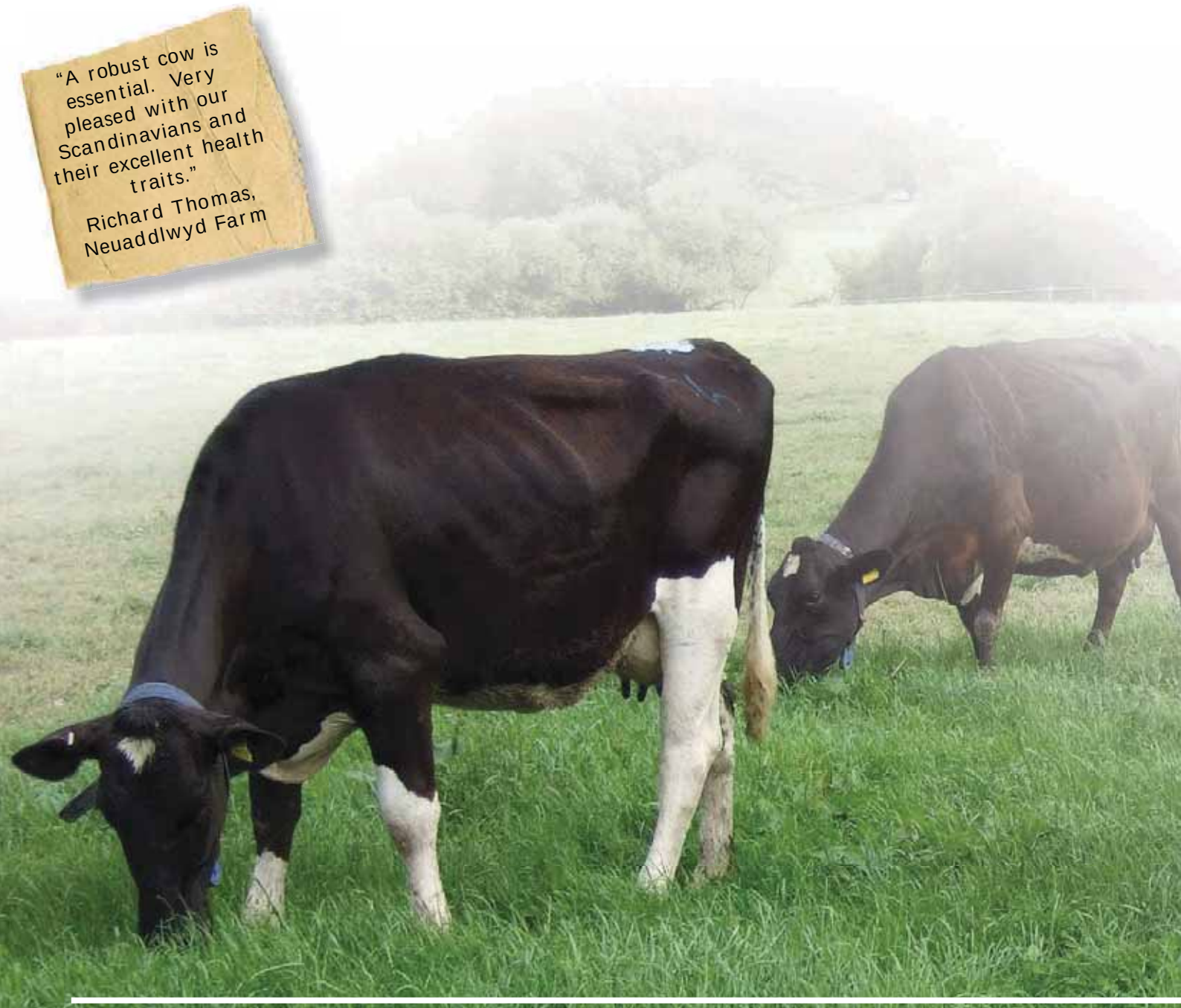
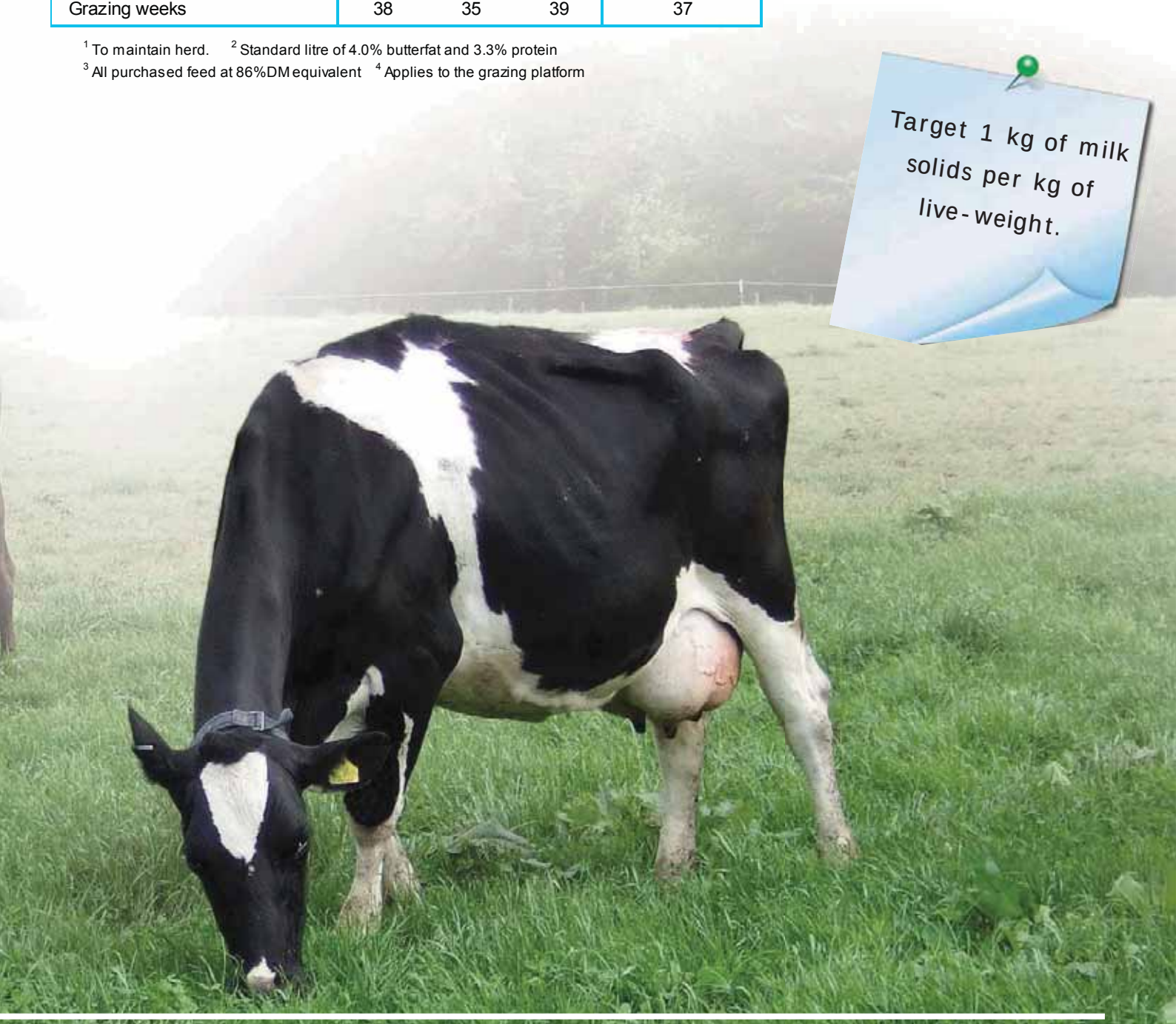


Table 8 Overall Project Herd Performance

	2011	2012	2013	3 Year Average
Herd size	245	263	279	263
Replacement rate [1]	21%	25%	17%	21%
Yield per cow (litres) [2]	6,205	5,993	6,048	6,078
Litres per ha [2]	16,852	17,692	19,333	18,003
Milk solids per cow (kg)	453	437	442	444
Purchased feed per cow (kg) [3]	1,047	1,223	1,498	1,262
Yield from forage per cow (litres)	4,070	3,446	3,065	3,511
per hectare (l)	11,053	10,173	9,797	10,341
Stocking rate (cows per ha) [4]	2.72	2.95	3.20	2.96
Grazing weeks	38	35	39	37

