AHDB

Dairy Research Review 2020

DAIRY

Contents

Foreword

AHDB Dairy Research and Development: Your levy, your future

Robust research providing clear evidence to drive change underpins the way our industry develops and remains competitive. New challenges are continuously emerging. Our research programme must be agile and evolve to be able to assist dairy farmers to remain competitive, resilient and sustainable and at the forefront of global dairy production.

Our mission as an evidence-based organisation is to fund practical research that can be applied on farm and drive continuous improvements. This then delivers advantages for your business and for the dairy industry as a whole. However, the research we do results in improved genetics, better nutrition and improved production efficiency, meaning that the animals themselves change over time. This means that some research needs regular updating to be relevant to our modern systems and animals. These continuous advances, supported with data collection and analysis, are the key to maintaining improvement and to unlocking our future potential.

Traditionally, research has been conducted by individual organisations, but the last few years have seen a shift in the realisation that greater advances can be achieved by partnership working. We work in collaboration with other AHDB sectors and with other funders and organisations to strengthen the science, avoid duplication, amplify dissemination and maximise the return on your levy. AHDB is absolutely key to ensuring that fundamental research will ultimately be applicable to our dairy farmers. We are continuing to develop and strengthen those important relationships to enable us to have that input. New technologies and scientific advances are emerging at a rapid rate and while this is exciting, it comes with additional costs. While the time taken for the research to end up on farm can take some years, it is essential that the applied part has been proven before changes are implemented on farm. We must also ensure we maximise the work of other researchers around the world in an attempt to reduce duplication and to use the expertise of others, rather than compete with them. As an example, we have a European Cattle Innovation Partnership with dairy levy bodies in Europe and we are partners in the EU Interreg project Dairy-4-Future.

The Research Booklet 2020 presents an updated selection of the results of our research activity. Animal health and welfare are the main focus of our research programme: prevention of diseases, proper nutrition and high welfare conditions are all areas of research that will lead to healthier animals and eventually to a more responsible use of antibiotics. Genetic improvements resulting in healthier and more efficient animals, together with a proper grazing and grassland management, are essential in reducing the impact of dairy farming on the environment.

Our scientists at AHDB are key to ensuring that the work we support is designed to improve our industry at farm level. I am proud to work with a dedicated team of scientists who have delivered and facilitated the work in this book.

Mandy Nevel
Head of Animal Health and Welfare

Genetics

Profitable Lifetime Index – £PLI

An economic breeding index for UK autumn block-calving and all-year-round-calving herds.

What is the £PLI?

The national Profitable Lifetime Index (£PLI) is published by AHDB as part of its genetic evaluation service. The £PLI is a within-breed genetic ranking index developed for UK dairying conditions in consultation with industry partners and is expressed as a financial value.

The £PLI will:

- Promote yield while protecting milk quality
- Increase emphasis on fertility
- Improve functional type – Feet & Legs and Udders
- Increase emphasis on longevity
- Reduce costs associated with maintenance
- Improve udder health and lameness
- Improve calving performance

£PLI explained

The £PLI value represents the additional profit a high-£PLI bull is expected to return from each of its milking daughters over their lifetime compared with an average bull of £0 PLI. The £PLI reflects the latest UK market and farming conditions.

The £PLI is a within-breed ranking. Bulls of each dairy breed are shown on a separate breed base and £PLI values from different breeds are therefore not directly comparable.

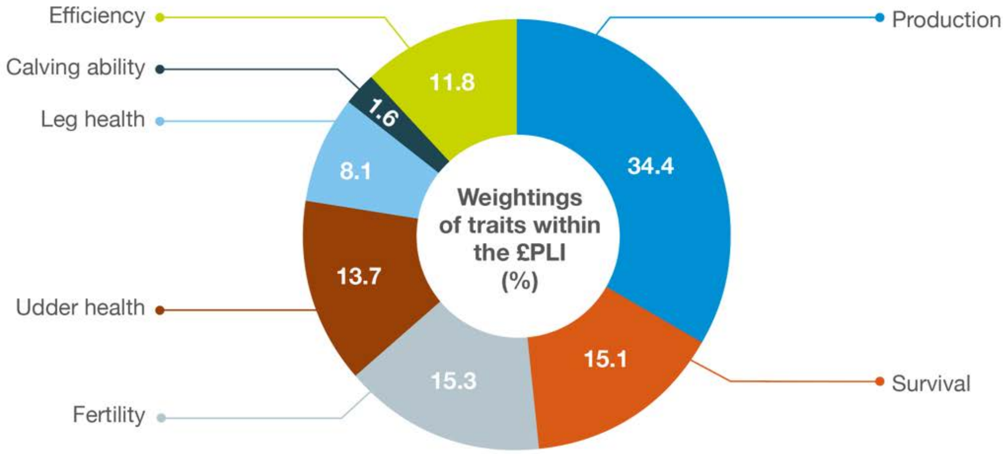


Figure 1. The percentage weightings of traits within the £PLI

When to use the £PLI

The £PLI is recommended for use by all-year-round-calving UK farming operations and should be used as the initial screening tool in bull selection; then look within this group for the traits that most need improving in your herd. This will vary with individual herds but should include the Lifespan and Fertility indexes. Use the £PLI to select the best bulls to breed profitable cows for typical all-year-round-calving UK systems.

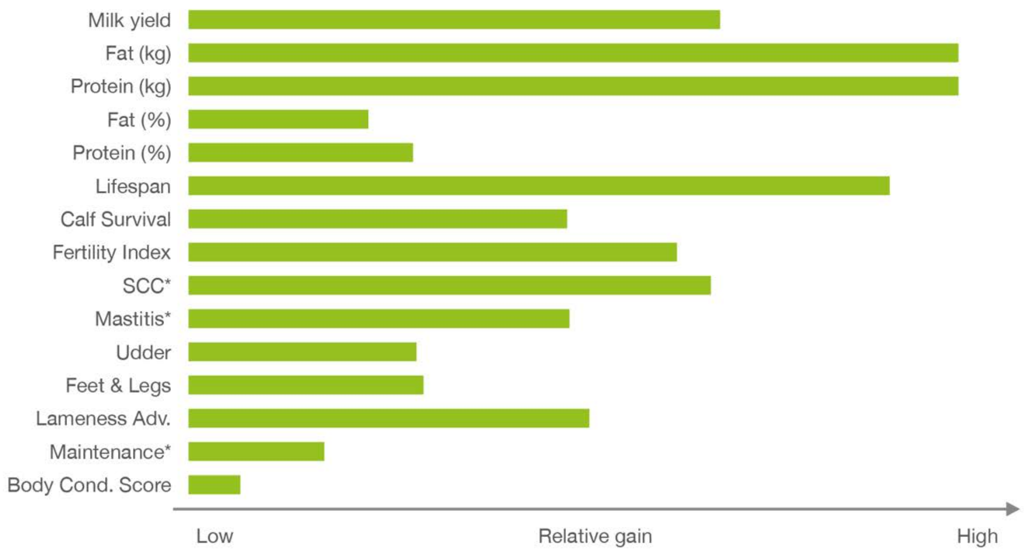


Figure 2. Relative genetic gain for a range of traits, based on the average of all available Holstein bulls; July 2018 (* trait reversed for presentation purposes)

£PLI – Frequently asked questions

What are the relative weightings in the £PLI on production and health traits?

The £PLI has approximately 35% weighting on production and 65% on health and fitness, placing a particularly strong emphasis on female fertility, longevity, udder health and maintenance cost to reflect the efficiency with which the cow produces milk.

What is the maintenance cost trait?

Farmer experience and research indicate the greater cost of feeding a larger cow. If two cows are identical in every other way (production, health, fertility, etc.), smaller cows, which cost less to feed, will be more profitable and have a higher £PLI.

How is the cost of maintenance calculated?

The cost of maintaining a cow is related to its weight. As we don't routinely weigh dairy cattle, we have studied the traits most closely related to the cow's weight. These traits are stature, chest width, body depth and angularity. These traits are closely correlated to liveweight and are, therefore, used as an indicator of the costs of maintenance.

Have other factors that relate to the cow's weight been considered, such as calf values?

Liveweight as an indicator of maintenance has not been considered in isolation. The value of the heavier cull cow comes into the calculation, as does the higher-value calf from a larger dam. The cost of rearing a larger heifer has also been considered in the revised £PLI.

What is the Mastitis index?

The Mastitis index allows farmers to breed cows with improved resistance to mastitis, tackling a common issue on farm on both a genetic and management level.

Why has the Mastitis index been included in the £PLI alongside somatic cell count (SCC)?

Although there is a strong link between the SCC index and a reduction in mastitis cases, there are a small number of bulls who reduce SCC but not necessarily cases of mastitis – this new index will help to identify those bulls and allow farmers to make more informed breeding decisions for their herd.

Therefore, as part of the udder health component, we have reduced the weighting given to SCC, as we can now directly select for increased mastitis resistance.

What is used in the Lameness Advantage Index?

The Lameness Advantage Index combines existing type data for Locomotion and Feet and Legs, with bone-quality scores, digital dermatitis and lameness records to allow farmers to breed cows with improved resistance to clinical lameness. This index helps to address a costly welfare issue faced by British dairy farmers today.

How should the Calf Survival Index be used?

The Calf Survival Index can be used to improve calf survival rates between tagging and 10 months of age by selecting bulls with above zero PTAs.

How does the Calf Survival Index differ to the Lifespan Index?

Calf Survival is based on BCMS records of calf deaths between tagging and 10 months of age when mortality is high but does not include stillbirths or deaths before tagging. Lifespan PTAs, on the other hand, predict the survival of animals once they are in the milking herd. These two indexes have a correlation of +0.4 so are not the same trait, as the common causes of calf deaths are not the same as the common reasons for cows leaving the herd.

Can £PLI be used to compare cattle of different breeds with one another?

£PLI is a breed-specific index with all values and Predicted Transmitting Abilities (PTAs) calculated on each breed's own base. Anyone wishing to make across-breed comparisons is advised to contact AHDB for a conversion formula for this purpose.

Which type of herds should use £PLI as their main breeding goal?

The index is recommended as the primary selection tool for UK dairy herds operating an all-year-round-calving system. £PLI should be used as an initial screening tool for bulls and, following this, producers are advised to place emphasis on traits that need improvement in their own herd. The Spring Calving Index (£SCI) and Autumn Calving Index (£ACI) are available solely for producers operating a spring block-calving or autumn block-calving system, respectively.

Spring Calving Index – £SCI

An economic breeding index for spring block-calving systems.

What is the £SCI?

The Spring Calving Index (£SCI) is an across-breed genetic ranking index developed in consultation with industry partners specifically for spring block-calving herds and expressed as a financial value.

The £SCI will:

- Promote milk quality rather than volume
- Place strong emphasis on fertility
- Select for reduced maintenance cost
- Improve udder and leg health
- Place strong emphasis on longevity
- Promote easier calving
- Protect functional type – Feet & Legs and Udders

£SCI explained

The £SCI value represents the additional profit a high-£SCI bull is expected to return from each of its milking daughters over her lifetime compared with an average bull of £0 SCI. These are specifically calculated for UK markets and farming conditions.

The £SCI will ensure important genetic areas are maintained or improved, e.g. fertility (calving interval and non-return rate), SCC and milk solids.

Increased emphasis on the maintenance cost by reducing cow liveweight will give the daughters of high-£SCI bulls improved efficiency suited to a spring-calving, grazing-based system.

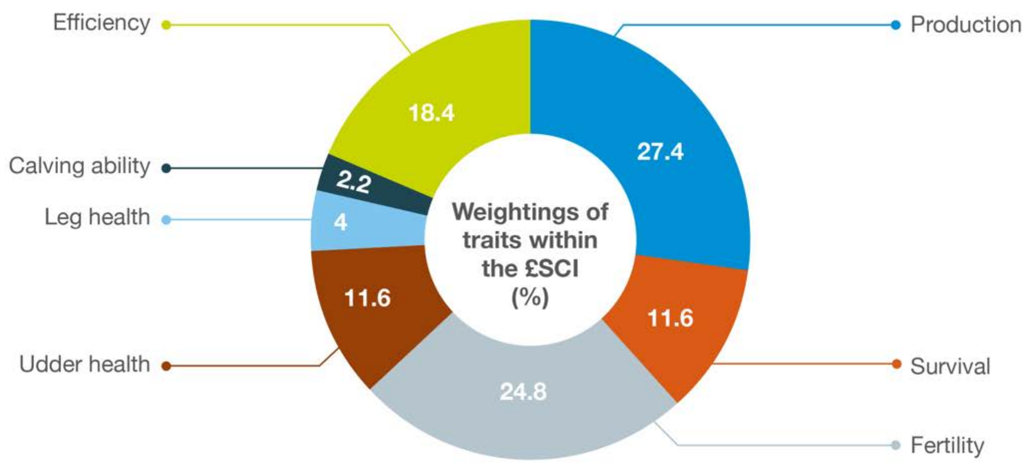


Figure 3. The percentage weightings of traits within the £SCI

When to use the £SCI?

The £SCI has been created specifically for spring block-calving systems, which place a heavy reliance on grazed grass. For autumn block-calving herds, we recommend using the Autumn Calving Index (£ACI). As it is an across-breed ranking, bulls of all breeds will be shown on the same base, so their £SCI values are directly comparable.

Use the £SCI to select the best bulls to breed profitable cows for a spring block-calving system. The index should be used as the initial screening tool in bull selection; then look within this group for the traits which most need improving in your herd.

UK genetic evaluations are undertaken and published by AHDB Dairy three times a year: April, August and December. For more information, visit the web: **ahdb.org.uk/dairy-breeding-genetics**

£SCI – Frequently asked questions

Why has AHDB Dairy launched the £SCI?

The Spring Calving Index (£SCI) has been introduced at the request of farmers to provide them with a genetic index to help breed a cow that suits a spring block-calving system, making extensive use of grazed grass. The index has been developed to breed a cow which produces lower volumes of milk of a higher quality and places a particular emphasis on fertility and calving ease to achieve a tight calving block.

The index also favours bulls that will produce a smaller cow with lower maintenance requirements. As with the £PLI and £ACI, lower SCC and sound legs, feet and udders are all important.

Functional type is important in these systems. Why isn't there more emphasis on this in £SCI?

Functional type forms part of £SCI, just as it does with £PLI and £ACI. Udder health and conformation, together with feet and legs, are included, but it is important to note that these traits are also strongly correlated with some of the other components of the index, including lifespan, so they're more important than would seem at first glance.

Why has £SCI been developed as an across-breed index?

£SCI is being presented by AHDB as an across-breed index because this is considered to be the most useful format for spring block-calving herds. Many of these herds use more than one breed, either as pure or cross-bred animals, so it is important for them to be able to compare the genetic potential of bulls from different breeds against one another.

Can the £PLI, £ACI and £SCI be compared?

No. The indexes have been designed for different farming situations, with the £SCI set on its own unique breeding base.

Why should the £SCI be used instead of other country indexes?

Different milk payment systems in different countries is one of several reasons why you should use the UK breeding values when making breeding decisions for a UK dairy herd. It is important to note that the £SCI considers the economic influences to UK dairy farmers, so although it may be very similar to other country indexes, it is the most appropriate index for UK spring block-calving dairy farmers to use when making their breeding decisions.

Why are there minus PTA milk bulls near the top of the £SCI list?

Bulls near the top of the £SCI will transmit a range of attributes which make them suitable for spring block-calving herds. Their particular strengths will inevitably be in different areas and producers are advised to choose those which will transmit the characteristics most needed for their own situation.

Can I use £SCI if I block-calve at a different time of year?

£SCI has been formulated specifically for herds which block-calve in spring and place a heavy reliance on summer grazing. It is only suitable for use in these circumstances and not recommended for autumn block-calving herds, which have a higher requirement for winter concentrate feeding.

Autumn calvers should use the £ACI for their breeding decisions.

More information on AHDB Dairy Breeding, dairy genetics and how to access your herd genetic report can be found on the AHDB website: **ahdb.org.uk/dairy-breeding-genetics**

Autumn Calving Index – £ACI

An economic breeding index for autumn block-calving systems.

What is the £ACI?

The Autumn Calving Index (£ACI) is an across-breed genetic ranking index developed in consultation with industry partners specifically for autumn block-calving herds and expressed as a financial value.

The £ACI will:

- Promote milk quality with more weight on volume than the £SCI
- Place strong emphasis on fertility
- Select for reduced maintenance cost
- Improve udder and leg health
- Place strong emphasis on longevity
- Promote easier calving
- Improve functional type – Feet & Legs and Udders

£ACI explained

The £ACI value represents the additional profit a high-£ACI bull is expected to return from each of its milking daughters over her lifetime compared with an average bull of £0 ACI. These are specifically calculated for UK markets and farming conditions.