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

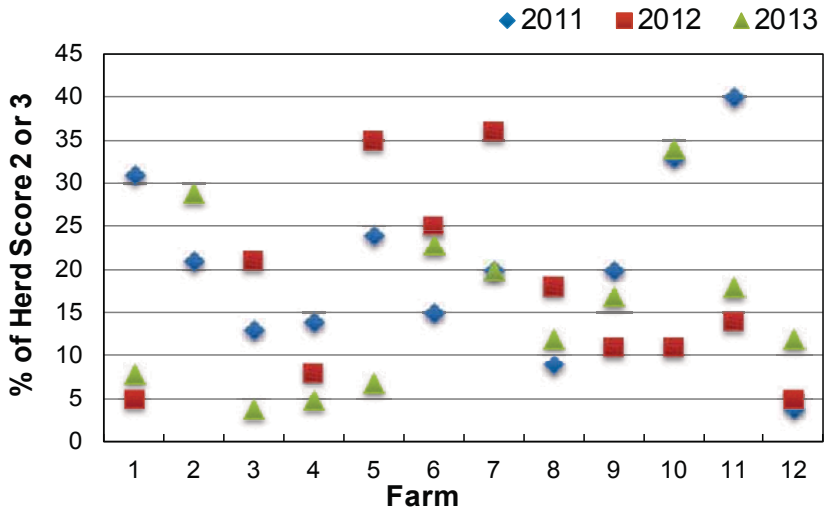
The summary of herd performance (Table 8) shows that the highest herd output was in 2011, where most project farms experienced less extreme weather than in the following two years. The cold Spring of 2013 impacted on production and whilst total output per cow was maintained through extra supplementation, milk from forage per cow and per hectare fell.



Herd Health

The Royal Veterinary College staff and students from the Welsh Regional Veterinary Centre at Gelli Aur visited all the project farms to assess cow body condition score (BCS) and mobility. The overall herd results are shown below.

Figure 40 Herd Mobility Score

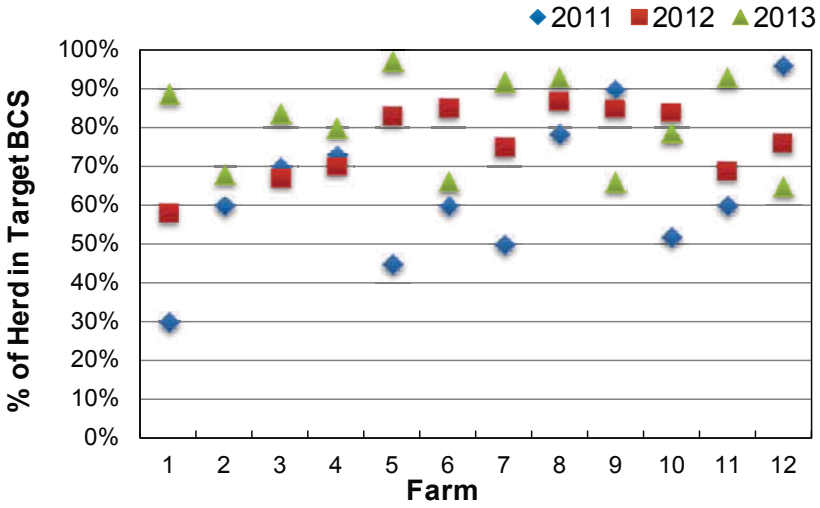


"Independent cow mobility and condition scoring has helped us focus on further improvements."
Eilir Evans, Henbant Farm

The group showed a gradual improvement in mobility within the project period, with less cows exhibiting mobility scores of 2 or 3.

Prompt treatment of lameness and well maintained tracks were two common factors within the project farms.

Figure 41 Herd Body Condition Score



An independent assessment of cow condition and mobility should be a valued part of a herd health programme.

The average body condition score of the cows was acceptable on all project farms and improved through the course of the project, with a greater proportion of the herd at target BCS. Fewer lame cows may have contributed to easier management of BCS.

The project farms that had more visits from the veterinary staff showed a greater improvement, particularly in mobility. This highlights the value of independent assessment and advice as part of an improvement programme.

The profitability of the project farms is expressed as the proportion of the farm output that was retained as net margin. The average results over the three years are shown in Table 9.

- Overall 31% of the output from the project herds was retained as margin. This compares very favourably with other UK herds evaluated within DairyCo Milkbench+ (2013) that on average retained 4% of output as net margin, with the top 25% retaining 22%.

Table 9 Overall Project Herd Net Margin

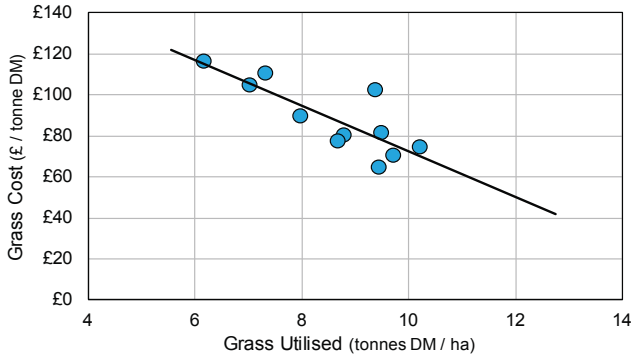
	2011	2012	2013	3 Year Average
Net Margin as % of output	33%	34%	27%	31%

Linking Grass Value to Herd Profitability

From the outset a key goal of the project was to demonstrate the positive impact of effective grass production and utilisation on herd profitability.

Evaluating the full production costs of grazed grass on each individual project farm and relating that to grass production highlights the direct correlation. More grass utilised = less cost per tonne of dry matter.

Figure 42 Effect of Grass Utilisation on Production Cost



The DairyCo Milkbench+ system was used to evaluate herd profitability each year. To allow comparisons between the herds in this project external impacts were removed by applying a standard milk pricing formula and a standard purchased feed cost per tonne.

Figure 43 Link between Grass Utilised and Net Margin
(annual results of all farms)

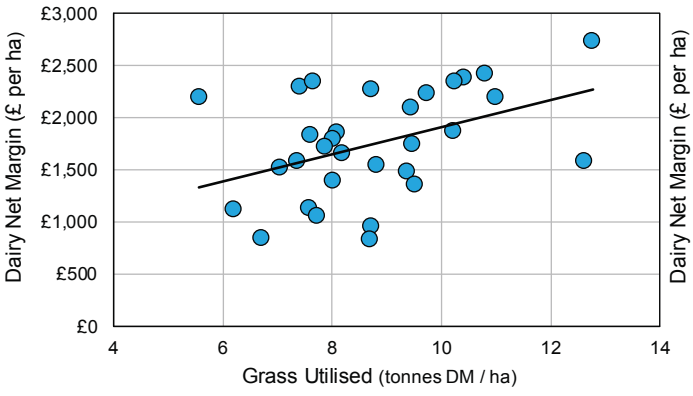
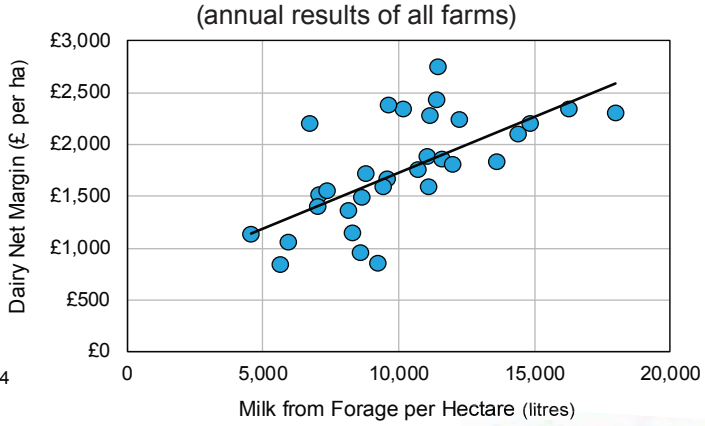


Figure 44 Link between Grass Utilised and Net Margin
(annual results of all farms)



There was a clear trend indicating that herds that grew more grass per hectare and produced more milk from forage per hectare, have a higher net margin per hectare.

The detailed study of these twelve project farms has clearly shown that focusing on producing the optimum dry matter yield of grass per hectare, combined with effective grassland management results in high levels of grass utilisation, a good proportion of milk from forage, low feed costs and healthy profits – **true value from grass**.

"New grazing units can be set up relatively cheaply. The vital infrastructure are tracks, water and fencing."

Rhys Williams, Padog Farms Ltd

Project Farm Profiles

To allow producers who wish to put findings from this report into practice and increase the value that grass contributes to herd performance and profitability, a summary of key farm characteristics is shown in the table below and further details are included on the following pages.

TABLE 10 SUMMARY OF KEY CHARACTERISTICS OF EACH PROJECT FARM

Farm	Bangeston Farm	Coxlake Farm	Henbant Farm	Hendre Farm	Maesllwch Home Farm	Moor Farm
Farm size (dairy area) (ha)	125	62	134	93	170	47
Conventional / organic	Conventional	Conventional	Conventional	Conventional	Organic until spring 2013	Conventional
Predominant soil types	Shallow red sandstone	Clay loam	Medium clay loam	Clay	Medium Loam & alluvial loam on gravel	Medium & clay loam
Annual Rainfall - mm (inches)	1,155 (46)	1,322 (53)	1,165 (47)	1,030 (41)	880 (35)	661 (26)
Herd size	316	168	285	278	423	118
Cow type	Crossbreds	Friesian Crossbreds	Jersey / Fr Crossbreds	Kiwi Crossbreds	Jersey / Fr Crossbreds	Holstein Friesian
Calving pattern	Spring	Spring	Spring	Spring	Spring	Spring

Farm	Nantybach Farm	Neuaddlwyd Farm	Padog Farms Ltd	Plas Newydd Farm	Plas-y-Berllan Farm	Tyn Ffynnon Farm
Farm size (dairy area) (ha)	142	162	73	42	85	70
Conventional / organic	Conventional	Conventional	Conventional	Conventional	Organic	Conventional
Predominant soil types	Light loam over rock	Silty loam	Medium loam with some peat	Medium loam & peat	Medium loam	Medium & clay loams
Annual Rainfall - mm (inches)	1,007 (40)	939 (38)	1,435 (57)	1,155 (46)	849 (34)	1,299 (52)
Herd size	327	332	423	231	291	118
Cow type	Jersey / Fr Crossbreds	Pedigree Scandinavian Reds	Friesian Crossbreds	Friesian Crossbreds	Friesian Crossbreds	Jersey / Fr Crossbreds
Calving pattern	Spring	Spring & Autumn	Spring	Autumn	Autumn	Spring

The following pages provide a summary of the characteristics and key performance measures on each of the twelve project farms.

Bangeston Farm

MDM Farms Ltd. is run by Martin Mathias and family at Bangeston Farm, Stackpole, Pembrokeshire. The farm overlooks the Pembrokeshire coastline benefitting from a mild coastal climate, the farm is prone to drought mid-season but is one of the earliest growing farms in Wales. When converting to Spring calving Martin imported 50 pedigree Montbeliarde cows, but has since changed his breeding policy to New Zealand Jerseys and Friesians. A section of Bangeston is in a Nitrate Vulnerable Zone, one of a very few such zones in Wales.

- Spring calving with virtually 100% calved within 12 weeks
- New Zealand Jersey and Friesian crossbred cows, with some Montbeliardes
- Constituent contract
- A dry farm with light soils
- Around 6% of paddocks reseeded annually with late heading PRG and clover mixtures
- Dry cows out-wintered on deferred grazing with bale silage.

Bangeston Farm has grown on average 9.7 tonnes DM ha / year across the three year project.

- Grass utilisation averaged 87% of grass grown
- The highest performing 10% of paddocks yielded 13.2 tonnes DM / ha / year with the lowest recording 5.7 tonnes DM / ha
- The farm applied on average 200 kg N ha per year of bagged N, delivering a response rate of 64 kg DM per kg N applied
- The farm had one of the greatest improvements in ryegrass % in the sward over the project period
- Margin as a % of output was consistently around 30%.

Key performance pointers:

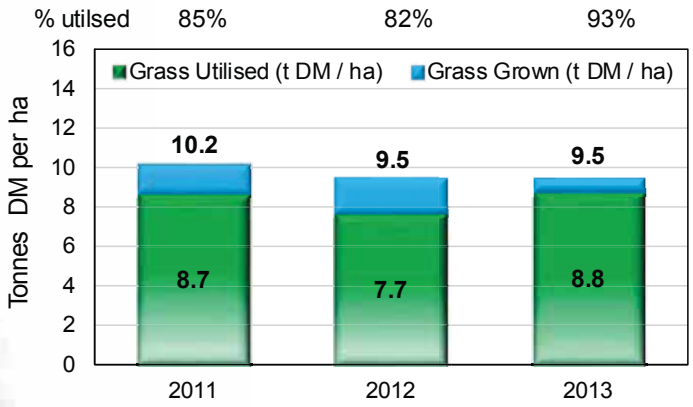
- Target turnout cover of 2,200 kg DM per ha
- Flexible paddock grazing system with a fresh break after each milking. On-off grazing practised in wet weather
- Typically cuts each paddock once for silage when they reach 3,000 kg DM / ha.

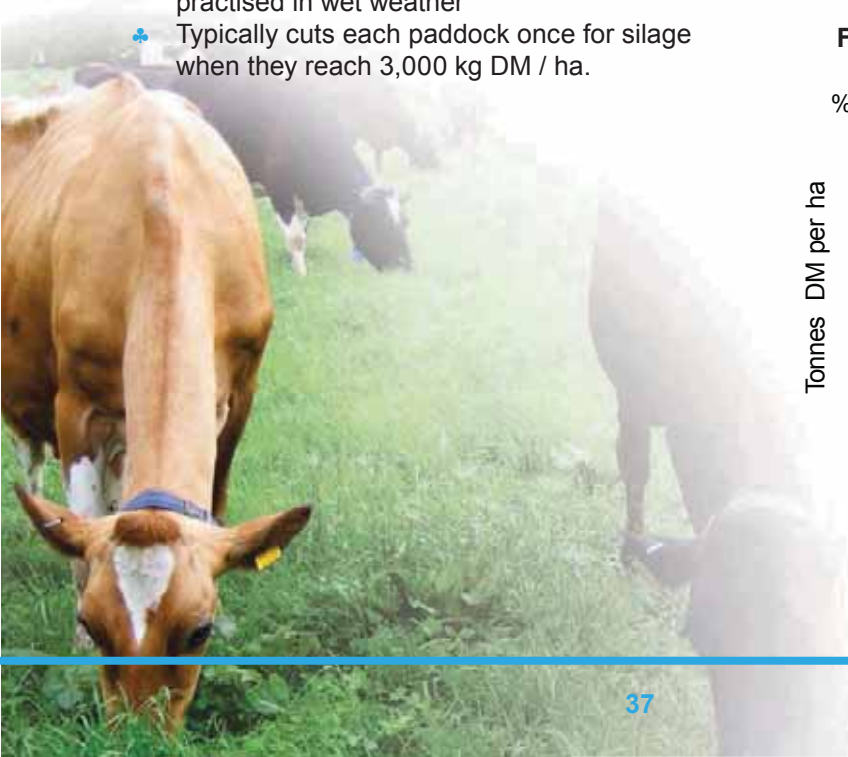
Table 11 Summary of Bangeston Farm Performance

	2011	2012	2013
Herd size	242	273	316
Replacement rate [1]	26%	18%	14%
Yield per cow (litres) [2]	5,459	5,363	5,277
Litres per ha [2]	9,714	10,927	18,127
Milk solids per cow (kg)	399	392	385
Purchased feed per cow (kg) [3]	1,137	1,205	1,651
Yield from forage per cow (litres)	3,178	2,931	2,150
Stocking rate (cows per ha) [4]	1.78	2.04	3.43
Annual rainfall (mm)	1,004	1,387	1,073
Grazing weeks	31	38	39
Inorganic nitrogen (kg per ha)	203	180	217
Net margin as % of output	29%	30%	27%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 45 Grass Grown and Utilised at Bangeston Farm





Coxlake Farm

Tim and Delyth Simons, directors of Coxlake Farm Ltd., farm at Narberth Pembrokeshire. Tim was one of the first exponents of the New Zealand influenced Spring calving system in Wales. His cost control and grazing management has been used as an example to others by numerous organised visits. The farm carries 170 crossbred, Spring calving cows. Tim runs a very simple system with very little outside labour. Coxlake is a very heavy farm, but is well serviced by a network of tracks. All of the replacements are reared at home.