The £ACI will ensure important genetic areas are maintained or improved, e.g. fertility (calving interval and non-return rate), Somatic Cell Count (SCC) and milk solids.

Increased emphasis on the maintenance cost by reducing cow liveweight will give the daughters of high-£ACI bulls improved efficiency suited to an autumn calving system.

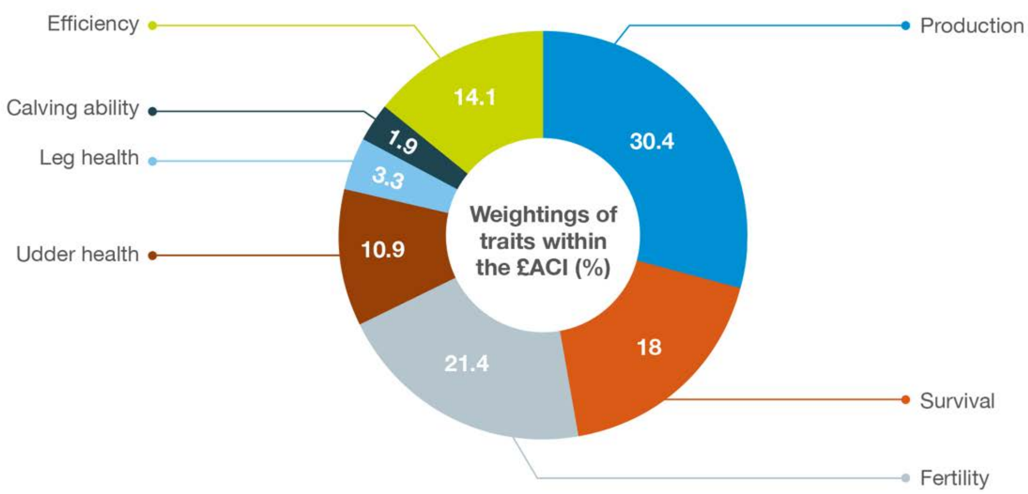


Figure 4. The percentage of weightings of traits within the £ACI

When to use the £ACI?

The £ACI has been created specifically for autumn block-calving systems, which have a higher requirement for winter feeding. For spring calving herds, we recommend using the Spring Calving Index (£SCI). £ACI should be used as the initial screening tool in bull selection; then look within this group for the traits that most need improving in your herd.

The £ACI is an across-breed ranking. Bulls of all breeds will be shown on the same base, so their £ACI values are directly comparable, and it should be used to select the best bulls to breed profitable cows for an autumn block-calving system.

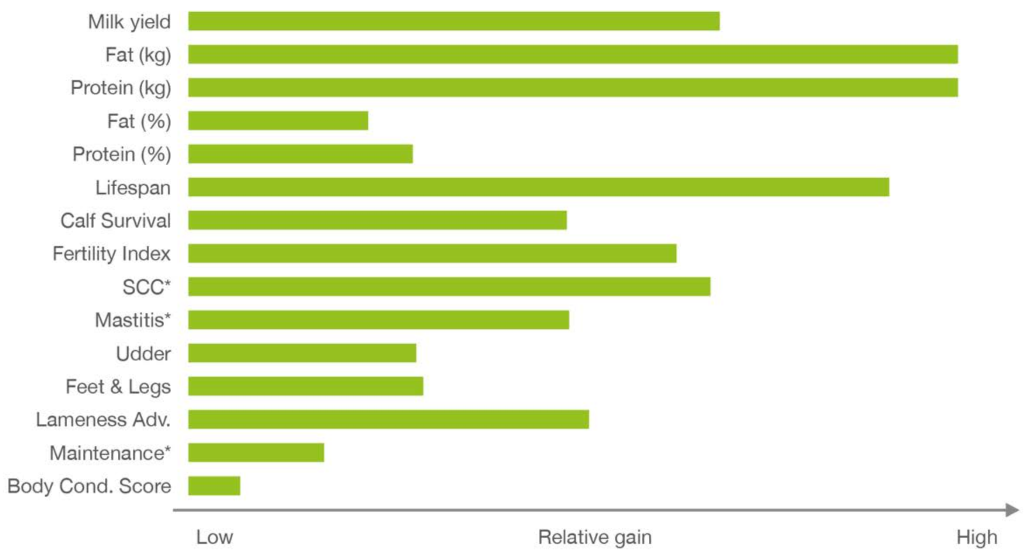


Figure 5. Relative genetic gain for a range of traits, based on the average of all available Holstein bulls; July 2018 (*trait reversed for presentation purposes)

£ACI – Frequently asked questions

Why has AHDB Dairy launched the £ACI?

The £ACI has been introduced to make bull selection for farmers operating tight autumn block-calving systems easier and more profitable. It also complements the Optimal Dairy Systems strategy. Through this, we are asking farmers to hold up a mirror to themselves and decide whether the system they are currently operating is the best one for them. Genetics is one of the Key Performance Indicators (KPIs) and it was felt that the new £PLI no longer addressed the requirements of autumn block calving. The £ACI has been developed to breed a cow that produces lower volumes of milk than the £PLI but with a higher quality (similar to the £SCI) and places a particular emphasis on fertility and calving ease to achieve a tight calving block, similar to the £SCI. The index also favours bulls that will produce a smaller cow with lower maintenance requirements. As with the £PLI and £SCI, lower SCC and sound legs, feet and udders are all important.

Functional type is important in these systems. Why isn't there more emphasis on this in £ACI?

Functional type forms part of £ACI, just as it does with £PLI and £SCI. Mammary health and conformation, together with Feet and Legs, are included, but it is important to note that these traits are also strongly correlated with some of the other components of the index, including lifespan, so they are more important than would seem at first glance.

Why has £ACI been developed as an across-breed index?

£ACI is being presented by AHDB Dairy as an across-breed index because this is considered to be the most useful format for autumn block-calving herds. A number of these herds use more than one breed, either as pure or cross-bred animals, so it is important for them to be able to compare the genetic potential of bulls from different breeds against one another.

Can the £PLI, £ACI and £SCI be compared?

No. The indexes have been designed for different farming situations so should not be compared.

Is the £ACI right for my herd?

The £ACI has been developed for herds targeting around 7,500 litres of milk, calving within a 12-week block and supplementing peak yield feed with concentrates. It is only suitable for use in these circumstances and not recommended for spring block-calving herds, which place a heavy reliance on summer grazing. Spring block-calving herds should use the £SCI for their breeding decisions.

Genetic evaluations for TB Advantage

What is TB Advantage?

TB Advantage is a genetic index published by AHDB Dairy to help dairy farmers make informed decisions to breed cows which have an improved resistance to bovine tuberculosis (bTB).

The index follows extensive research into the genetics of bTB, undertaken jointly by the University of Edinburgh, Roslin Institute and Scotland's Rural College (SRUC), and which was supported by Defra and the Welsh Government. Their work showed genetic variation between animals and formed the basis of the TB Advantage – the first genetic index of its kind in the world.

Initial development of the index used data on over 650,000 Holstein cows who have bTB data recorded by the Animal and Plant Health Agency (APHA). This data was combined with 87,683 Holstein cows in April 2017, supplied by the Department of Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland. From this data, breeding patterns have been established and more resistant bloodlines identified. The TB Advantage is available for all traditionally evaluated dairy breeds, but genomic PTAs are currently only available for the Holstein breed. Work is also underway to establish if the index can be extended to beef breeds.

It is important to note that breeding cattle with a reduced susceptibility to bTB is a long-term approach to disease control and should comprise just part of a much broader eradication strategy. All other existing and emerging control measures therefore remain critically important and should continue to be taken to protect cattle against bTB, irrespective of the choice of bull.

How to use TB Advantage

TB Advantage can be used as part of a range of important genetic traits to form a balanced breeding plan for the herd; this way, the herd's strengths are maintained and weaknesses improved. The degree of emphasis on the TB Advantage may further depend on whether the herd is within, or close to, a TB-affected area or not.

The index indicates the degree of resistance to bTB a bull is predicted to pass on to his offspring and is expressed on a scale which typically runs from -3 to +3 and, as for most other traits, positive values are desired. For every +1 point in the index, 1% fewer daughters are expected to become infected during a TB breakdown.

TB Advantage has small but favourable relationships with all traits currently in the UK breeding indexes, £PLI and £SCI. Selecting bulls with positive TB Advantage therefore will, on average, have no detrimental effect on any other trait.

However, farmers should look at each bull on a case-by-case basis, as any individual could have weaknesses that should be avoided for a particular herd.

A few considerations when using the index

The TB Advantage is available for all sires which have daughters milking in the UK (daughter-proven bulls with milking daughters in at least 10 herds affected by bTB) or Holstein bulls which have had their genotype (DNA) measured (young genomic bulls). Holstein females which have been genotyped will also be given a TB Advantage rating.

The reliability for the TB Advantage ranges from 20 to 99%, with an average reliability of 65% for bulls with UK daughters, and 45% for those with a genomic index only. Although the reliability of genomic predictions for the TB Advantage is currently less than for some other indexes, it can still be used as part of a dairy herd's breeding strategy and has shown to be valuable in predicting future performance.

For more information, please visit the AHDB website: **ahdb.org.uk/dairy-breeding-genetics**

Development of TB Advantage

What does this mean for dairy cattle selection?

Selecting bulls with high £PLI or £SCI, the UK dairy industry has already been, indirectly, selecting for desirable TB Advantage in the national herd. This new genetic index is an additional tool which now allows farmers to directly screen out the most negative TB Advantage bulls from their shortlist of bulls.

Due to the nature of dairy cattle breeding, this is a long-term aid, to be used in addition to current eradication policies already in place. But the decision to breed for improved resistance in your herd is a permanent benefit which accumulates with each new generation.

Where to find TB Advantage and further information

Predicted transmitting ability (PTA) for TB Advantage is now available on all bull reports and is part of the national genetic and genomic evaluations provided by AHDB Dairy in April, August and December each year. The PTA and reliability is included in the 'Management Traits' section of the bull factsheets which can be found through the £PLI and £SCI bull reports.

Further details on how to prevent the spread of bTB and other management measures you can take on farm can be found on the TB Hub – the home of UK TB information.

TB hub website

A joint industry online bTB hub was launched in autumn 2015. The website aims to be a one-stop shop for beef and dairy farmers to find practical advice on bTB, from wildlife and cattle biosecurity to trading rules and guidance on managing a TB breakdown. It has been developed and will be maintained by AHDB, APHA, BCVA, Defra, Landex and the NFU on behalf of the broader cattle industry. Chris Lloyd, AHDB Head of Knowledge Transfer Programme Development, who co-ordinated the development of the hub, said the aim is to provide a comprehensive resource on bTB that is easily navigable for the user to find the information of relevance to them: "It will be responsive to the needs of users and feedback on how its value can be further developed after launch will be welcome."

Practical advice and resources are available on the TB Hub at **www.tbhub.co.uk**, including advice on how to protect a herd from a TB breakdown, and how to deal with a breakdown if it occurs.

Mastitis Index

From April 2017, a mastitis index has been published for all breeds genetically evaluated in the UK. A genomic evaluation is also available for Holsteins. This index will allow farmers to breed cows with improved resistance to mastitis, tackling a common issue on farm, on both a genetic and management level.

Although there is a strong link between the Somatic Cell Count (SCC) index and a reduction in mastitis cases, there are a small number of bulls who reduce SCC but not necessarily cases of mastitis – this new index will help to identify those bulls and allow farmers to make more informed breeding decisions for their herd.

Development of the Mastitis Index

Over 10 years of animal data was supplied by the major milk-recording organisations to develop this index. From this data, mastitis was found to be 4% heritable – around the same level as fertility. The resultant index has a strong correlation with SCC and other Mastitis indexes published by other countries, of 0.8 and 0.88 respectively, with international correlations validated by Interbull.

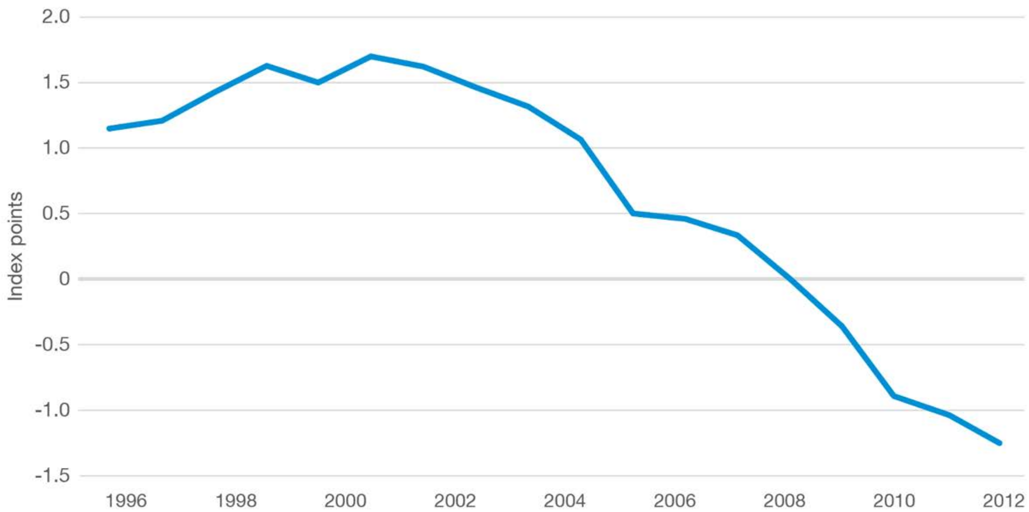


Figure 6. Mastitis trend – Holstein sires

How to use the Mastitis Index

The Mastitis index is published on a scale from -5 to +5 and expressed as a percentage. Similar to SCC, negative values are favourable in the Mastitis index. This means that for every per cent decrease in a bull's index, there will be a corresponding 1% decrease in his daughters' mastitis cases – illustrated in Figure 7.

This translates into, on average, 10 fewer cows with mastitis per year in a herd of 100 cows if a -5 mastitis bull is used instead of a +5 mastitis bull.

Not only is the Mastitis index published alongside SCC, it has also been incorporated into the Profitable Lifetime Index (£PLI). The process of bull selection will not change; the £PLI should be used as an initial screening tool and then traits of interest to your herd should be considered to progress your herd genetically.

These specific traits will vary between herds, depending upon system, management and breeding goals, but health traits, now including the Mastitis index, should always be taken into consideration when selecting bulls. Health traits may have a low heritability, but by including them in your breeding decisions they will have a cumulative effect on your herd.

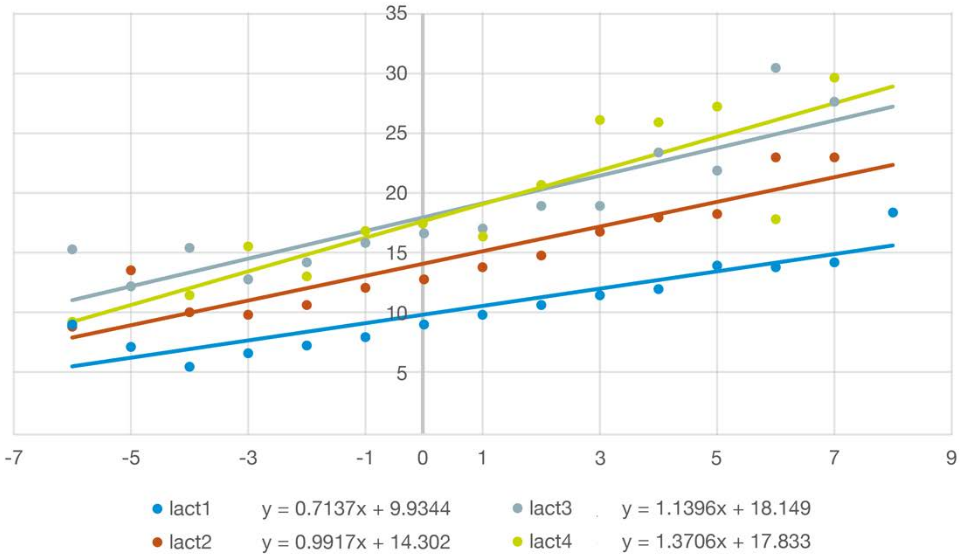


Figure 7. Per cent daughters with mastitis by sire PTA

Calf Survival Index

Genetic index to aid dairy calf survival

The Calf Survival Index, published by AHDB Dairy from April 2018, is available for all bulls evaluated in the UK and genomically evaluated Holsteins. Improved management for calf rearing has always been a focus for dairy farmers and the Calf Survival Index allows breeders to approach this on a genetic level. In addition to current management practices, bulls can now be selected for progeny which stand a better chance of survival from tagging to 10 months of age. The Calf Survival (CS) predicted transmitting ability (PTA), based on research conducted by Scotland's Rural College (SRUC), using close to 3 million animal records from the British Cattle Movement Service (BCMS), gives dairy producers a new tool to select bulls with above-average calf survival. The heritability of CS has been found to be around 5%, which will enable breeders who continually select bulls with improving calf survival genetics to achieve incremental improvements with each new generation of calves.

How does Calf Survival PTA differ from the Lifespan Index?

The new PTA for CS is based on BCMS records of calf deaths between tagging and 10 months of age. This captures a period when mortality is high, although it excludes stillbirths and deaths in the first 24 hours of life – information that is harder to obtain from national records. In contrast, the existing PTA for lifespan predicts the survival of animals once they are in the milking herd. There is a correlation between the two PTAs of +0.4, indicating they are not the same trait. (This is unsurprising as the common causes of calf deaths are not the same as the common reasons for cows leaving a herd.)
The CS PTA is one of only a few such dairy indexes in the world – giving UK producers more information with which to make well-informed breeding decisions.

How to use Calf Survival PTAs

The CS PTA can be used to improve calf survival rates between tagging and 10 months of age by selecting bulls with above zero CS PTAs. The typical range of CS PTA goes from -6% (bad) to +6% (excellent), which gives a full 12% difference in survival probability between the worst and best bulls, as shown in Figure 8. Calf Survival is published as a stand-alone trait but will be incorporated into the UK national breeding indexes, the Profitable Lifetime Index (£PLI) and Spring Calving Index (£SCI), in the future.

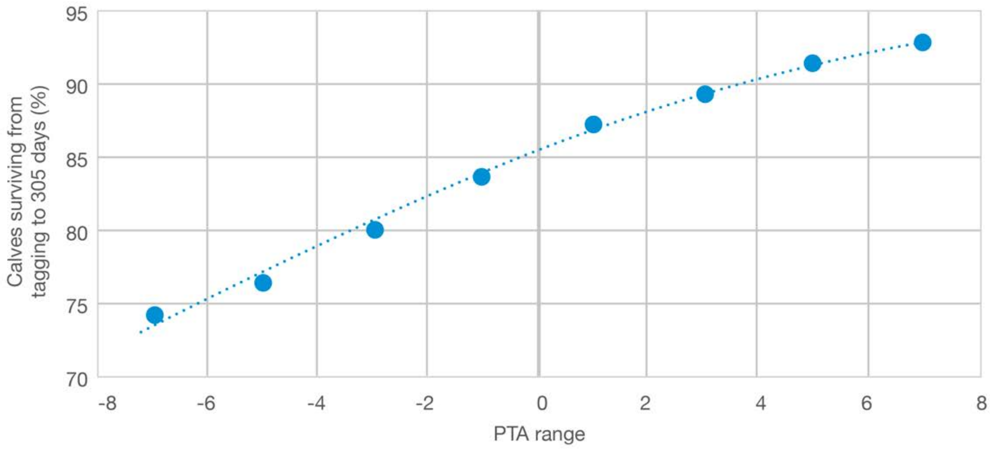


Figure 8. The per cent of calves surviving from tagging to 305 days based on sire calf survival PTA

Lameness Advantage

Genetic index to reduce lameness

Lameness Advantage enables dairy farmers to reduce the incidence of lameness in their herd through direct genetic selection, rather than indirect selection, through, for example, selecting for improved locomotion or Feet & Legs composites. Published by AHDB Dairy from April 2018, Lameness Advantage helps to address one of the most costly challenges faced by British dairy farmers today, as well as a major welfare concern of the industry.

Lameness Advantage Predicted Transmitting Abilities (PTAs) combine existing type data for locomotion and Feet & Legs, together with bone-quality scores and digital dermatitis records from the National Bovine Data Centre (NBDC) type classification system and, most importantly, include direct lameness recording, supplied by the milk-recording companies, National Milk Records (NMR) and Cattle Information Service (CIS). This PTA is available for all breeds of bull evaluated in the UK and genomically evaluated Holsteins.

Research by our partners at EGENES-SRUC* found the heritability of lameness to be 4%, which provides the potential to make a real change to the prevalence of lameness on dairy farms when used alongside current management protocols.

Lameness Advantage has been incorporated into the UK national breeding indexes, the Profitable Lifetime Index (£PLI), Spring Calving Index (£SCI) and Autumn Calving Index (£ACI).

How to use Lameness Advantage PTAs

Lameness Advantage PTAs can be used to reduce cases of lameness in the herd. These PTAs are expressed as a percentage and range from -5% (bad) to +5% (excellent). For every 1% change in a bull's Lameness Advantage PTA, a change of 1% of daughters becoming lame per lactation is predicted, shown in Figure 9. For example, a bull with a +5% Lameness Advantage is expected to have 5% fewer cases of lameness in his daughters per lactation compared with a 0% PTA bull.

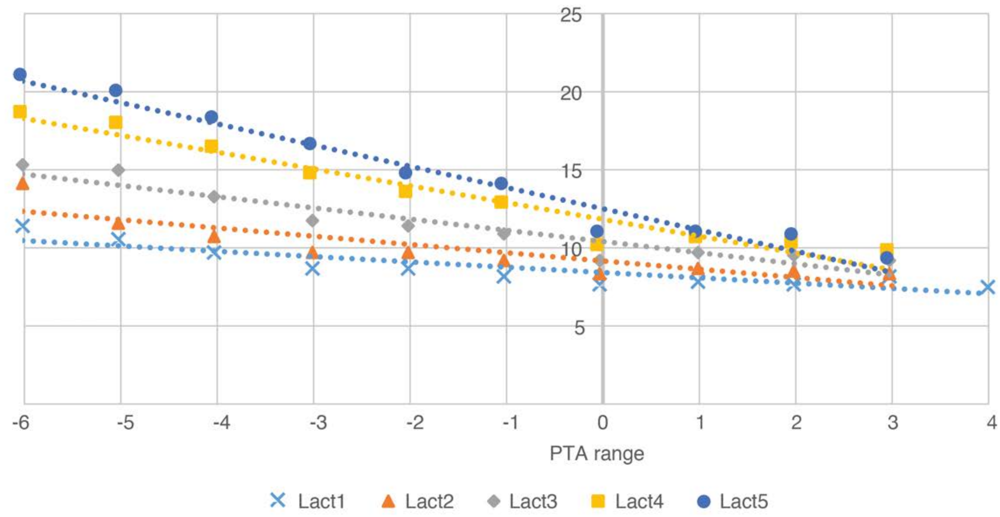


Figure 9. The relationship between sire Lameness Advantage PTA and the per cent of daughters with lameness

*EGENES-SRUC currently provides genetic evaluations for UK dairy cattle on behalf of AHDB Dairy as part of its breeding services.

Dairy Carcase Index

Genetic index to aid dairy carcase quality

With around 55% of UK beef originating from the dairy herd, there is a supply chain efficiency desire to monitor and, where possible, improve dairy cattle carcases.

The Dairy Carcase Index (DCI) has been created to improve dairy cattle carcases. The DCI is calculated using the average daily carcase gain and carcase conformation predicted transmitting abilities (PTAs).

These two PTAs have been developed using data from seven major abattoirs around GB and were found to have heritabilities between 50–60%.

Table 1 indicates the fat and conformation scores of carcases processed in 2016. From the data used from this project, the average dairy carcase fell into the 3O- class (highlighted by the yellow square), failing to meet the optimal market specification in conformation of at least R.

Resulting genetic evaluations are being made available by AHDB Dairy for the dairy breeds and AHDB Beef & Lamb for the beef breeds in the data set.

The DCI is primarily based on:

- Average daily carcase gain
- Carcase conformation

Table 1. Fat and conformation of 2016 processed carcases

Prime cattle		Fat class → Increasing fatness							
		1	2	3	4L	4H	5L	5H	Total
Conformation class → Improving conformation	E	0.0	0.2	0.3	0.1	0.0	0.0	0.0	**0.7**
	U+	0.1	0.9	2.3	1.1	0.2	0.0	0.0	**4.5**
	-U	0.1	1.4	6.1	6.4	1.4	0.1	0.0	**15.5**
	R	0.1	2.7	15.0	19.6	6.6	0.5	0.0	**44.7**
	O+	0.1	1.4	7.2	9.1	3.1	0.3	0.0	**21.3**
	-O	0.1	1.7	5.3	3.4	0.5	0.0	0.0	**11.1**
	P+	0.2	0.7	0.8	0.2	0.0	0.0	0.0	**1.9**
	-P	0.2	0.1	0.1	0.0	0.0	0.0	0.0	**0.4**
	Total	**0.9**	**9.2**	**37.2**	**39.9**	**11.8**	**0.9**	**0.1**	

How to use the Dairy Carcase Index (DCI)

DCI is published on a scale of about -5% (bad) to +5% (excellent). For each percentage point increase, an improvement is predicted in both carcase conformation and average daily carcase gain in a bull's progeny. From April 2018, the DCI is published by AHDB Dairy alongside existing dairy genetic evaluations but is not included in the total economic merit indexes (£PLI/£SCI). Therefore, farmers interested in improving the carcase quality of their cattle are advised to pay attention to bulls rating higher for the DCI. However, even farmers not directly interested in improving carcase quality are advised to monitor how the bulls used for breeding dairy replacements score. From a shortlist of sires with similar genetic merit for traits of interest, the ones with higher DCI could be favoured for use.

Initial research funded by AHDB Beef & Lamb, AHDB Dairy and Hybu Cig Cymru (HCC). The genetic evaluation of carcase traits for beef and dairy cattle is jointly funded by AHDB Beef & Lamb and AHDB Dairy.

Herd Genetic Reports

Herd Genetic Reports (HGRs) have been available for a number of years through AHDB Dairy to all UK dairy farmers who milk record. These HGRs allow farmers to see the genetic potential of their herd by providing the following information for the cows registered on their farm:

- Profitable Lifetime Index (£PLI)
- Spring Calving Index (£SCI) (available since December 2016)
- Milk (kg)
- Fat and Protein (kg and %)
- Inbreeding Level
- Management Traits – SCC, Lifespan, Fertility, Calf Survival, Lameness Advantage and Dairy Carcase Index

Within the HGR, the data is displayed in four parts – Herd Genetic Report Summary, Individual Milking Cow, Individual Youngstock and Breed Herd Standards.

Herd Genetic Report Summary

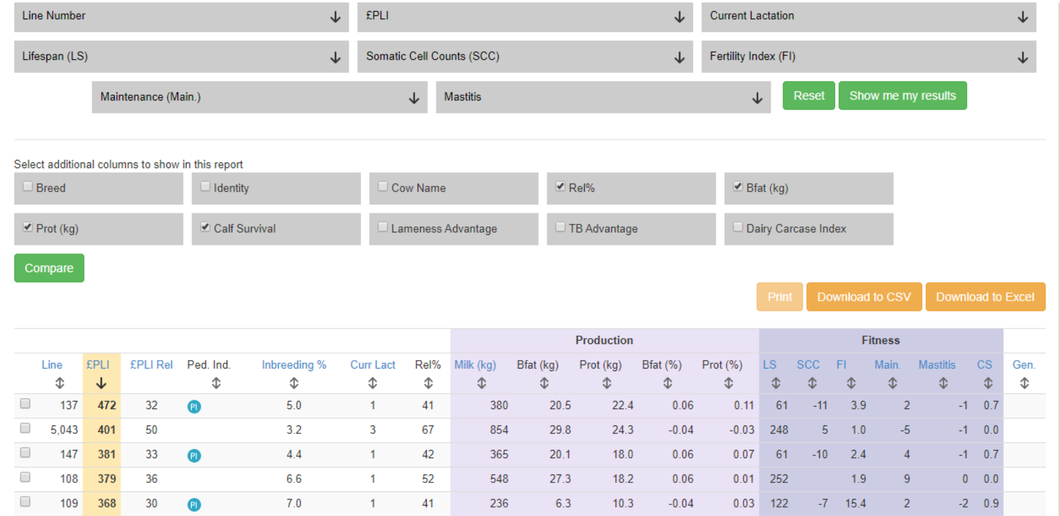
The Herd Genetic Report Summary allows your herd's strengths and weaknesses to be identified by age or lactation number, enabling you to monitor the genetic trends of your herd for a variety of traits. In addition, this summary allows genetically weaker traits to be identified and targeted on a whole-herd basis.

Table 2. Herd Genetic Report Summary

Lactation group	Predicted Transmitting Ability (PTA 2014) Herd Averages											
	No. of animals	£PLI	Inbreeding (%)	Ref (%)	Milk (kg)	Fat (kg)	Prot (kg)	Fat (%)	Prot (%)	Lifespan	SCC	Fertility Index
0–12 Months	85	255	2.2	34	71	10.6	6.1	0.10	0.05	0.25	-8.5	4.2
12–18 Months	46	195	2.2	37	110	9.9	6.3	0.07	0.03	0.19	-5.2	1.7
18–24 Months	33	205	1.5	37	64	7.1	5.4	0.06	0.04	0.19	-6.8	4.0
24+ Months	69	132	2.0	39	13	3.2	3.0	0.03	0.03	0.10	-2.8	3.3
1st Lactation	73	122	1.8	51	10	3.4	2.1	0.04	0.02	0.13	-5.8	2.0
2nd Lactation	57	79	2.0	63	60	4.6	4.2	0.03	0.03	0.08	0.6	-0.3
3rd Lactation	27	56	2.0	66	55	3.6	3.1	0.02	0.02	0.01	-1.9	0.8
4th Lactation	34	61	1.8	67	-20	1.6	2.1	0.03	0.03	0.03	-2.6	0.8
5th Lactation	13	-43	2.6	68	-15	-0.2	1.5	0.01	0.03	-0.07	0.1	-3.8
>5th Lactation	21	-19	1.6	68	-252	-5.5	-5.0	0.06	0.04	0.03	-3.1	0.4
Average	458	136	2.0	48	30	5.1	3.6	0.05	0.03	0.13	-4.3	2.0

Individual milking cow

The Individual Milking Cow Report can be used to identify the strengths and weaknesses of each cow (highlighted on the example report below); corrective breeding can then be implemented, either on a cow-by-cow basis or by highlighting the key traits that require improvement when identifying bulls for future breeding.

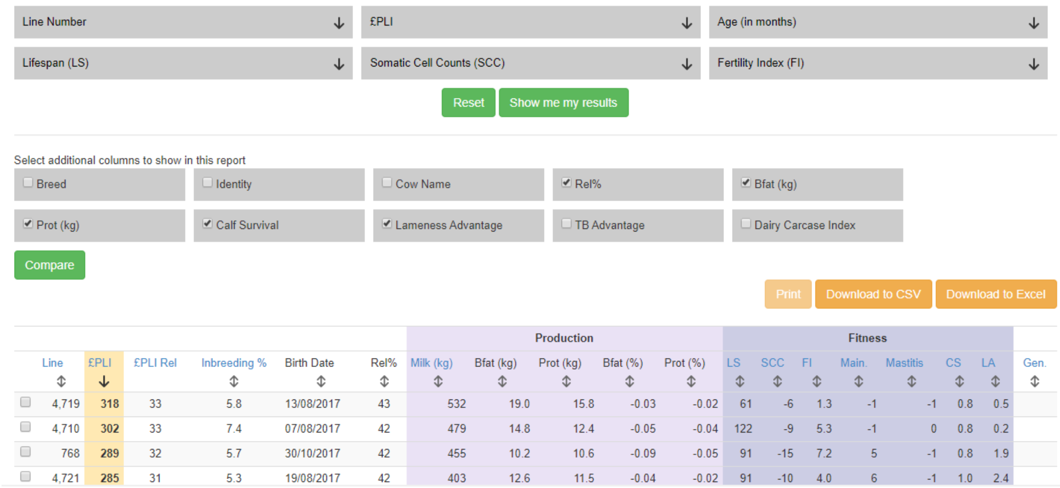


							Production					Fitness						
Line	£PLI	£PLI Rel	Ped. Ind.	Inbreeding %	Curr Lact	Rel%	Milk (kg)	Bfat (kg)	Prot (kg)	Bfat (%)	Prot (%)	LS	SCC	FI	Main.	Mastitis	CS	Gen.
137	472	32	PI	5.0	1	41	380	20.5	22.4	0.06	0.11	61	-11	3.9	2	-1	0.7	
5,043	401	50		3.2	3	67	854	29.8	24.3	-0.04	-0.03	248	5	1.0	-5	-1	0.0	
147	381	33	PI	4.4	1	42	365	20.1	18.0	0.06	0.07	61	-10	2.4	4	-1	0.7	
108	379	36		6.6	1	52	548	27.3	18.2	0.06	0.01	252		1.9	9	0	0.0	
109	368	30	PI	7.0	1	41	236	6.3	10.3	-0.04	0.03	122	-7	15.4	2	-2	0.9	

Figure 10. Milking Herd Report

Individual youngstock

Similar to the Individual Milking Cow Report, individual animal strengths and weaknesses can be easily re-ranked and identified. Future breeding policies can then be implemented with youngstock. In addition, if the youngstock have been genomically tested, the report will use this more accurate information in the tables. As with the Individual Milking Cow Report, filters have been added to the report, along with a print function, allowing groups of animals due to be mated to be assessed more easily.