- Friesian crossbred herd
- Spring calving for past 15 years
- Breeding for milk quality, fertility and longevity
- Tight Spring calving, 100% calved in 12 weeks
- Heavy clay loam soils
- No reseeding in the last 10 years.

Coxlake Farm achieved high grass yields, averaging 12.3 tonnes DM / ha, partly as a result of maintaining higher average grass covers. This consistently high performance herd has a focus on high feed efficiency with an average feed rate 0.16 kg of purchased feed per litre.

- Grass utilisation averaged 89%
- The farm applied an average 219 kg N / ha, giving a response rate of 58 kg DM of grass per kg N applied
- Average milk yield was 5,995 litres per cow or 438 kg milk solids, with 4,106 litres per cow from forage
- With a high stocking rate, 11,305 litres per ha were produced from forage
- Margin as a % of output averaged 36%.

Key performance pointers:

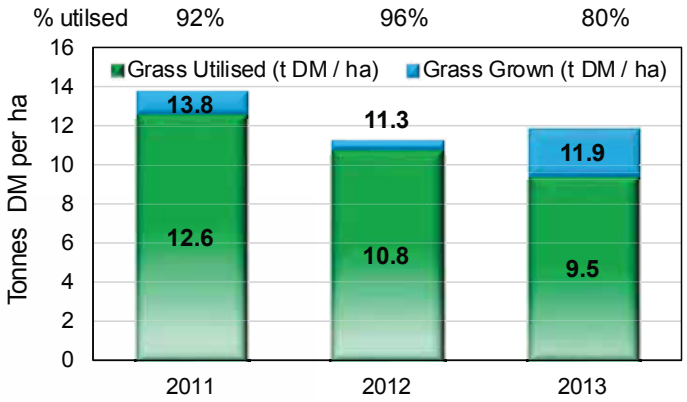
- High level of grass production and utilisation from paddocks not re-seeded in recent years
- Turnout grazing covers typically 2,100 kg DM / ha, with a closing cover of 2,200 kg DM / ha
- Paddocks typically topped once
- Quarry stone cow tracks, 'AstroTurf' has been rolled on top of some of the tracks for the 2014 grazing season
- Water troughs sited beside tracks rather than in paddocks.

Table 12 Summary of Coxlake Farm Performance

	2011	2012	2013
Herd size	169	172	168
Replacement rate [1]	19%	21%	23%
Yield per cow (litres) [2]	6,274	5,811	5,899
Litres per ha [2]	14,055	17,847	17,386
Milk solids per cow (kg)	458	424	431
Purchased feed per cow (kg) [3]	656	1,036	1,189
Yield from forage per cow (litres)	4,968	3,719	3,633
Stocking rate (cows per ha) [4]	2.24	3.07	2.95
Annual rainfall (mm)	1,221	1,523	1,224
Grazing weeks	36	36	37
Inorganic nitrogen (kg per ha)	221	240	195
Net margin as % of output	36%	42%	32%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 46 Grass Grown and Utilised at Coxlake Farm



Henbant Farm

Eilir and his wife Catrin, together with Eilir's parents trade as E Evans and Son Ltd. at Henbant, Talgarreg, Ceredigion. They run a herd of 270, Spring calving crossbred cows. Henbant is a very undulating farm with medium soils and challenging slopes for grazing and tractor operations. Serviced with good tracks the cows have to endure steep gradients on a daily basis. The business has recently entered into a joint venture with a local sheep farmer and converted a neighbouring farm to a 300 cow unit.

- Friesian and crossbred cows
- Tight, Spring calving block
- Constituent based milk contract
- Medium clay loam soil
- 5% of paddock area re-seeded each year. Paddocks to re-seed chosen from annual grass production recorded
- The 2012 replacement rate was high due to milking cows being transferred to the new unit.

A well run Spring calving herd with high grass utilisation and feed conversion, Henbant Farm grew an average 10.4 tonnes DM per hectare per year.

- Grass utilisation was very high at 94% (see page 31 for further explanation)
- The farm used 285 kg of artificial N / ha, giving a response rate of 36 kg DM of grass per kg N applied. The actual response rate is likely to be higher than this if the full yield was taken into account
- Average yield was consistent at 5,788 litres or 423 kg milk solids per cow, with 3,635 litres per cow from forage
- Margin as a % of output averaged 34%.

Key performance pointers:

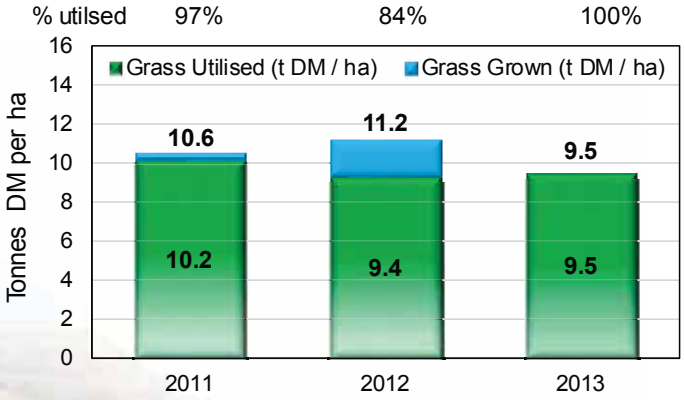
- Flexible grazing system, with multiple gateways and use of on-off grazing
- Increased use of Jerseys to reduce cow bodyweight
- Infertility culling rate of only 6%
- Effective use of slurry through shallow injection.

Table 13 Summary of Henbant Farm Performance

	2011	2012	2013
Herd size	270	287	285
Replacement rate [1]	23%	36%	22%
Yield per cow (litres) [2]	5,880	5,657	5,827
Litres per ha [2]	14,564	14,946	15,128
Milk solids per cow (kg)	429	413	425
Purchased feed per cow (kg) [3]	684	1,154	1,291
Yield from forage per cow (litres)	4,467	3,285	3,154
Stocking rate (cows per ha) [4]	2.48	2.64	2.60
Annual rainfall (mm)	985	1,296	1,214
Grazing weeks	39	39	40
Inorganic nitrogen (kg per ha)	272	297	286
Net margin as % of output	41%	32%	28%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 47 Grass Grown and Utilised at Henbant Farm



Hendre Farm

Eurig Jones trades as Huw Eurig Jones Cyf. at Hendre, Tregeuan, Anglesey. Eurig graduated in accountancy and could see the business opportunity in dairying. Supported by his father Tom, a keen exponent of low cost dairy farming, Eurig set up on his own on a tenanted farm. He now milks 300 Spring calving crossbred cows on a very low cost system. Hendre is a challenging farm that tends to be heavy land on shallow rock. All of the youngstock are reared off-farm with some of the dry cows off wintered on his father's farm.

- Spring calving herd with 85% calved in first 12 weeks
- Constituent contract
- Kiwi cross bulls used for last three years
- Medium loam and peat soil
- Flexible paddock grazing system with a fresh break each day.

Hendre Farm has grown on average 10.1 tonnes DM ha / year across the three year project.

- The highest performing 10% of paddocks yielded 12.8 tonnes DM per ha per year with the lowest recording 7.1 tonne DM per year
- The farm is applying on average 207 kg N ha per year from bagged N, delivering a response rate of 55 kg DM for every kg N applied
- Grass utilisation averaged 78% of grass grown
- Hendre grazed cows for an average of 45 weeks, one of the highest within the group
- A very consistent 31% margin as a % of output.