						Production					Fitness							
Line	£PLI	£PLI Rel	Inbreeding %	Birth Date	Rel%	Milk (kg)	Bfat (kg)	Prot (kg)	Bfat (%)	Prot (%)	LS	SCC	FI	Main.	Mastitis	CS	LA	Gen.
4,719	318	33	5.8	13/08/2017	43	532	19.0	15.8	-0.03	-0.02	61	-6	1.3	-1	-1	0.8	0.5	
4,710	302	33	7.4	07/08/2017	42	479	14.8	12.4	-0.05	-0.04	122	-9	5.3	-1	0	0.8	0.2	
768	289	32	5.7	30/10/2017	42	455	10.2	10.6	-0.09	-0.05	91	-15	7.2	5	-1	0.8	1.9	
4,721	285	31	5.3	19/08/2017	42	403	12.6	11.5	-0.04	-0.02	91	-10	4.0	6	-1	1.0	2.4	

Figure 11. Youngstock Report

Breed herd standards

Finally, a benchmarking report is included to allow each herd to benchmark itself against the breed average by whole herd or lactation group. The report highlights areas where the herd is performing well but also allows potential goals to be set when making future breeding decisions.

Table 3. Herd benchmarking

Percentile	£PLI	PTA milk (kg)	PTA fat (kg)	PTA potein (kg)	PTA fat (%)	PTA protein (%)	Lifespan	SCC	Fertility Index
1	122	262	7.3	5.9	0.12	0.08	0.27	-5	9.7
5	81	168	4.2	3.3	0.08	0.05	0.20	-3	5.6
10	61	121	2.8	2.1	0.06	0.04	0.15	-2	3.5
15	51	87	1.9	1.4	0.05	0.03	0.13	-2	2.4
20	42	60	1.2	0.8	0.04	0.03	0.11	-1	1.7
25	35	37	0.6	0.3	0.03	0.02	0.10	-1	1.2
30	29	17	0.1	-0.1	0.03	0.02	0.09	-1	0.8
35	24	-3	-0.5	-0.5	0.02	0.01	0.08	0	0.5
40	19	-21	-0.9	-0.9	0.02	0.01	0.07	0	0.3
45	13	-41	-1.4	-1.3	0.01	0.01	0.06	0	0.1
50	8	-58	-1.9	-1.7	0.01	0.00	0.05	1	-0.2
55	3	-78	-2.4	-2.1	0.00	0.00	0.05	1	-0.3
60	-2	-99	-2.9	-2.6	0.00	0.00	0.04	1	-0.5
65	-8	-124	-3.6	-3.2	-0.01	-0.01	0.03	1	-0.7
70	-14	-152	-4.3	-3.8	-0.01	-0.01	0.02	2	-0.9
75	-21	-183	-5.2	-4.5	-0.01	-0.01	0.01	2	-1.2
80	-29	-224	-6.3	-5.4	-0.02	-0.02	0.00	3	-1.4
85	-41	-268	-7.8	-6.5	-0.02	-0.02	-0.01	3	-1.7
90	-57	-336	-9.9	-8.1	-0.03	-0.03	-0.03	4	-2.1
95	-89	-443	-13.3	-11.2	-0.04	-0.04	-0.06	5	-2.6

How often is it updated?

HGRs are updated at every bull proof run in April, August and December. The updates are based upon new data received about individual cows, progeny (daughters) or relatives.

How do I register for a Herd Genetic Report?

Email AHDB Dairy at: **breeding.evaluations@ahdb.org.uk**

To register for your login details, we will need your milk recording number, trading name and email address. For the reports to be created, you need to be fully milk recording with CIS, NMR or UDF.

Can my vet/consultant be given access to my Herd Genetic Report?

Yes. Contact AHDB Dairy by emailing: **breeding.evaluations@ahdb.org.uk**

An adviser login can be created and your herd will then be added to your vet's/consultant's account once the relevant authorisation form has been completed.

Inbreeding checker

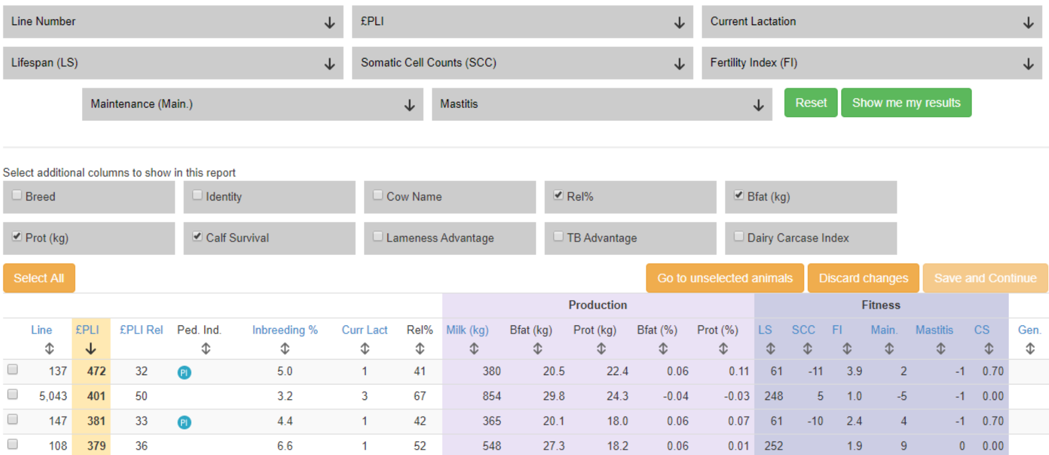
Breeding individuals who are closely related can cause dangerous levels of inbreeding (above 6.25%) and result in inbreeding depression in the herd. Inbreeding has a detrimental effect on the performance and vigour of the resulting offspring and increases the risk of bringing undesirable recessive genes together. The Inbreeding Checker is a new addition to the Herd Genetic Report (HGR) which will check how closely related any sire with a genetic index is to any heifer or cow in a milk-recording herd. With increasing numbers of available sires and ever-more complex pedigrees, this tool makes checking the inbreeding level of any proposed mating, from the entire database of dairy sires listed on the AHDB Dairy website, quick and simple.

Step 1 – Select group of cows to mate

Choose the group of cows that you would like to mate from the list. Youngstock and milking animals have been kept in separate groups, as breeding priorities for bulls to be mated to youngstock may differ slightly from those to be mated to the milking herd – e.g. easier-calving bulls used on youngstock.

Step 2 – Select cows to mate

Select the cows from the chosen group that you want to mate using the tick box at the left-hand side of each listing. The arrows along the top of the columns can be used to reorder records by specific traits of importance to the breeding goals of the herd. Use the 'Save and Continue' button to save changes or a new group and move on to the next step.



							Production					Fitness						
Line	£PLI	£PLI Rel	Ped. Ind.	Inbreeding %	Curr Lact	Rel%	Milk (kg)	Bfat (kg)	Prot (kg)	Bfat (%)	Prot (%)	LS	SCC	FI	Main.	Mastitis	CS	Gen.
137	472	32	PI	5.0	1	41	380	20.5	22.4	0.06	0.11	61	-11	3.9	2	-1	0.70	
5,043	401	50		3.2	3	67	854	29.8	24.3	-0.04	-0.03	248	5	1.0	-5	-1	0.00	
147	381	33	PI	4.4	1	42	365	20.1	18.0	0.06	0.07	61	-10	2.4	4	-1	0.70	
108	379	36		6.6	1	52	548	27.3	18.2	0.06	0.01	252		1.9	9	0	0.00	

Figure 12. Inbreeding checker

Step 3 – Select breed/group of mating sires

Choose a breed or previously created group of bulls that you want to use. For purebred herds, select the breed of your herd. For cross-breeding herds, select the first breed of interest and run this group through, then return to this step to run a different breed of bulls against your herd.

- Top International Guernsey Bulls Ranked on GMI
- All Available Ayrshire and Red Bulls
- Available Brown Swiss Bulls
- Available Fleckvieh Bulls
- Available Friesian Bulls
- Available Holstein Bulls
- Available Jersey Bulls
- Available Montbeliarde Bulls
- Available Ayrshire Bulls
- All top Shorthorn bulls ranked on £PLI
- Available Holstein Genomic young sires

Step 4 – Select mating sires

Choose the bulls from the available bull or breed list that you want to check for suitability, using the tick box at the left-hand side of each listing. Similar to step 2, arrows along the top of the columns can be used to re-rank the bulls by trait.

The 'Average expected inbreeding' column gives the average expected inbreeding level of the progeny for each bull, when mated to the group of cows selected in step 2. The 'Number of safe matings' column indicates the number of cows which can safely be mated to the bull (resulting in less than 6.25% inbreeding). These two columns allow the user to instantly see whether it is acceptable to use a particular bull, and if so, the number of cows in the herd which would be a suitable match. The ability to check the 'expected inbreeding' on specific cows against all available bulls allows famers to consider sires that may previously have been disregarded due to concerns over their relatedness to the herd. Depending on number of records, the lists may take a short while to load.

The 'Bull Search' bar can also be used to search for bulls no longer available or stock bulls with a genetic index. By including historic bulls, users can ensure that excess straws from their last purchase do not go to waste. Again, use the 'Save and Continue' button to save changes or a new group and move onto the final step.

Step 5 – Results

All inbreeding levels for potential matings are shown with cow IDs down the left and bull IDs along the top. Arrows below each bull name allow the user to reorder the cow IDs by inbreeding level against the bull. Cows and bulls can be selected for printing and downloaded for future reference.

Line Number	Cow Name	Herdbook Number	£PLI	AARDEMA PISTOLERO 767	BLUMENFELD SEDONA 760	BOGHILL GLAMOUR PERSUADE 761	DE-SU 14673 APPEAL 758	KOEPON RAPTOR A1A2 KCBE 763	WESTCOAST RIVER 771
26	26	320533704254	**344**	6.84 !	6.65 !	7.84 !	7.33 !	6.88 !	6.63 !
69	69	320533304222	**348**	5.63	4.83	6.07	4.93	4.52	5.55
108	108	320533304600	**379**	9.02 !	8.45 !	10.13 !	8.29 !	8.76 !	9.69 !
109		320533204711	**368**	8.28 !	6.83 !	8.79 !	7.94 !	7.5 !	8.12 !
121		320533204774	**362**	5.43	6.21	6.02	7.09 !	6.22	5.23
137		320533304740	**472**	6.91 !	7.29 !	7.46 !	8.04 !	7.36 !	6.7 !
147		320533604729	**381**	6.18	6.92 !	6.85 !	7.96 !	7.08 !	6.03
5043	5043	320533604043	**401**	6.78 !	5.83	7.32 !	6.34 !	6.08	6.8 !

Figure 13. Inbreeding checker results indicating some unsafe levels of inbreeding in these matings

! Unsafe level of inbreeding from this mating (>6.2%)

Health and welfare

Break free from BVD

Join in making BVDFree a success.

What is BVDFree England?

BVD (bovine viral diarrhoea) is a virus that affects cattle, which costs herds between £13 and £31 per cow per year. To address BVD in English herds, the national scheme BVDFree was set up to eradicate BVD from all cattle in England by 2022. The scheme is industry-led, supported by over 100 organisations and open to all cattle farmers in England. Importantly, it is voluntary and free to join.

BVD persistently infected (PI) cattle

If cows and heifers become infected within the first 120 days of gestation, the unborn calf may become persistently infected – PI. A calf will only become PI if its mother is infected during pregnancy; it cannot become PI after birth.

PIs will shed high quantities of BVD virus into their environment for life. They are the most significant source of infection to other cattle.

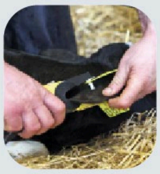
Within infected herds, PIs often only account for 1 or 2 out of every 100 animals. It is contact with these PI animals that leads to infection of other animals within your herd, which is why PI animals should be removed from the herd.

Are you testing?

Identify PIs using:

BLOOD

MILK



TISSUE

How to eradicate BVD on your farm

Use ADAM to devise your plan:

- **A**ssess the level of biosecurity and disease risk on farm
- **D**efine the BVD status of you herd
- **A**ction plan for BVD put in place
- **M**onitor progress – annual status check

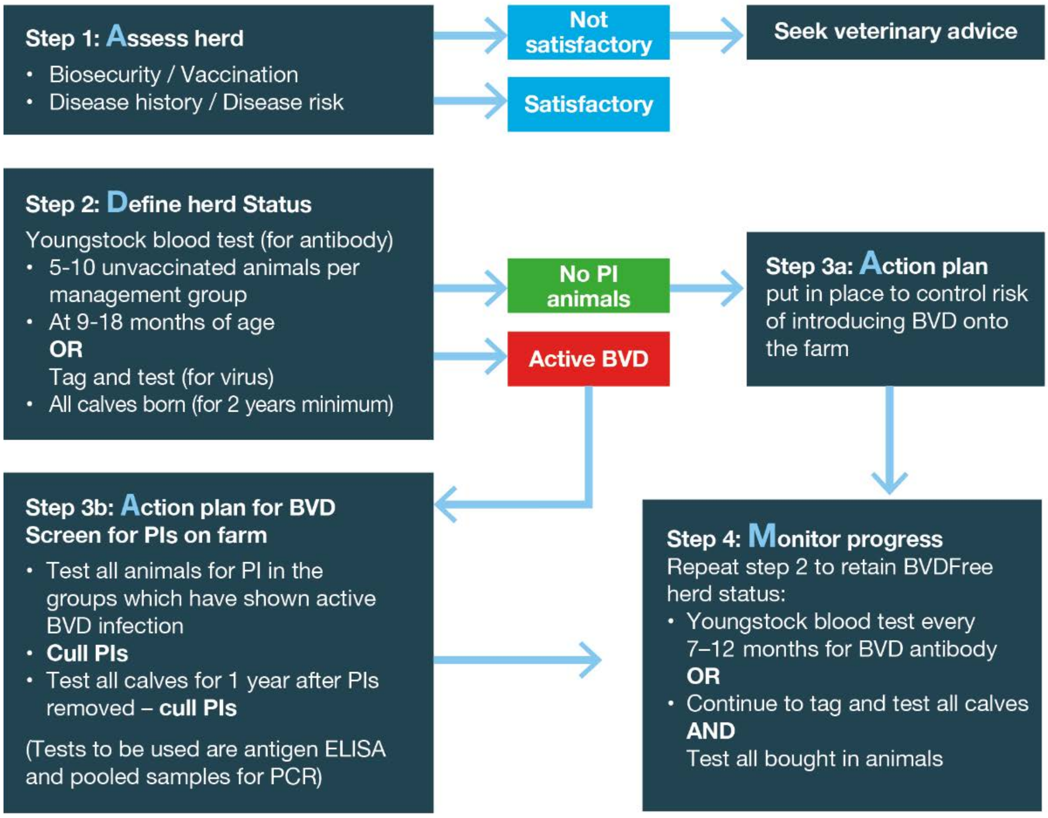


Figure 14. BVD elimination using ADAM

How to eradicate BVD from England

- Join BVDFree and remove PIs, if any
- Keep BVD out with good biosecurity
- Check the national database for BVD status
- Only buy BVD-free stock

Biosecurity – keep BVD out!

Buying

Determine the health status of the herd of origin of the purchased animals, whether animals are certified free of BVD or whether they are vaccinated. If the animals are not vaccinated, the screening history of the herd should be determined.

Keep purchased animals in isolation until the results of testing for BVD virus is known. During this time, the purchased animals should be vaccinated, if appropriate. Make sure any PI animals are rejected.

Appreciate the risk posed by animals that are pregnant or that have a young calf at foot because of the possibility of the foetus or young calf being persistently infected, even if the dam is not.

Boundaries

Always use boundary double fencing or avoid contact with neighbours’ cattle.

Bringing in

To avoid bringing BVD on to farm, always cleanse and disinfect overalls, vehicles and footwear (boots, shoes, etc.), and avoid direct and indirect contact from farm to farm, e.g. shared equipment or stock workers.

Vaccination

Vaccination can reduce the risk of spread but needs to be used effectively and in discussion with a veterinarian.

Costs of BVD

BVD costs herds between £13 and £31 per cow per year. Economic impacts include reproductive disorders and losses in heifers and cows – returns to service, early embryonic death and abortions. Veterinary, diagnostic, treatment and production costs are also often associated with immune suppression, which in itself leads to higher levels of secondary disease, such as pneumonia and scour in calves, lameness and mastitis in adults, lower milk yields and poorer growth rates. The death of persistently infected animals, either through secondary infection or mucosal disease, also incurs costs.

Further details of factors used in developing models available from AHDB can be found in the report by the Royal Veterinary College (RVC).

Table 4. Estimates by RVC of BVD impact (£/year) in England

	Prevalence of BVD in affected herd – (PI%)		
	Best (1%)	Average (1.5%)	Worst (2%)
BVD impact at cow level (£/year)			
Dairy	21	31	43
Beef	27	40	54
BVD impact at farm level (£/year)			
Dairy	3,133	4,625	6,266
Beef	1,151	1,127	2,302
BVD impact at national level (£/year)			
Dairy	6,173,977	9,114,362	12,346,442
Beef	5,038,107	7,557,160	10,076,213
Total	11,212,084	16,671,522	22,422,655

Profit from mastitis control

Background

In 2004, an AHDB Dairy-funded study trialled a mastitis control plan in herds with more than 35 cases of clinical mastitis per 100 cows per year. Reductions of 20% in cases of clinical mastitis and somatic cell count were seen after one year and those who fully complied with the plan saw a reduction of close to 30%. This study led to the development of the AHDB Dairy Mastitis Control Plan, which was launched nationally in 2009, and by 2013, it was estimated that more than 2,000 herds had enrolled on the plan.

The AHDB Dairy Mastitis Control Plan

The plan is a proven and cost-effective solution that is specific to each farm that engages with it. It is a structured approach to talking mastitis that is focused on prevention and a source of practical solutions to your problems.

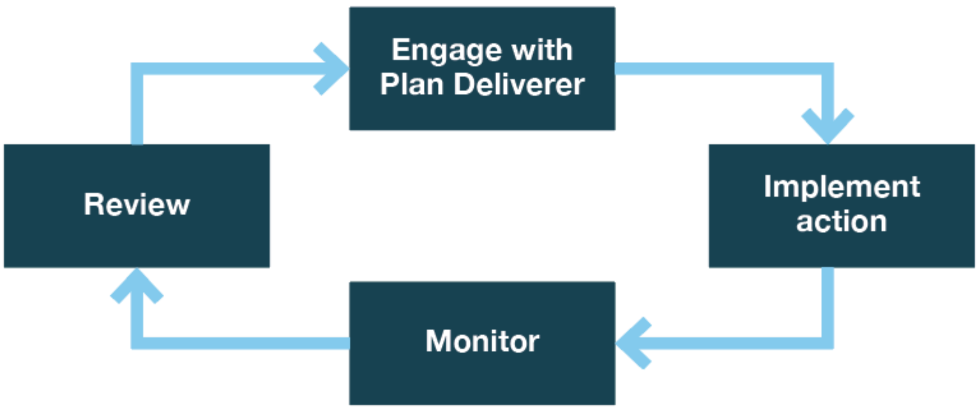
Who deliverers the plan?

Trained vets and consultants, known as Plan Deliverers, use farm-specific information, such as milk records, clinical records and on-farm questionnaires, to identify the main factors contributing to mastitis on farm across the country.

How does the plan work?

Find a Plan Deliverer: **ahdb.org.uk/mastitis-control-plan**

1. **Plan Deliverer examines farm data:** Look for patterns in the data (milk recording, clinical and cell count data). Identify the origin of the infection, e.g. dry vs lactation period, and how the infection is being spread, e.g. environmental or contagious.
2. **Farm visit:** Conduct on-farm survey. Observe all areas on farm, including management practices, such as milking routine.
3. **Action plan:** Produce a list of achievable action points individual to the farm. Discuss with Plan Deliverer priority action points and how best to implement them on farm.
4. **Review plan:** Agree a date for review of action plan, usually three months after the initial visit.



What is the cost of mastitis?

The AHDB Dairy Mastitis Control Plan cost calculator will help to conduct a full assessment of the current costs of mastitis on your farm. These costs will include milk discarded, reduced milk yields, drugs, increased culling, labour and vet costs. The cost of clinical mastitis lies in the range of 1–6p/litre of total milk produced on farm.

Key features and benefits

- Detailed evaluation of herd mastitis patterns
- Identify main source of new infection
- Full assessment of current costs of mastitis
- Thorough farm visit to assess current policies
- Identify areas for improvement
- Estimate of likely return on investment
- Discuss plan and agree on action points together
- Frequently monitor mastitis management
- Continual review of mastitis control measures

What users have said about the plan

"Helped us nail mastitis – I'm certain that, without this, we would not have survived financially"
Gary Dalton, Bushton Farm

"Over a three-month period, prior to using the plan, we used 360 tubes and 7,800 ml of injectable. Now, we use 30 tubes and 600 ml of injectable"
Henry Freeman, Upper Farm

Profit from mastitis control today

Firstly, speak to your vet to see if anyone in the practice is a trained deliverer or, alternatively, visit the Plan Deliverer Map at **mastitiscontrolplan.co.uk**

The cost of the plan is set by your Plan Deliverer.

A number of AHDB Dairy resources are available to support on-farm best practice.

Control and prevention of mastitis in dairy herds

Background

Mastitis control plans aim to implement a small number of management items that are usually related to the control of persistent 'contagious' pathogens. However, the assumption that infection is spreading between infected cows ignores the fact that the environment is often more important in GB dairy farms.

AHDB Dairy-funded research has found that individual farm control plans, designed around the specific disease pattern on that farm, can be very effective at reducing mastitis. This approach has since been made available to all GB dairy farms as the AHDB Dairy Mastitis Control Plan.

Identifying the source of infection

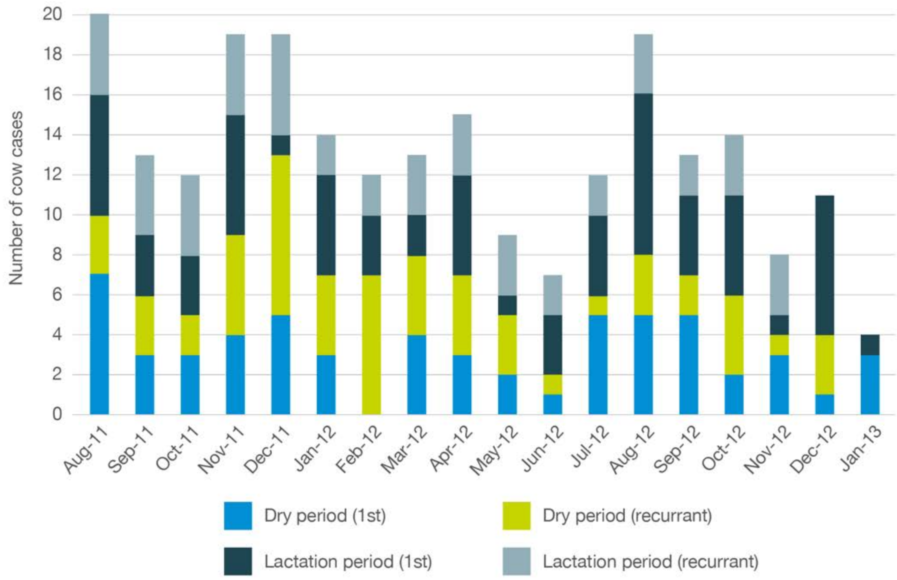
This relies on the interpretation of somatic cell count and clinical mastitis records (Figure 15) to identify:

- The main source of new infections with respect to pathogen type, e.g. environmental or contagious
- Whether most infections are acquired during the dry period or during lactation

A 'diagnosis' is assigned, based on the source of new infections:

- Environmental dry period (EDP)
- Environmental lactating period (ELP)
- Contagious dry period (CDP)
- Contagious lactating period (CLP)

The herd 'diagnosis' is used to identify management and husbandry changes that are most likely to result in significant benefits.



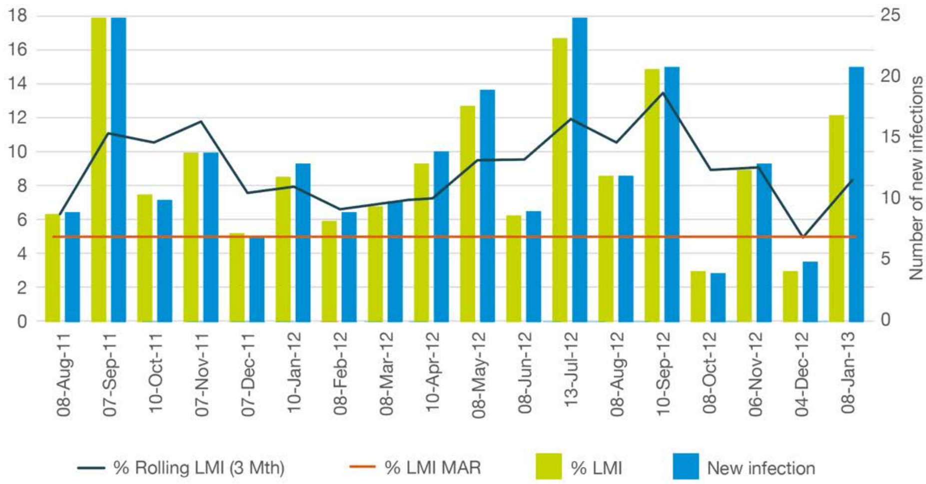


Figure 15. Clinical mastitis data with a dry-period-origin infection pattern (top). Somatic cell count data showing an increased rate of new intramammary infections in the summer months, denoting an environmental infection pattern (bottom) (Total Vet, QMMS/SUM-IT)

LMI = Lactational intramammary infection; MAR = Maximum advisable rate

Control measures

The AHDB Dairy Mastitis Control Plan involves a comprehensive questionnaire that covers all aspects of management relevant to mastitis. Key areas are identified from the questionnaire according to the 'diagnosis' made. This approach avoids wasting time and money on measures that are unlikely to benefit a particular farm.

The control of mastitis may focus on some of the areas described below.

Environmental dry period (EDP)

- Management of dry cow yards
- Pasture management
- Selection and use of dry cow therapy
- Infusion technique at drying-off
- Management of calving cows

Environmental lactation period (ELP)

- Cubicle hygiene and comfort
- Teat hygiene and pre-milking teat disinfection
- Pasture rotation
- Slurry management
- Teat end condition

Contagious

- Prompt identification of clinical mastitis
- Post-milking teat disinfection
- Cow segregation
- Parlour maintenance
- Biosecurity

Summary

There is no 'one size fits all' approach to effective mastitis control, each farm is different, as is each plan developed. It is crucial that somatic cell count and clinical mastitis data are used to identify the source of new infections. By doing this, the approach, as used by the AHDB Dairy Mastitis Control Plan, has been proven to be effective and is currently available to all GB dairy farmers.

Pete Down, James Breen and Martin Green, School of Veterinary Medicine and Science, The University of Nottingham

Mastitis Pattern Analysis Tool: A tool to help farmers make better decisions about mastitis management in their herds

MASTITISCONTROL

Background

Introduction of the AHDB Mastitis Control Plan has provided a structured framework for a holistic, evidence-based approach to mastitis control. In 2018, an AHDB Dairy-funded project created an electronic **Mastitis Pattern Analysis Tool** that provides a fully automated method of making an initial herd-specific assessment based on herd somatic cell count and clinical mastitis records.

How does it work?

This tool provides a fully automated method of assessing the predominant mastitis infection patterns present on farm, using somatic cell count (SCC) and clinical mastitis records. Milk-recording herds are at an advantage as cow SCC information is readily available. Using the tool, records are converted and merged into a simple output, allowing farmers to assess the patterns of mastitis in the herd.

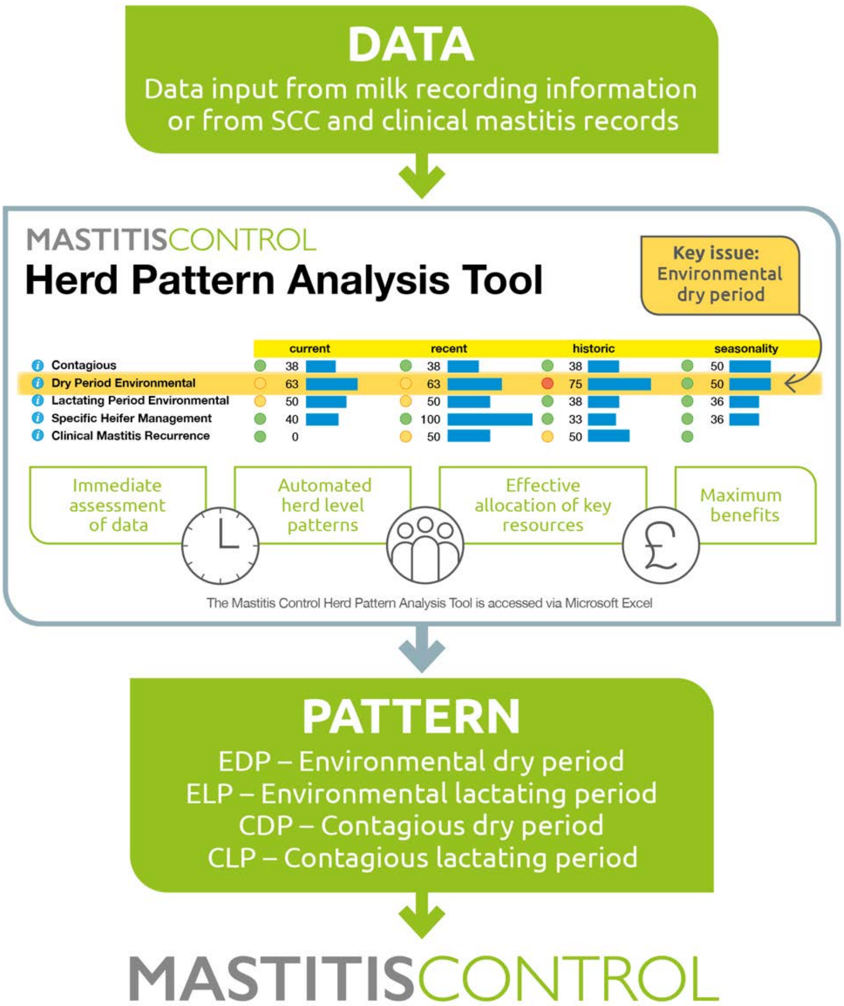


Figure 16. Flowchart of Mastitis Control Plan process

Key benefits

- An effective way to track udder health
- Identifies problem areas and potential risks to udder health
- Identifies the predominant mastitis infection pattern present in the herd
- Helps dairy farmers prioritise key management areas

Download the tool

ahdb.org.uk/mastitis-pattern-analysis-tool

QuarterPRO

Background

Mastitis is one of the most common health problems on dairy farms. Its treatment and control is one of the largest costs to the British dairy industry and it is a very painful condition and results in lower production, increased costs and a poorer-quality product. There is a greater need to use antibiotic treatments if mastitis control is poor. QuarterPRO is an industry initiative to promote and improve udder health.

QuarterPRO is a four-step process

1. PREDICT	2. REACT	3. OPTIMISE	4. REVIEW
Analyse data	Decide what to do	Take action on farm	Check results

1. Sit down with the farm team and advisers once a quarter – review clinical mastitis and somatic cell count data. Use the Mastitis Pattern Analysis Tool to **PREDICT** the most important udder health issues on farm in the next quarter.
2. Identify key management areas to be addressed and **REACT** by deciding on management changes – use AHDB pattern-specific resources.
3. Work together as a team to **OPTIMISE** udder health.
4. **REVIEW** on a quarterly basis to monitor progress and changes in udder health patterns.

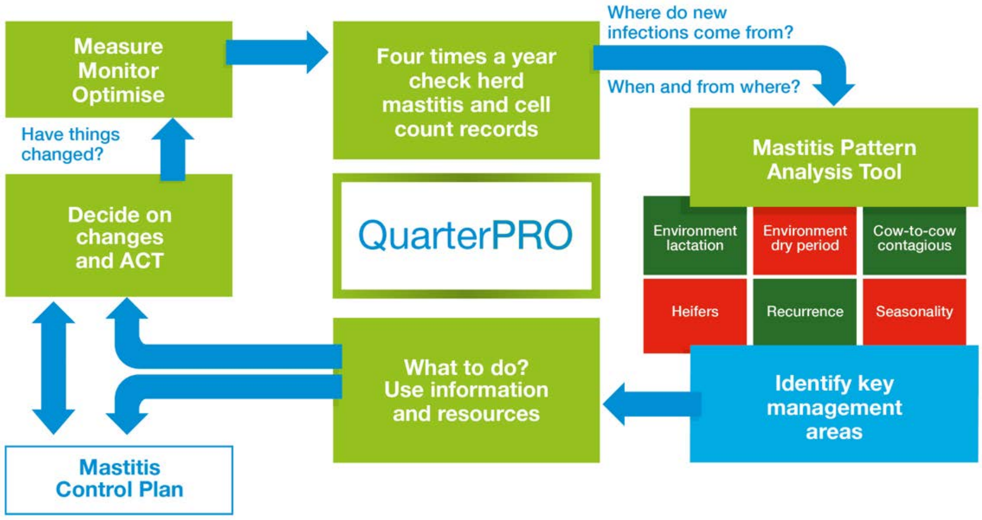


Figure 17. Flow chart of QuarterPRO process

The following resources are available as part of the QuarterPRO initiative at **ahdb.org.uk/quarterpro**:

- Managing mastitis
- The QuarterPRO approach factsheet
- Control of contagious mastitis
- Control of heifer mastitis
- Dry cow management
- Control of environmental mastitis in lactation

Implementation of vaccination strategies on British dairy farms: Understanding challenges and perspectives

Key messages

- Challenges to cattle vaccination arise from differences in how risk is perceived between vets and farmers and farmers' potential lack of awareness of their herd's disease status
- There are four main areas which need attention:
  - The farmer–vet relationship
  - Risk-related decision-making behind vaccination
  - The issue of compliance
  - The use of vaccination guidelines
- Understanding and enhancing the relationship between farmers and veterinary surgeons is a crucial step for optimisation of vaccination strategies

Background

Despite the apparently widespread use of vaccines, there is limited evidence describing the decision-making behind the vaccination of cattle. Currently, there are 38 vaccines registered for use in cattle in the UK, offering protection against viral, bacterial and fungal infections.