Key performance pointers:

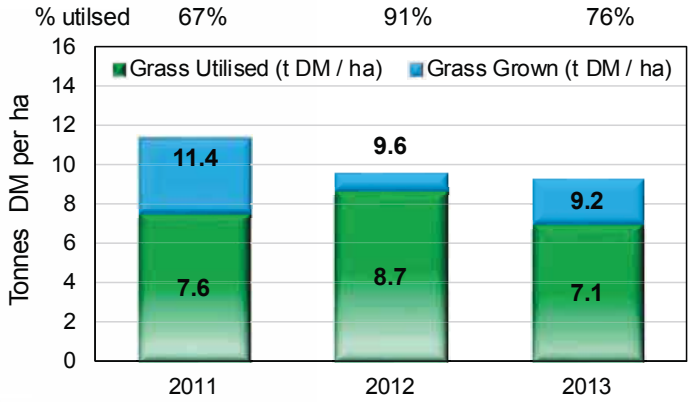
- Grass requirements budgeted in Spring and Autumn
- Target turnout cover of 1,900 kg DM per ha and typically a 60 day first round
- A good track network with 12 foot wide, quarry stone tracks
- Use stand-off areas in wet conditions
- Pre-grazing cover increased in the Autumn to up to 3,200 kg DM / ha
- Typically 13% of paddocks re-seeded each Spring. Ploughed and sown with high sugar, tetraploid ryegrass mixture with clover.

Table 14 Summary of Hendre Farm Performance

	2011	2012	2013
Herd size	200	277	278
Replacement rate [1]	19%	29%	14%
Yield per cow (litres) [2]	5,768	3,790	4,936
Litres per ha [2]	11,537	10,461	13,673
Milk solids per cow (kg)	421	277	360
Purchased feed per cow (kg) [3]	628	325	1,134
Yield from forage per cow (litres)	4,163	3,127	2,565
Stocking rate (cows per ha) [4]	2.00	2.76	2.77
Annual rainfall (mm)	804	1,272	1,015
Grazing weeks	48	42	44
Inorganic nitrogen (kg per ha)	183	210	229
Net margin as % of output	30%	29%	32%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 48 Grass Grown and Utilised at Hendre Farm



Maesllwch Home Farm

Andrew and Rachel Giles are Directors of A & R Giles Farming Ltd. They farm the tenanted Maesllwch Home Farm, Glasbury in the Wye Valley on the border with Wales and England. They currently farm 425 crossbreed cows on a Spring calving system. For the first two years of the project the farm was run organically, but reverted to conventional from May 2013. The youngstock are reared off-farm on a contract rearing agreement from weaning until point of calving. Andrew and Rachel are supported by a herd manager, farm foreman, apprentice and relief milkers.

- Converted from organic to conventional in 2013
- Cross breeding policy in place for 15 years. Currently two way cross Jersey / NZ Friesian
- Medium loam and alluvial loam soils on gravel
- Up to 10% of paddocks re-seeded each year. Selects bespoke grass and clover varieties.

Maesllwch Farm grew an average of 8.4 tonnes DM / ha / year over the three year project.

- Grass utilisation averaged 93%
- The highest performing 10% of paddocks yielded 11.6 tonnes DM / ha / year with the lowest recording 5 tonne DM / ha / year
- An average of 39% of output was retained as margin.

Key performance pointers:

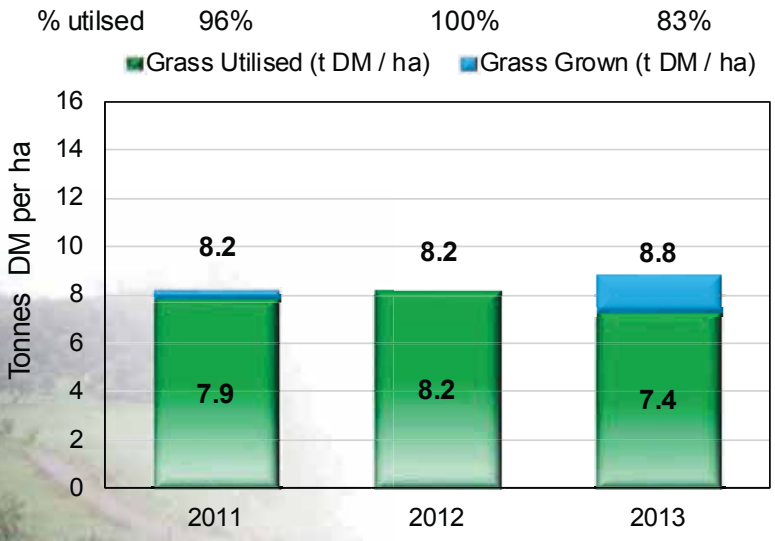
- Spring and Autumn grass allocation budgets carried out and implemented
- A fresh allocation of grass is given after each milking in the Autumn and Spring but daily allocation from April to Autumn
- Increase post-grazing cover to 1,600 kg DM per ha when breeding
- Pre-mowing only where previous round high covers have not been grazed effectively
- Paddocks taken out of rotation for silage when average grass cover exceeds 2,200 kg DM / ha and growth exceeds demand
- Spring fertiliser application of 30:15:0 kg /ha.

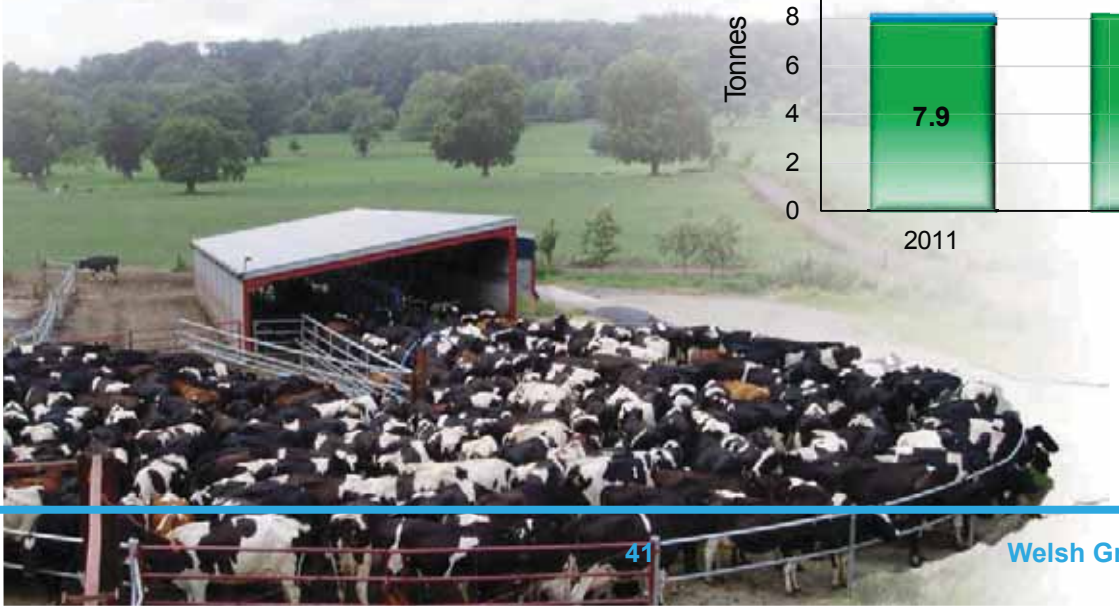
Table 15 Summary of Maesllwch Home Farm Performance

	2011	2012	2013
Herd size	348	375	423
Replacement rate [1]	14%	29%	12%
Yield per cow (litres) [2]	5,757	5,624	5,707
Litres per ha [2]	11,743	13,099	14,235
Milk solids per cow (kg)	420	411	417
Purchased feed per cow (kg) [3]	712	728	945
Yield from forage per cow (litres)	4,325	4,113	3,799
Stocking rate (cows per ha) [4]	2.04	2.33	2.49
Annual rainfall (mm)	656	1,099	884
Grazing weeks	34	28	42
Inorganic nitrogen (kg per ha)	0	0	173
Net margin as % of output	44%	39%	33%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 49 Grass Grown and Utilised at Maesllwch Home Farm





Moor Farm

Dei and Heulwen farm in partnership as DL & HL Davies at Moor Farm, Holywell, Flintshire overlooking the Dee Estuary. Moor Farm is a Flintshire County holding farm. Their 120 Holstein / Friesian cows were moved from Autumn to Spring calving three years ago, to allow for an increased focus on efficient production from grazed grass. Milk is sold to Arla on a constituent contract. Dei and Heulwen's son Rhys is a lecturer at Llysfasi College and very interested in Moor Farm's herd genetics.