The aim of this research was to understand what motivates or impedes implementation of vaccination strategies on British dairy farms by farmers and vets.

Approach

During the study, 26 farmers and 15 vets were interviewed. The farms and veterinary practices were located throughout England, Scotland and Wales, and included a variety of farm and practice types.

Key findings

The interviews confirmed variability in the use of vaccines: 16 farmers were currently using one or more vaccines, and three farmers had never vaccinated their cattle. The most commonly used vaccines were BVD, leptospirosis and IBR; this corresponds with what vets perceive to be the 'core' vaccines for cattle use.

Vaccination on British dairy farms is generally implemented in reaction to 'a problem' instead of a preventive tool. However, farmers and vets perceive vaccines to be an effective and useful tool to control and prevent disease on British dairy farms. Farmers see vaccination decision-making as a process and not a one-off event, and they perceive their vet to have an important role throughout this process. Local epidemiology is important to vaccination decision-making and vets are often trusted advisers in this area. Because of this, farmers trust their vet's advice on vaccination; however, this does not always mean the advice is followed.

The vets interviewed were reluctant to advise against the use of vaccines because of the risk of a subsequent disease outbreak. The study showed that there is scope for a more proactive approach from vets regarding vaccination; however, their time and resources are scarce. Compliance was not a barrier to implementation of vaccination, but it was seen as a barrier to effective vaccination.

Best-practice vaccination

AHDB Dairy along with the University of Nottingham have produced a short film for farmers and farm staff to demonstrate the correct technique used to vaccinate cattle safely and effectively. The film on best practice in safe and efficient vaccination of cattle is available at **ahdb.org.uk/youngstock-health**

Imogen Richens, Pru Hobson-West, Marnie Brennan, Wendela Wapenaar, School of Veterinary Medicine and Science, The University of Nottingham

Successful management of lameness

Background

On completion of the Healthy Feet project led by University of Bristol, its legacy was handed over to the GB dairy industry, and in 2011, the AHDB Dairy Healthy Feet Programme was launched nationally.

The AHDB Dairy Healthy Feet Programme

A bespoke plan for lameness reduction that will:

- Diagnose the lameness problem
- Assess what is causing the problem
- Plan actions to rectify the problem
- Develop skills for long-term lameness control
- Monitor the progress being made

Who delivers the programme?

Trained vets or licensed foot trimmers known as 'Mobility Mentors' deliver the Healthy Feet Programme. Currently, there are 100+ Mobility Mentors nationally giving professional guidance.

How does the plan work?

1. Find Mobility Mentor: **ahdb.org.uk/healthyfeetprogramme**
2. Farm visit: Mobility Mentor conducts on-farm survey and independent herd mobility scoring.
3. Mobility contract: Mobility Mentor works with farm team to produce a list of achievable actions specific to the farm. Discuss with Mobility Mentor priority actions and how best to implement them on your farm.
4. Implement and monitor: Mobility Mentor conducts independent herd mobility scoring every three months.
5. Review mobility contract: Agree a date for review of actions.

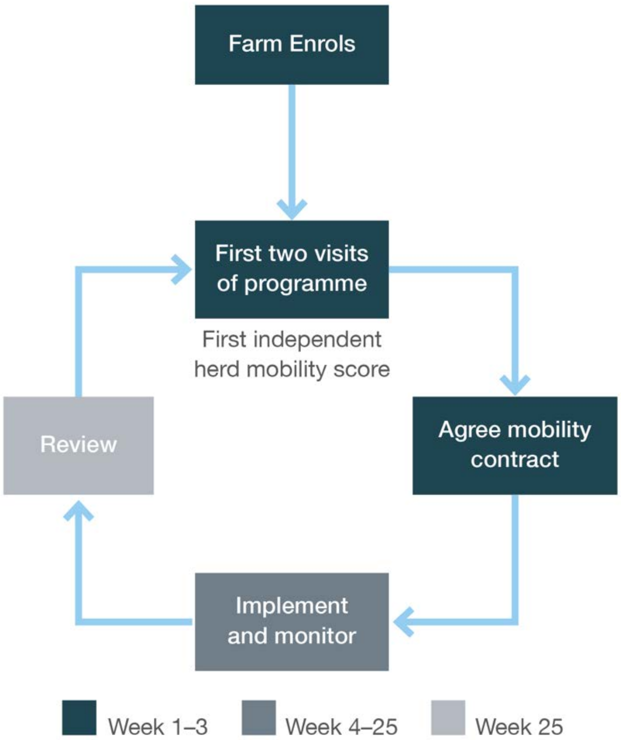


Figure 18. Flowchart of the Healthy Feet process

Success factors

AHDB Dairy Healthy Feet Programme focuses on success factors to reduce lameness. The ‘four success factors’ for healthy feet are:

1. Low Infection pressure.
2. Good hoof shape and horn quality.
3. Low forces on feet (short standing times; good cow flow; appropriate floor surfaces).
4. Early detection followed by prompt, effective treatment of lame cows.

Key features

The programme offers access to experts and dedicated resources, which will enable you to: recognise, treat and record lesions properly; mobility score effectively and ensure your staff can too; understand foot-bathing and make sure it works for your herd and; cost out herd lameness and calculate a cost benefit for changes considered. The thorough farm visit to assess current lameness policies and independent mobility scoring of the herd will enable a continual review of lameness control.

Key benefits

- Identifies areas for improvement
- Increases skills and knowledge of the farm team, which motivates staff
- Improves management of cows and reduces numbers of lame cows
- Improves milk yield and milk quality
- Reduces veterinary costs

Start to successfully manage lameness

Firstly, speak to your vet to see if anyone in the practice is a Mobility Mentor or, alternatively, find a local Mobility Mentor here: **ahdb.org.uk/mobility-mentors**

The cost of the programme is set by the Mobility Mentor.

AHDB Dairy will continue to incorporate findings from research studies into the programme.

Effective treatment of claw horn lesions

Key messages

- Lameness cure is maximised by using NSAID treatment in addition to the common practices of therapeutic trimming and elevating the diseased claw using a block when cows are newly and predominantly mildly lame
- This combined approach helps to reduce trauma to the tissue as it heals, prevents excessive inflammation and physical pressure and reduces pain, allowing the cow to cope better and recover quicker

Appearance of claw horn lesions

There are three main types of claw horn lesions seen in dairy cows (Figure 19).

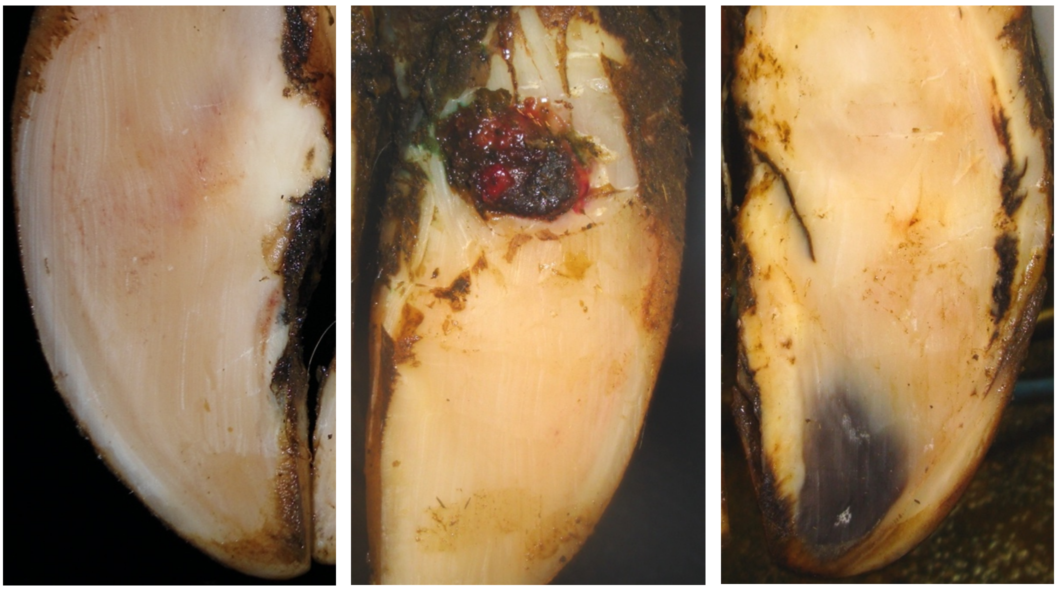


Figure 19. Three main types of claw horn lesions seen in dairy cows – (left to right) sole haemorrhage, sole ulceration and white line disease

Effective treatment of claw horn lesions

Little scientific evidence exists to show the effectiveness of commonly used treatments for claw horn lesions.

To address this, a 12-month study was undertaken on five commercial farms, testing the effectiveness of foot blocks and painkilling medication on newly lame cows. During the study, 500 cows were identified through fortnightly mobility scoring as having recently gone lame and 180 cows were treated at random with one of the following treatments:

- Trim only
- Trim + foot block on the sound claw
- Trim + three-day course of anti-inflammatory (NSAID) painkiller
- Trim + foot block + NSAID

Findings

The efficacy of each treatment was evaluated by mobility scoring the cows five weeks after the initial treatment. For the study, a mobility score of 0 and 1 indicated that the cow was not lame.

A key finding was that by five weeks after treatment, 85% of the cows receiving a trim + block + NSAID were improved (Figure 20).

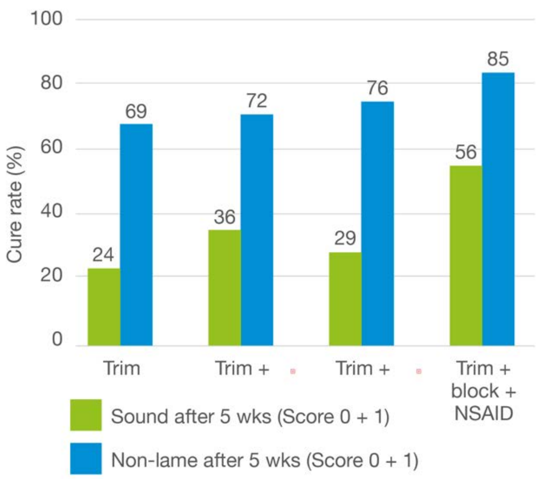


Figure 20. Cure rates for each of the treatments

Further detail

This work was published open access in Journal of Dairy Science: Thomas et al., 2015, *Evaluation of treatments for claw horn lesions in dairy cows in a randomized controlled trial*.

Heather Thomas and Jon Huxley, University of Nottingham

Achieving the correct body condition reduces claw horn lesions

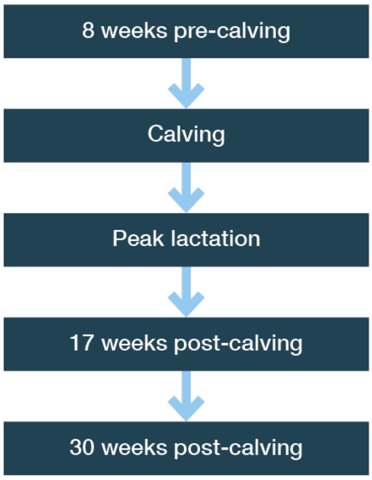
Key messages

- When cows lose body condition, they begin mobilising fat from all areas of the body, including the digital cushion in the cow's hoof
- Cows with thinner digital cushions are more likely to have claw horn lesions, such as sole ulcers, haemorrhages and white line disease

The study

Researchers at the University of Nottingham explored if the thickness of the digital cushion changed with body condition throughout lactation – 179 cows on two commercial farms were examined at the following time points:

- 8 weeks pre-calving
- Calving
- Peak lactation
- 17 weeks post-calving
- 30 weeks post-calving



At each exam, the following data was collected:

- Digital cushion and soft tissue thickness, using ultrasonography at three sites beneath the pedal bone (Figure 21)
- Body condition score (BCS) and backfat thickness
- Lesion scores

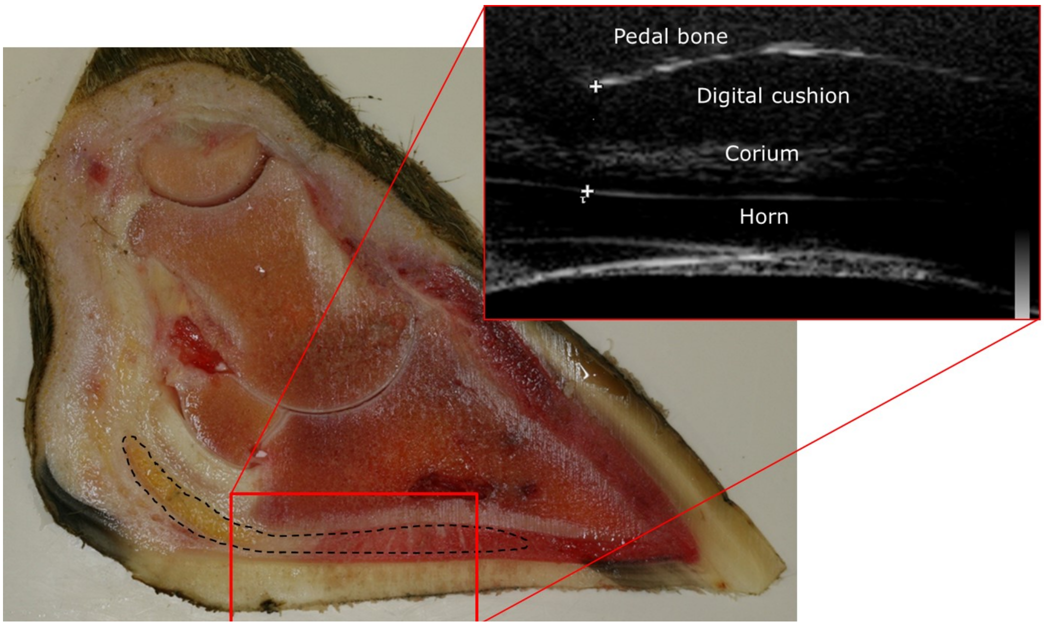


Figure 21. Ultrasound image of the hoof horn, soft tissue, digital cushion and pedal bone

What is the digital cushion?

The digital cushion is also known as the fat pad. Along with the elastic horn in the heel, the digital cushion acts to cushion and dissipate force during walking and standing. It consists of three cylinders of fat under the pedal bone in the hoof and plays a vital role in protecting the pedal bone and soft tissues of the sole from being damaged as the cow walks. By a cow's second lactation, the digital cushion is fully formed.

To prevent claw horn lesions, control of body condition loss to peak yield in early lactation will help. You should be aiming for a BCS of 2.5–3.0 at drying-off and calving, dropping only half a condition score to peak yield.

Mobility scoring regularly will help to identify cows with reduced mobility, enabling you to treat them quickly and effectively with a five-step trim, hoof block and NSAID.