- Spring calving herd of Holstein / Friesian cows
- Constituent contract
- Low replacement rate despite moving calving pattern
- Low rainfall farm but with reasonable moisture retentive medium and clay loam soils
- One of the highest milk solids production per cow
- Around 6% of paddocks re-seeded annually, with high sugar perennials and clover.

Moor Farm has grown on average 12.2 tonnes DM / ha / year, the highest average production of all the farms over the three year project.

- Grass utilisation averaged at 72% of grass grown
- The highest performing 10% of paddocks yielded 16.8 tonnes DM / ha / year, with the lowest recording 8.8 tonnes DM / ha / year
- The farm applied an average of 260 kg N / ha from bagged N, delivering a response rate of 46 kg DM of grass for every kg N applied
- An average of 31% of output was retained as margin.

Key performance pointers:

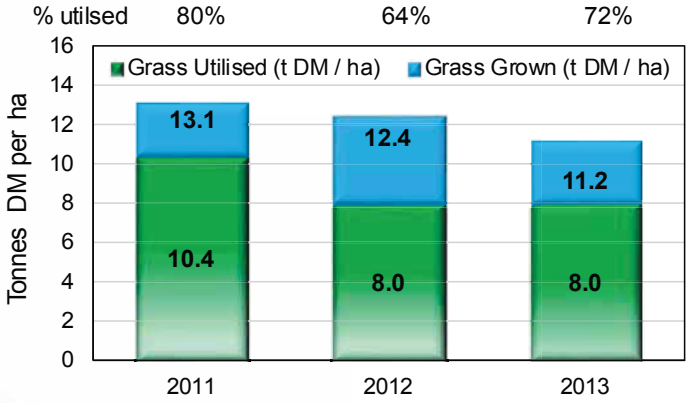
- Sets a grass budget and rotation planner
- Flexible paddock grazing system with a fresh break after each milking and use of on-off grazing when required
- Maximum pre-grazing covers are relatively high at 3,500 kg DM per ha in the Spring and 3,800 in the Autumn
- Pre-mow each paddock at least once in each season
- Focus on adapting to conditions.

Table 16 Summary of Moor Farm Performance

	2011	2012	2013
Herd size	113	111	118
Replacement rate [1]	24%	22%	14%
Yield per cow (litres) [2]	6,438	6,842	6,539
Litres per ha [2]	18,187	18,816	19,289
Milk solids per cow (kg)	470	499	477
Purchased feed per cow (kg) [3]	1,541	1,366	2,122
Yield from forage per cow (litres)	3,417	4,370	2,385
Stocking rate (cows per ha) [4]	2.83	2.75	2.95
Annual rainfall (mm)	656	728	600
Grazing weeks	33	33	43
Inorganic nitrogen (kg per ha)	245	249	286
Net margin as % of output	41%	30%	22%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 50 Grass Grown and Utilised at Moor Farm



Nantybach Farm

Chris Mossman and family run Mossman Farming Ltd. at Nant-y-Bach, Llangrannog, Ceredigion. Nantybach is a coastal farm overlooking the picturesque seaside village of Llangrannog. The farm is prone to drying out mid-season but enjoys a mild climate and higher than average winter growth. The farm has increased cow numbers from 250 crossbred cows at the start of the project to 350. Extra land has become available next door to Nantybach and Chris has been able to take on the land as cow numbers have expanded through home bred replacements. The herd at Nantybach has consistently been the highest yielding as far as milk solids per cow produced from forage.

- Crossbreeding for 13 years. Jersey x Friesian bred for milk quality and fertility
- Constituent contract
- Out at grass day and night from calving mid-February
- Light soils but with reasonable average rainfall 1,007 mm (43 inches).

One of the top 25% grass-producing farms in the group, achieving on average 11.8 tonnes DM / ha on light land.

- Grass utilisation was high at 95% (see page 31 for further explanation)
- The farm used 313 kg of artificial N / ha, giving a response rate of 35 kg DM of grass per kg N applied. The actual response rate is likely to be higher than this if the full yield was taken into account
- Margin as a % of output averaged 30%.

Key performance pointers:

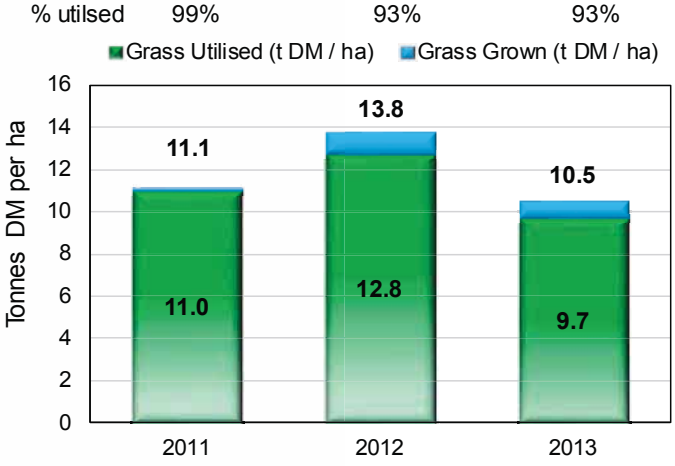
- A fresh allocation of grass given once a day
- The grass production of the acquired sheep land was increased through nitrogen applications and rotational grazing, without the need to re-seed. The rotational grazing helped to open up the sward, promoting ryegrass growth and improving sward composition
- Pre-grazing Autumn cover up to 3,800 kg DM / ha
- Tracks re-surfaced every five years
- Very little re-seeding and low levels of clover maintained in swards.

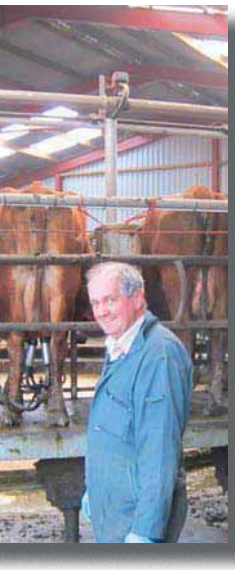
Table 17 Summary of Nantybach Farm Performance

	2011	2012	2013
Herd size	283	302	327
Replacement rate [1]	18%	21%	15%
Yield per cow (litres) [2]	6,933	6,744	6,959
Litres per ha [2]	21,681	21,908	24,469
Milk solids per cow (kg)	506	492	508
Purchased feed per cow (kg) [3]	1,042	1,083	1,657
Yield from forage per cow (litres)	4,746	3,535	3,484
Stocking rate (cows per ha) [4]	3.13	3.25	3.52
Annual rainfall (mm)	834	1,208	980
Grazing weeks	48	39	41
Inorganic nitrogen (kg per ha)	325	304	311
Net margin as % of output	28%	37%	26%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 51 Grass Grown and Utilised at Nantybach Farm





Neuaddlwyd Farm

Richard Thomas and family farm at Neuaddlwyd Farm, Llanfair Caereinion, Powys in Mid Wales. Richard has imported numerous Scandinavian Red cows and bulls, with the whole herd now grading up to full pedigree status. The herd calves mainly in the Spring and Autumn and Richard uses a team of pedigree bulls for natural service. Herd numbers have increased to coincide with Richard's two sons joining him in the business, and together they have recently completed a comprehensive building project to accommodate the extra cows.

The farm joined the project at the end of 2011.

- Autumn and Spring calving herd
- High milk solids producing herd
- Pedigree Scandinavian Reds selected for longevity
- Over 90% of swards over 10 years old
- Silty loam soil
- Cows typically housed from end of October.

Neuaddlwyd Farm has grown on average 10 tonnes DM / ha / year.

- Grass utilisation averaged 59% of grass grown
- The highest performing 10% of paddocks yielded 13.5 tonnes DM / ha / year, with the lowest recording 6.7 tonnes / ha DM / year
- The farm applied on average 239 kg N / ha from bagged N, delivering a response rate of 45 kg DM of grass for every kg N applied.
- 30% of output retained as margin.

Key performance pointers:

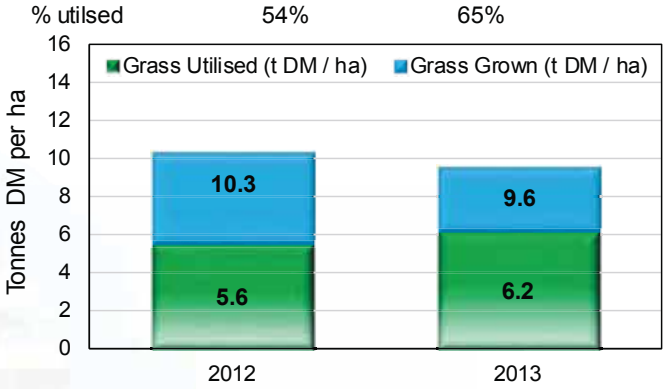
- Annual grass budget developed and implemented
- 90% of paddocks have good track access
- Develops a nutrient plan with advisor input.

Table 18 Summary of Neuaddlwyd Farm

	2012	2013
Herd size	310	332
Replacement rate [1]	22%	22%
Yield per cow (litres) [2]	6,783	6,201
Litres per ha [2]	18,713	18,323
Milk solids per cow (kg)	495	453
Purchased feed per cow (kg) [3]	2,151	2,350
Yield from forage per cow (litres)	2,453	1,550
Stocking rate (cows per ha) [4]	2.76	2.95
Annual rainfall (mm)	1,124	926
Grazing weeks	33	33
Inorganic nitrogen (kg per ha)	285	192
Net margin as % of output	36%	20%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 52 Grass Grown and Utilised at Neuaddlwyd Farm



Padog Farms Ltd, Tyn y Bryn

David Wynne Finch and Rhys Williams, Directors of Padog Farms Ltd., supported by farm manager Eifion Jones and a team of dedicated staff, together run Tyn y Bryn, Pentrefoelas. Tyn y Bryn is part of the Wynne Finch Estate and has up until conversion been a typical upland sheep farm within the Snowdonia National Park. Since the start of conversion, the farm has been evolving to the current state of infrastructure, with a network of tracks servicing manageable grazing paddocks, milking facilities and winter housing for all of the cows. David and Rhys have had a major influence on the development of pasture based dairying in Wales and have been able to give fantastic opportunities to a number of young people to progress within the industry.

- A newly developed unit
- High rainfall, high altitude farm. Average 1,435 mm rainfall (56.5 inches)
- Friesian crossbred cows
- Spring calving with 100% calved in 12 weeks
- Consistently stocking over three cows per ha
- Applies DAP to grazing swards in early Spring
- 3 km to furthest paddock.

Padog Farms Ltd. have grown on average 9.8 tonnes DM ha / year across the three year project.

- Grass utilisation averaged 83% of grass grown, with cows grazed for 45 weeks
- The farm applied an average of 228 kg N ha of bagged N, achieving a response rate of 57 kg DM of grass per kg N applied
- With its young herd, Padog has one of the lowest replacement rates at 14%
- One of the highest profit margins, with 38% of output retained.

Key performance pointers:

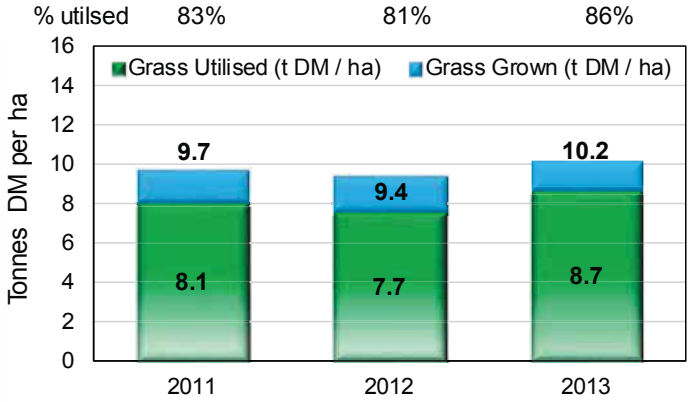
- Grass cover at turnout of 1,950 kg DM / ha
- Spring rotation planner used to allocate grass up to 'Magic Day' (when growth matches demand)
- Paddocks with covers above 3,500 kg DM / ha removed for silage
- Cows housed in December when grass cover reaches 1,900 kg DM / ha
- 100% of paddocks have good track access, typically 5 metres wide constructed with quarry stone dug on farm.

Table 19 Summary of Padog Farms Performance

	2011	2012	2013
Herd size	403	430	423
Replacement rate [1]	15%	14%	14%
Yield per cow (litres) [2]	4,729	5,320	5,580
Litres per ha [2]	14,259	16,627	17,357
Milk solids per cow (kg)	345	388	407
Purchased feed per cow (kg) [3]	443	988	1,036
Yield from forage per cow (litres)	3,846	3,260	3,589
Stocking rate (cows per ha) [4]	3.02	3.13	3.11
Annual rainfall (mm)	1,531	1,512	1,260
Grazing weeks	52	44	39
Inorganic nitrogen (kg per ha)	226	228	230
Net margin as % of output	35%	40%	38%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 53 Grass Grown and Utilised at Padog Farms



Plas Newydd Farm

Dyfed and Llinos Griffith and Dyfed's parents trade as GH Griffith ai Gwmni at Plas Newydd Farm, Llwyndyrus, Pwllheli on the Llyn Peninsula. Dyfed and Llinos' son Ifan, has recently joined the farm business, having spent some time in New Zealand. They run 200 Autumn calving crossbreed cows on 42 ha. Previously the farm had a pedigree herd of Holstein cows that were dispersed and replaced with crossbreeds. The farm is at the foothills of the Eifl range and is on particularly heavy land with high peat content. The Griffith family have recently purchased a further holding on the peninsula on which they intend to establish a Spring calving herd.

- Irish Friesian and crossbreds, Kiwi Friesian on heifers. Breeding for milk volume and fertility
- Constituent contract
- Proportion of the herd grazing day and night from February
- Maize was grown off farm until 2012.

Plas Newydd Farm was one of the farms with the highest grass production, growing 12.0 tonnes DM / ha / year

- Grass utilisation increased from 53% to 81% during the project period
- The farm applied an average 326 kg of artificial N / ha and achieved a response rate of 32 kg DM of grass per kg N applied
- Average yield was 7,104 litres per cow, or 519 kg milk solids per cow, with 2,927 litres from forage
- The farm has the highest stocking rate of the project farms, at 4.23 cows / ha
- Dry cows are grazed off farm to build up cover for the Autumn calving cows.

Key performance pointers:

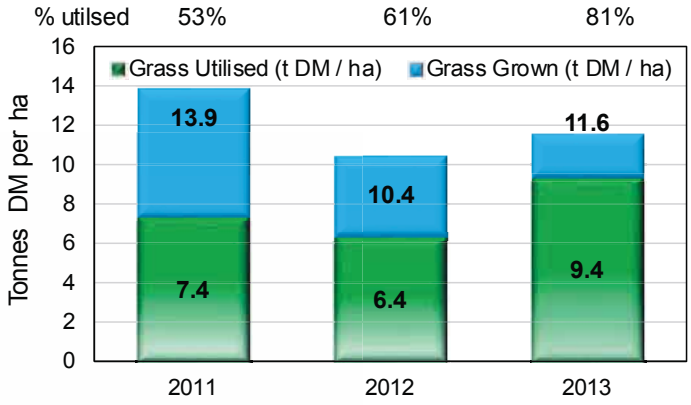
- The farm achieves one of the highest Spring grass growth rates, which supports the high stocking rate
- Cows are typically housed by early October, to allow covers to build up over winter to accommodate the high stocking rate
- Cows are given a fresh allocation of grass once a day
- No pre-mowing or topping carried out. Paddocks with excessive grass cover are cut for silage.