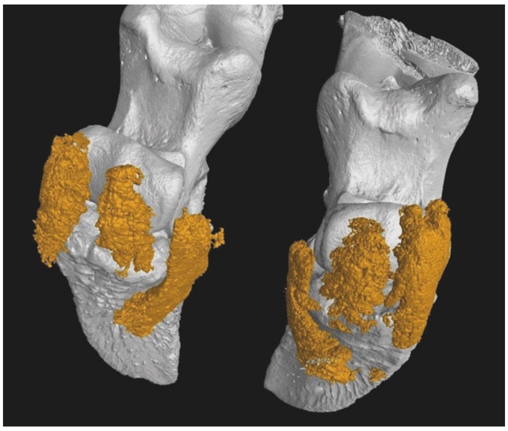


Figure 22. CT images of the three cylinders of fat under the pedal bone (in yellow)

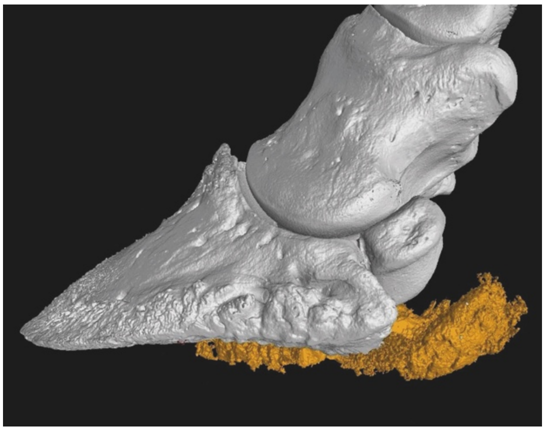


Figure 23. CT images of the digital cushion (in yellow)

Findings

When cows lose body condition to peak yield they mobilise fat, which thins the fat pad and interferes with its protective role, leading to damage and resulting in claw horn lesions. During this study, cows that developed lesions had a thinner digital cushion before the lesion occurrence, which became thickened with sole ulcer presence, perhaps representing inflammation.

Further detail

This work was published open access in Journal of Dairy Science: Newsome et al., 2017, *A prospective cohort study of digital cushion and corium thickness*. Part 1 & 2**.**

Reuben Newsome and Jon Huxley, The University of Nottingham

Untreated claw horn lesions lead to abnormal bone growth in the hoof

Key messages

- Failure to treat claw horn lesions (sole haemorrhage, sole ulcer and white line lesions) early on can lead to new bone formation to the pedal bone
- This new bone formation is irreparable, leading to chronically lame cows. These cows will be more difficult to treat and less likely to recover
- Early identification and effective treatment of claw horn lesions is vital in preventing reoccurrence

Study on bone development, lameness and claw horn lesions

The study saw researchers at the University of Nottingham assess whether bone development was associated with lameness and the occurrence of claw horn lesions during a cow's life. A total of 282 hind hooves from 72 Holstein-Friesian cull cows from the SRUC research herd were retrieved from the abattoir. These hooves were imaged using an X-ray micro CT scanner to examine the anatomy of the pedal bones within the hoof. Extensive historical records were retrieved on these cows, including weekly mobility scores from first calving.

Findings

The X-rays of the cows' hooves identified new bone growth on the rear end of the pedal bone and this new bone development was greater in cows with a history of lameness caused by claw horn lesions.

It was found that cows that had experienced more lameness in the 12 months before slaughter had increased bone growth, therefore the bone growth is likely due to chronic lameness.

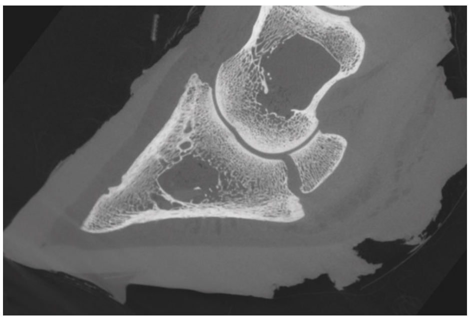


Figure 24. Normal pedal bone

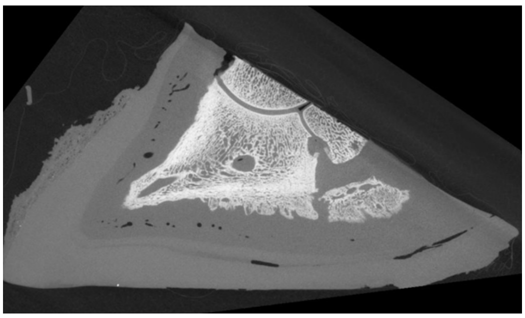


Figure 25. New bone growth on pedal bone

What events lead to extra bone growth?

In an attempt to explain how this new bone growth is involved in the overall development of claw horn lesions, the researchers propose the sequence of events outlined in Figure 26.

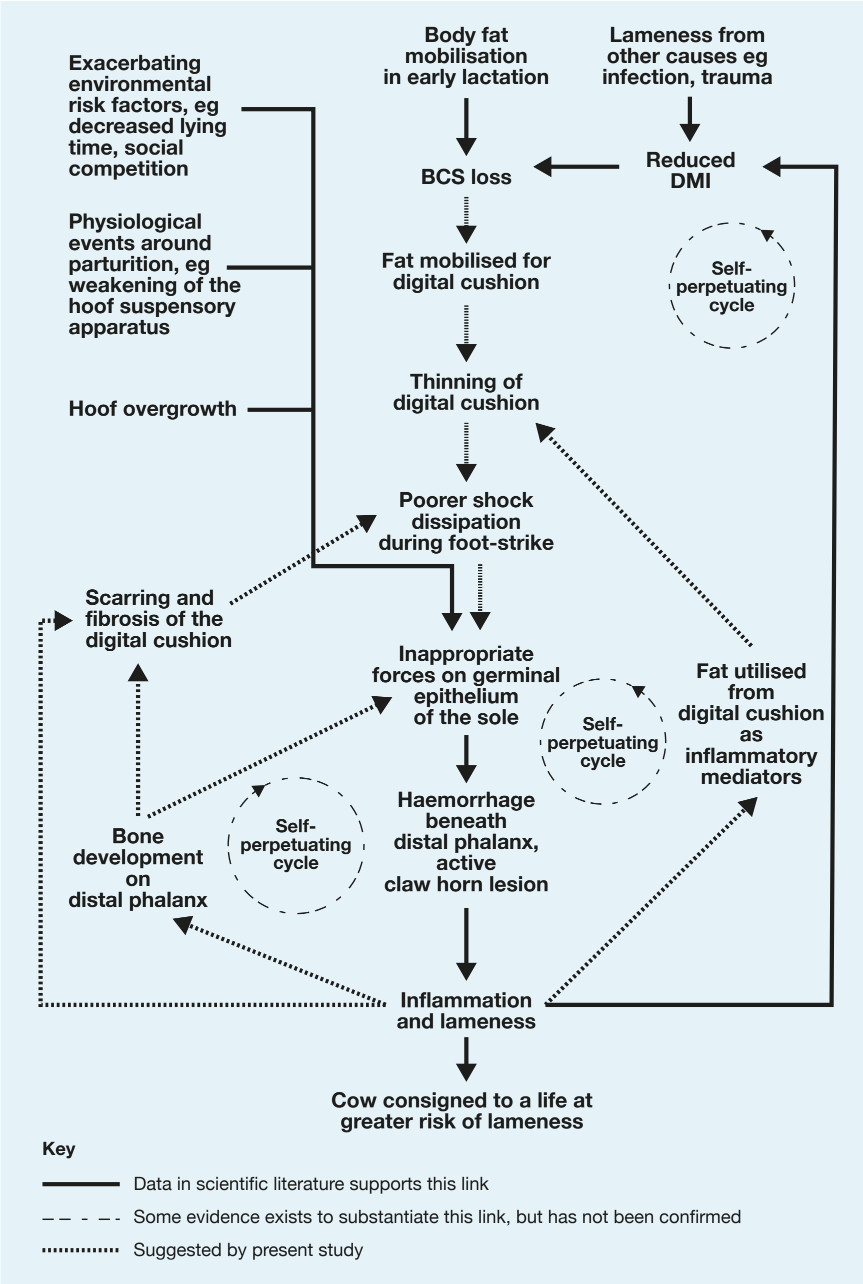


Figure 26. Proposed sequence of events involved in the development of claw horn lesions. The level of evidence to support the links are displayed in the key

Further detail

This work was published open access in Journal of Dairy Science: Newsome et al., 2016, *Linking bone development on the caudal aspect of the distal phalanx with lameness during life*.

Reuben Newsome, Simon Archer and Jon Huxley, The University of Nottingham

Foot trimming claw length: One size doesn't fit all

Key messages

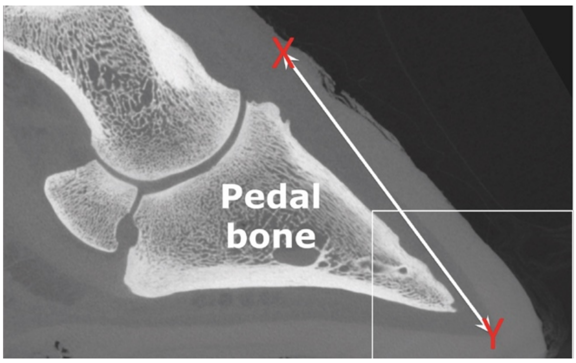
- Trimming length varies with the trimming landmark used and also varies greatly between cows
- Trimming to 75 mm is not safe for all cows, regardless of which common landmark is used
- One size does not fit all, but 90 mm would be appropriate for 96% of claws studied, if trimming the toe to a point
- 85 mm would be suitable for heifers and second-lactation cows or if leaving a small step at the toe
- New foot trimming operators should be trained to use a more cautious measure, to reduce the risk of over-trimming

Background

Over-trimming of cows' feet can cause thin soles and predisposes cows to toe ulcers and lameness. Step one of the Dutch trimming method (Toussaint-Raven, 1985) states – trim the medial claw to 75 mm, based on a Friesian cow, but leave it longer for larger cows. The modern Holstein is a larger cow than the Friesian, but the same trimming guidelines are used, so 75 mm may be too short.

Approach

The hind feet of 72 Holstein cows were CT-scanned and from this the minimum safe trimming length for each claw was deduced (Figures 27 and 28). The cows studied were those culled for production reasons from the SRUC Crichton Herd, Dumfries, UK, between Nov 2013 and Aug 2014, with an age range of 31 to 119 months.



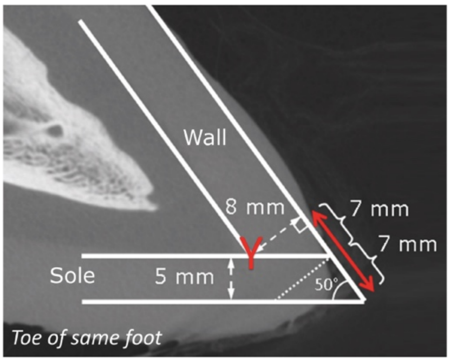


Figure 27 (left). CT image displaying the measurement from the top of the wall horn to the tip of the toe. The minimum appropriate trimming length for each claw was calculated

Figure 28 (right). A 14 mm adjustment was added to leave a minimum sole thickness of 5 mm (adjustment of 7 mm) and an 8 mm wall thickness (another adjustment of 7 mm)

Results

Measurements are reported as if trimming the toe to a point. If leaving a 5 mm step, 7 mm can be subtracted.

- The median minimum dorsal wall length was 83 mm, and ranged from 66 to 93 mm (IQR: 80 to 85)
- The lateral claw was 1 mm longer than the medial
- The proportion of claws that would have been cut too short for any trimming length is displayed in Figure 29
- Trimming to 75 mm and leaving a point at the toe would have been too short for the majority of claws
- Trimming to 75 mm and leaving a 5 mm step at the toe would have been too short for 55% of claws

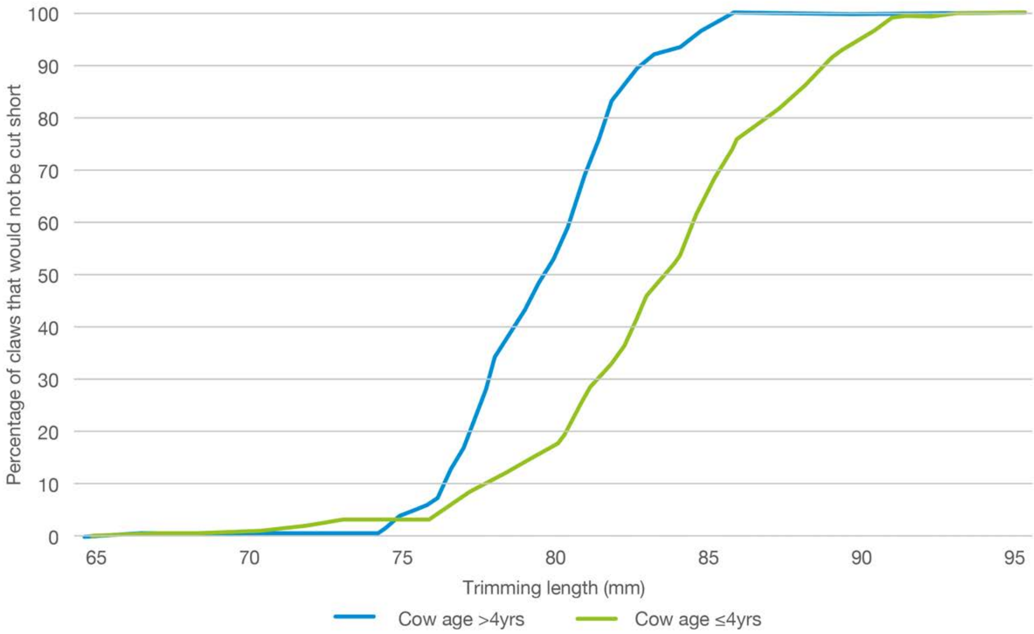


Figure 29. Cumulative frequency plot demonstrating the percentage of claws that would have been cut too short given any trimming length, if trimming the toe to a point. Two age categories are shown. If leaving a 5 mm step at the toe, remove 7 mm from the trimming length

Further detail

This work was published open access in Veterinary Record: Archer, Newsome et al., September 2015, *Claw length recommendations for dairy cow foot trimming*.

Simon Archer, Reuben Newsome, Harry Dibble, Craig Sturrock and Jon Huxley, The University of Nottingham

Mizeck Chagunda and Colin Mason, SRUC

Reducing the spread of digital dermatitis by disinfection of hoof-trimming equipment

What is digital dermatitis?

Digital dermatitis (DD) is a skin infection found near the bulb of the heel that affects dairy cattle worldwide (Figure 30), costing on average approx. £82 per case[1]. Currently, there is no single effective treatment or preventive measure for DD that exists.

Figure 30. A typical DD lesion

Cause of digital dermatitis

Bacteria called treponemes are found in all DD lesions and are thought to be the cause of DD[2]. These treponemes are, typically, found in the gut of cows (Figure 31) and while they do not normally cause disease in the gut[3], they do have the potential to feed on secretions from the mucous membrane of the gut, which can be passed out in cattle faeces.

There are three different types of treponemes that cause DD that have been identified, they are the same family as the treponemes that live in the gut but are slightly different in type.

Figure 31. A treponeme as seen under an electron microscope

How are DD treponemes transmitted?

There is evidence that DD is spread in slurry, but other transmission routes require investigation.

Project aim

The project aim was to investigate whether DD treponemes could be detected on hoof-trimming equipment after trimming the hooves of cattle with DD.

Methods

Tested trimming equipment used on cattle with digital dermatitis before and after disinfection protocols.

Results

After trimming, DD was found to be present on 100% of cattle blades[4]. This was reduced to 41% after disinfection protocols were undertaken (Figure 32).

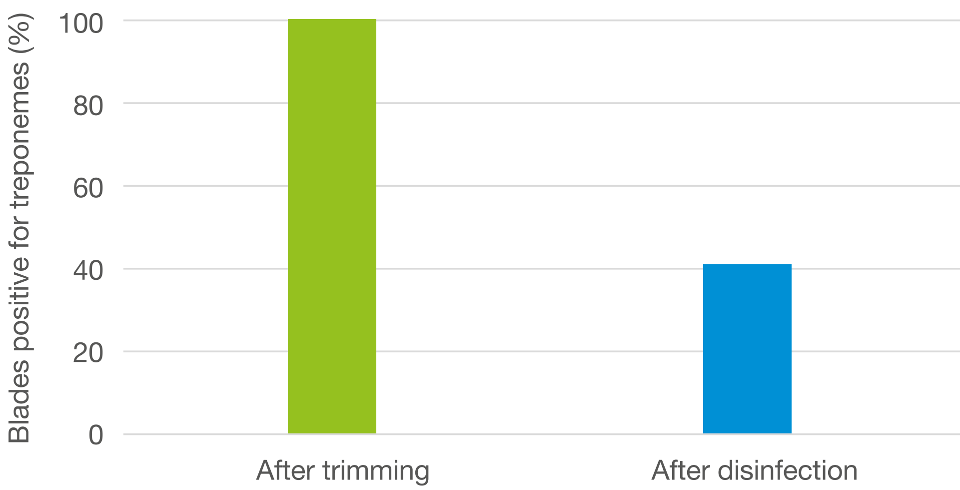


Figure 32. The percentage of trimming blades testing positive for DD treponeme after trimming and after disinfection

Conclusion

It appears that DD treponemes may be able to adhere to the blades of trimming knives used to trim cattle hooves, and the high detection rate of DD treponemes on trimming blades soon after trimming cattle suggests this may be a significant and worrying route for the transmission of DD between cows and, possibly, between farms.