Table 20 Summary of Plas Newydd Farm Performance

	2011	2012	2013
Herd size	225	215	252
Replacement rate [1]	28%	32%	16%
Yield per cow (litres) [2]	7,532	7,206	6,574
Litres per ha [2]	29,611	28,871	31,166
Milk solids per cow (kg)	550	526	480
Purchased feed per cow (kg) [3]	1,961	2,506	1,751
Yield from forage per cow (litres)	3,643	2,179	2,960
Stocking rate (cows per ha) [4]	3.93	4.01	4.74
Annual rainfall (mm)	998	1,365	1,100
Inorganic nitrogen (kg per ha)	351	306	321

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 54 Grass Grown and Utilised at Plas Newydd Farm



Plas-y-Berllan Farm

Hywel, Alex and Hywel's parents run James Partners business at Plas-y-Berllan, Cardigan. Hywel is a committed organic enthusiast and Plas-y-Berllan has been organic since April 2000 under the Soil Association accreditation, and the milk is sold to OMSCo. Hywel runs 300 crossbreed Autumn calving cows on the 85 ha mainly grass farm. All youngstock are reared off farm and the dry cows are grazed away in August and September to build up grass covers for the freshly calved cows in the Autumn. This accounts for the very high stocking rate.

- Organic Friesian crossbred cows. No crossbreeding in last five years due to liquid milk contract
- Autumn calving cows
- Medium loam soils
- 6% of paddock area re-seeded each year.

Plas-y-Berllan is a very efficiently run organic Autumn calving herd achieving a good farm profit.

- The farm grew an average 8.3 tonnes of DM with no fertiliser
- The highest 10% of performing paddocks yielded 11.3 tonnes DM / ha, with the lowest yielding 5.5 tonnes DM / ha
- Consistent yield of 6,872 litres or 502 kg milk solids per cow, with 4,032 litres per cow from forage
- Margin retained was an average of 23% of output.

Key performance pointers:

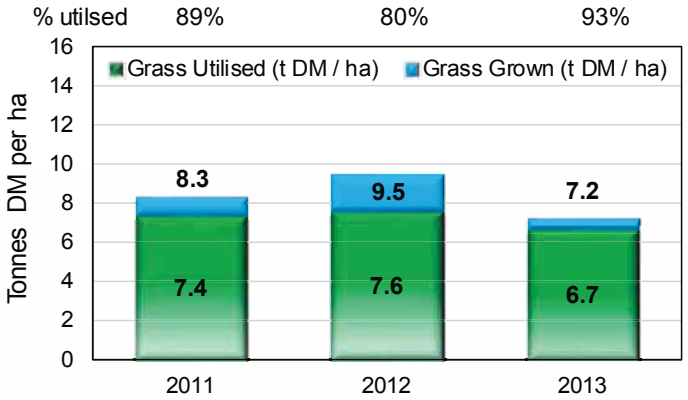
- Dry cows are taken off the milking platform, allowing cover to increase to approximately 2,600 kg DM / ha through the summer before the start of calving. Maximum pre-grazing Autumn cover of 3,600 kg DM / ha
- Typically pre-mowing of platform once within season
- Fresh allocation of grass after each milking and back fence on larger paddocks in wet conditions
- 4 to 5 metre quarry stone tracks to 90% of farm. Try to keep tracks clean and remove grass from the sides to allow rain to runoff
- Annual budget of £4,000 per year for sward improvement
- Hywel purposely extends the rotation length to take full advantage of clover nitrogen fixing.

Table 21 Summary of Plas-y-Berllan Farm Performance

	2011	2012	2013
Herd size	287	282	291
Replacement rate [1]	30%	22%	28%
Yield per cow (litres) [2]	7,081	6,905	6,630
Litres per ha [2]	23,714	23,123	23,161
Milk solids per cow (kg)	517	504	484
Purchased feed per cow (kg) [3]	836	1,394	1,858
Yield from forage per cow (litres)	5,373	4,066	2,656
Stocking rate (cows per ha) [4]	3.35	3.35	3.49
Annual rainfall (mm)	586	966	995
Grazing weeks	34	32	33
Inorganic nitrogen (kg per ha)	0	0	0
Net margin as % of output	32%	25%	12%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Figure 55 Grass Grown and Utilised at Plas-y-Berllan Farm



Tyn Ffynnon Farm

Gwydion and his parents run Alun Jones ai Gwmni at Tyn Ffynnon, Pandy Tudur, Abergele. The 40 ha farm carries 135 crossbreed cows bred from imported Jerseys. The farm runs to above 1,000 ft. and is very exposed. Youngstock are reared on a separate holding where they are wintered on crops. Gwydion recently entered a joint venture business in partnership with a farming friend and a beef and sheep farmer. They have converted the farm to a 300+ cow, Spring calving unit.

- Jersey / Friesian crossbreeds
- Breeding policy to cross back to Friesian, selecting for milk quality, fertility and longevity
- Tight Spring calving block, with 95% calved in 12 weeks
- Mixture of medium and heavy clay, average rainfall 1,299 mm (52 inches)
- Heifers out-wintered on kale and fodder beet.

A strict Spring calving farm, growing 11.6 tonnes DM / ha of grass per year:

- Grass utilisation averaged 88% over the three years. The grazing period was significantly restricted during the wet summer of 2012
- The farm applied an average of 248 kg artificial N / ha, achieving a response rate of 43 kg DM of grass per kg of all N applied
- Average yield was 6,068 litres per cow or 443 kg milk solids, with 4,108 litres from forage
- An average of 25% of output was retained as margin.

TABLE 22 SUMMARY OF TYN FFYNNON FARM PERFORMANCE

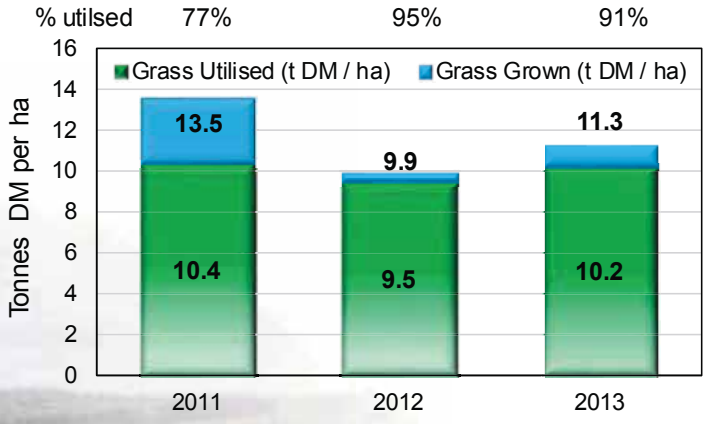
	2011	2012	2013
Herd size	107	130	138
Replacement rate [1]	22%	29%	9%
Yield per cow (litres) [2]	5,886	5,868	6,449
Litres per ha [2]	18,200	19,655	21,603
Milk solids per cow (kg)	430	428	471
Purchased feed per cow (kg) [3]	774	735	997
Yield from forage per cow (litres)	3,158	4,309	4,857
Stocking rate (cows per ha) [4]	3.09	3.35	3.35
Annual rainfall (mm)	1,186	1,535	1,175
Grazing weeks	35	24	39
Inorganic nitrogen (kg per ha)	274	227	241
Net margin as % of output	15%	30%	30%

[1] To maintain herd. [2] Standard litre of 4.0% butterfat and 3.3% protein
[3] All purchased feed at 86%DM equivalent [4] Applies to the grazing platform

Key performance pointers:

- A Spring rotation planner is used
- Cows stocked at an average of 3.26 cows / ha
- Turnout cover is 1,950 kg DM / ha, with closing covers typically at 2,000 kg DM / ha
- Good access is available to 90% of paddocks, with 3 to 4 metre wide tracks constructed of quarry shale
- Mobile water troughs are used to ensure sufficient water supply
- 90% of swards have been slit aerated in the last three years.

FIGURE 56 GRASS GROWN AND UTILISED AT TYN FFYNNON FARM



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