Best practice

- Routine foot-bathing is the most effective control of DD
- Monitor cows for DD lesions regularly during housing
- Provide clean and dry environment to optimise hoof hygiene
- Foot-bath dry cows and heifers
- Thoroughly disinfect hoof-trimming equipment between hooves, between animals and between farms (Figure 33)

Figure 33. Protocol to eliminate viable bacteria from foot-trimming knives and user gloves, thereby minimising the spread of digital dermatitis – full details can be found on the ***Reducing the spread of digital dermatitis by disinfection of hoof-trimming equipment*** factsheet

Leigh Sullivan, Stuart Carter and Nicholas Evans, the Department of Infection Biology, The University of Liverpool

Roger Blowey, Wood Veterinary Group, Gloucester

Managing for optimal cow lying comfort

Key messages

- Provide cows with a high-comfort lying area
- Ensure cows have enough space and time to lie down
- Observe your cows and monitor lying behaviour, where possible, to assess levels of lying comfort

Why worry about cow comfort?

Providing cows with a comfortable lying environment is important for ensuring good cow health and welfare and optimal milk production. It is known that as lying comfort and lying time increase so does milk production and, similarly, if lying time is restricted, stress and risk of lameness increases.

The study – How long do cows spend lying down?

A study by RVC and EBVC Ltd. recorded daily lying time of cows on 23 English dairy herds using electronic data loggers (Figure 34). During the study, it was found that the average daily lying time of the cows was 10 hours. However, some cows spent as little as 3 hours and others as much as 17 hours lying down a day. It was also discovered that cows from the same herd often differed in their lying times, by as much as 12 hours on some farms.

Figure 34. Electronic data loggers for recording lying time

What factors influence cow lying time?

The study found that daily lying time was influenced by many aspects of the cows' housing, such as:

- Cows in straw yards had some of the longest lying times, spending an additional ~1 hour lying down vs cows in cubicles (Figure 35)
- Cows in deep-bedded sand cubicles had the longest lying times, spending an additional ~1.5 hours lying down vs cows on mats or mattresses (Figure 36)
- Cubicle dimensions did not have a big impact on lying times, but longer cubicles did allow cows to move between lying and standing more easily

Other management factors, e.g. dryness of bedding, stocking density and time taken for milking, are also known to influence lying times – as do factors such as cow stage of lactation, age and health.

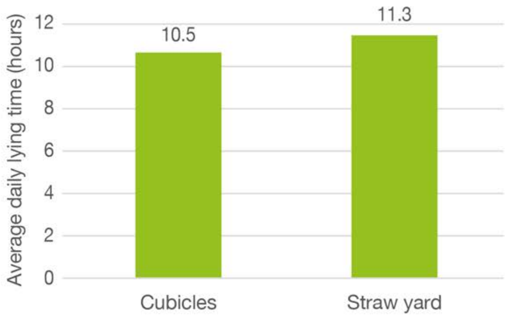


Figure 35. Lying times of cows in cubicles vs straw yards

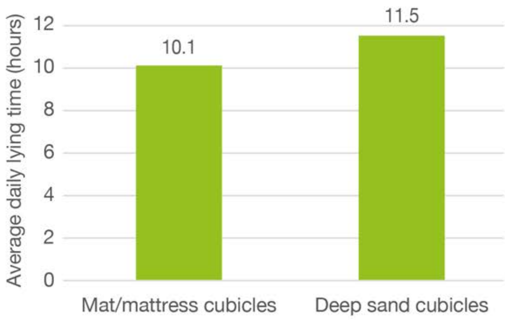


Figure 36. Lying times of cows in different types of cubicles

Case study

From mattresses, to deep bedded sand cubicles

A 300-cow herd in the South West (~8,500 kg 305-day milk yields) had all-year-round cubicle housing for high yielders and summer grazing for low yielders. The cubicles were converted from mattresses bedded with sawdust to deep-bedded sand and the brisket boards and neck rails were adjusted to further optimise lying comfort. These changes to the cubicles increased herd lying time by around one hour, from ~11.5 to ~12.5 hours per day.

Sophie Collins and Nick Bell, The Royal Veterinary College

Dan Gammon, EBVC

Jenny Gibbons, AHDB Dairy

A participatory approach to reducing farm antimicrobial usage

Key messages

- Enrolment to the project was a challenging process. Specific lunchtime recruitment meetings were the most successful way to engage and recruit farmers to the project
- Veterinarians should be included in this method of farmer engagement to decrease concerns about the implications of reducing antimicrobial use on animal health and welfare
- The farmer action groups (FAGs) have been instrumental in fostering dialogue between vets and farmers in some areas
- Feedback has been very positive and many participants have already implemented changes on farm as a direct result of their participation in a FAG

Background

There is increasing pressure for farmers to reduce their use of antimicrobials, especially critically important antibiotics (CIAs).

In Denmark, stable schools have been seen to be successful in helping farmers reduce their antimicrobial usage by allowing farmers to share common experiences and learn from each other.

Aims

The project established and followed five farmer action groups (FAG) across South West England, based on the format of stable schools. Using this method, the project looked at whether, when working together, dairy farmers can reduce the amount of antimicrobial used on farm. It also looked at how this approach could be adopted into policy on antimicrobial usage on farm.

Method

The project established five FAGs with 5–8 farm businesses in each. For each FAG, meetings were held on each other's farm every 4–8 weeks. Meeting framework was as follows:

- Introduction and 'around the farm' discussion – what has been happening on farm since last time?
- Medicine review – emphasis on areas where usage is particularly low/high, good practice is shared among the group and areas for improvement are considered
- Facilitated farm walk
- Reflection on farm walk – interactive discussion
- Farmer-led action plan created at each meeting with the aim of reducing reliance on antimicrobials

Once all members of the group had been visited, the second phase of meetings occurred, known as the review process. Each farm was visited again to assess and evaluate how the action plan had been implemented.

Enrolment

Enrolment of businesses in the project was done via veterinary practices, agricultural shows, NFU press releases, personal farmer contacts and, most successfully, by specific lunchtime recruitment meetings. Four separate recruitment meetings were held to discuss antibiotic use on farm and farmers were signed up to the project on the day. A total of 917 businesses were invited to the four recruitment meetings and 4.4% (n= 40) of these attended. Of the 40 businesses in attendance, 57.5% (n= 23) have signed up to the project.

Action plans

Each host farm co-created an action plan with the group on how they could improve their herd health and welfare to minimise the use of antimicrobials. The host farms were able to accept or disregard suggestions made by the other members of their FAG. The action plans were then revisited in the second phase of meetings to see what had and had not worked.

Lisa Morgans, Lisa van Dijk, Kristen Reyher and David C.J. Main, The University of Bristol

Sarah Bolt, AHDB Dairy

Henry Buller, University of Exeter

On-farm strategies to reduce the transmission of Johne's disease in British dairy herds

Background

Johne's disease is a chronic bacterial infection affecting the small intestine. The disease takes years to develop and cattle are usually infected as calves but do not show clinical signs until adulthood, typically 3–5 years old. It is caused by *Mycobacterium avium paratuberculosis* (MAP) and is often referred to as ParaTB, JD or Johne's.

How do calves become infected?

If calving yards are contaminated with the MAP bacteria, it can often be ingested by the calves via faeces, colostrum or milk. Calves can also ingest the bacteria while suckling if the cow's udder or coat is contaminated.

Research outline

Calf recruitment

Adult cows screened quarterly for Johne's antibody using milk ELISA

Blood samples taken from calves between three and 10 days of age to assess colostral antibody transfer

All calf treatments recorded up to weaning alongside mortality data

All heifer calves born over a 12-month period on the six project herds recruited to the study

Fixed camera equipment in calving yards, data collected on:

- Cleanliness of area
- Calving ease
- Timing & source of colostrum
- Time calf spent with dam
- Suckling behaviour
- Dam Johne's status
- Calf chest girth

First calving

Heifers commence quarterly Johne's antibody screening alongside the other adults

This data is used to identify recruited heifers that become Johne's positive and also their dams who become positive later

Production data collected via milk records

- Fertility data
- Number of services
- Age at first calving
- Calving to conception
- Milk yield, fat & protein
- Somatic cell count
- Culling

Subsequent calvings

Continued collection of Johne's and production data for further analysis

Figure 37. Research outline

Preliminary results

There is a strong relationship between the dam's Johne's status and the risk of the calf becoming infected. There is evidence that if a calf spends a long time in the calving yard then the potential for infection is increased, but if the yard is clean, the effect is greatly reduced. There is no evidence of any production effects in first lactation in those heifers that are Johne's positive but some evidence of a decrease in milk production in second lactation (subsequent lactations not studied yet).

Looking forward

As the recruited animals get older it is expected that more will become Johne's positive. This will allow the results given above to be refined and more accurately classified as the animals will be truly Johne's positive or negative. Data will be reanalysed as more cows become positive and analysis of three or more lactations will be done to determine production differences between Johne's positive and negative animals.

Farmer engagement

Six commercial dairy herds across GB participated in this project. Here are some comments from the farmers who were involved.

Farmer A

"Although the paperwork felt like a big hassle to begin with, it actually made us think about our calving protocols and how successfully we were managing to stick to them. It made us all more focused."

Farmer B

"We were quite shocked when we saw our calf passive-transfer results, they were very variable and overall not great. We did a review of our colostrum management and we were able to quickly see the results get better and better."

Farmer C

"We knew we had a Johne's issue, but being involved in this project gave us the kick we needed to really start to address it, and the cameras in the calving area really helped with quick and effective calving management."

Karen Bond and Javier Guitian, The Royal Veterinary College

Colostrum management

Key messages

- Newborn calves must receive at least 3 litres of high-quality colostrum within the first 2 hours of birth, followed by a further 3 litres within 12 hours of birth
- Only feed colostrum with at least 50 g/L of IgG
- Teat-feeding with a bottle is best
- Blood-test calves to check successful transfer of antibody to the calf

Background

Colostrum is vital to the newborn calf; it contains:

- Antibodies (immunoglobulins or IgG) to provide immunity against disease
- Essential nutrients to provide energy for growth

Aims

The aims of the project were to review the recent scientific literature on optimal colostrum management to newborn calves, to summarise the evidence and present the best-practice management in a series of films and supporting resources.

Recommendations

How much colostrum to feed?

It is recommended that newborn calves are given a first feed of 3 litres of colostrum within the first two hours of birth. This can be split into two feeds if necessary, particularly for smaller breeds, and should be followed up by another similarly sized feed within 12 hours of birth. The colostrum should be fed at body temperature of 38°C.

How to get good-quality colostrum?

Colostrum quality declines the longer it is held in the udder, so test colostrum from all cows and ensure cows are milked as soon as possible after calving so that the best possible colostrum is collected and fed to newborn calves.

- Test all colostrum with a Brix refractometer or colostrometer (Figure 38)
- Good colostrum contains 50 g/L of IgG
- Do not use colostrum with less than 20 g/L of IgG
- Keep the colostrum clean – bacterial contamination will reduce quality

How soon should colostrum be fed?

To optimise immunity, it is very important that calves receive their first colostrum feed as soon as possible after birth, ideally within two hours. The calf's ability to absorb antibodies declines quickly after birth and has nearly gone by 20 hours.

How should colostrum be fed?

Calves that are left to suckle their dam are 2.4 times more likely to receive insufficient antibodies compared with those calves who receive colostrum by teat bottle or feeding tube. It is recommended that colostrum should be fed by either teat bottle or feeding tube.

The absorption of antibodies by the calf is slightly better when colostrum is fed by a teat bottle, and although using a feeding tube ensures the full volume of colostrum is received, the efficiency of IgG absorption is slightly decreased. A feeding tube should be used if a calf is unable to suck a bottle or is too weak to consume the full amount of colostrum.

Are calves getting enough colostrum?

To understand if calves are getting enough colostrum, ask your vet to take blood samples of at least 12 calves within one week of birth. These samples can be tested for either IgG antibody level or the total protein (TP) in the blood. At least 80% of the group should be categorised as ‘good’ (see Table 5), any less and you should examine the potential cause.

Table 5. Categories of IgG antibody and true protein (TP) levels in calf blood

Quality	IgG g/L	TP g/L
Good	>12	>55
Marginal	10–12	50–55
Poor	<10	<50

Future care

The newborn calf does not make its own antibodies and even good-quality colostrum fed on time only contains a limited amount, so to provide a good follow-up to the calf receiving good-quality colostrum ensure that:

- The calf is kept in a suitable environment
- The calf is provided with sufficient feed
- High levels of cleanliness are maintained

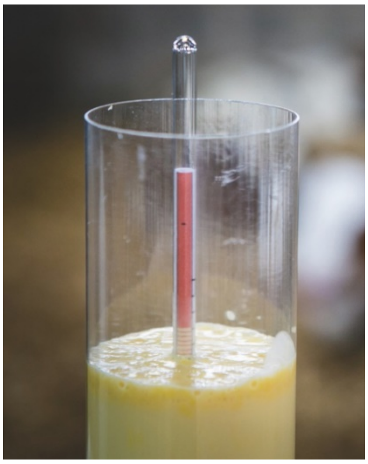


Figure 38. Colostrometer

Further detail

Films and resources on calf management are available at
ahdb.org.uk/knowledge-library/dairy-calf-management

Stephanie Patel and Claire Wathes, The Royal Veterinary College

Jenny Gibbons, AHDB Dairy

Are calves with friends more content?

Key messages

- Contrary to popular belief, calves can be pair-housed without detriment to health or production
- Mode of feeding needs to be considered to reduce cross-sucking. Teat feeders, especially with low flow rates, are likely to reduce cross-sucking over bucket feeding
- Pair-housing calves at five days after birth reduced response to weaning
- Individual housing may impair the ability of calves to cope with challenges, in this case weaning

Background

In the UK, 60% of calves are housed individually until weaning, driven by attempts to reduce the risk of disease transmission. The remainder are housed in pairs or small groups. Several studies have shown that individual rearing in early life can impair solid feed intake and reduce the ability to cope with challenges, such as weaning and regrouping.

Aim

To test the effects of early and late pair-housing versus individual housing on calf health, concentrate intake, daily liveweight gain and distress response to weaning.

What we did

The project allocated forty female Holstein-Friesian calves at birth to one of three housing treatments: individual (eight calves), pair-housed from day 5 (eight pairs) or day 28 (eight pairs). All calves were fed 4 L/d, increasing to 6 L/d by day 21 of milk replacer. The milk replacer rate was 150 g per litre. Over a three-day period (day 48–50), the calves were gradually weaned and all calves were moved to a group pen of five on day 55. Feed intake, weight gain, health and behaviour (vocalisations) were all recorded during the project.

Results

Vocalisations are a distress response to weaning and this response was strongest in individually housed calves. The individual calves vocalised four times more than calves paired on day 5 and two times more than calves paired on day 28 (Figure 39). There was no statistical difference in concentrate intake (day 5–54), daily liveweight gain (DLWG) (day 0–55) or health (respiratory and faecal scores) between calves that were paired versus individually housed throughout the trial (Figures 40 and 41).

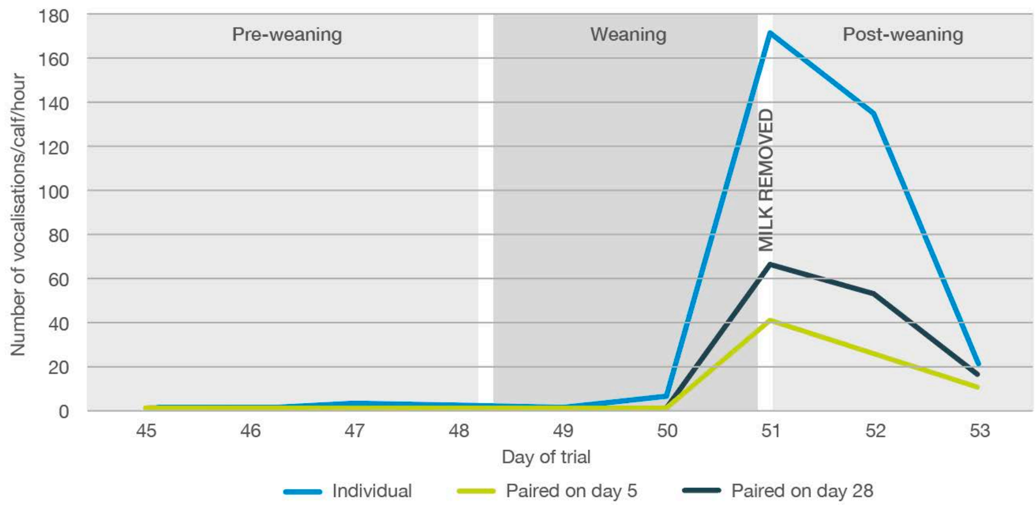


Figure 39. Vocalisations

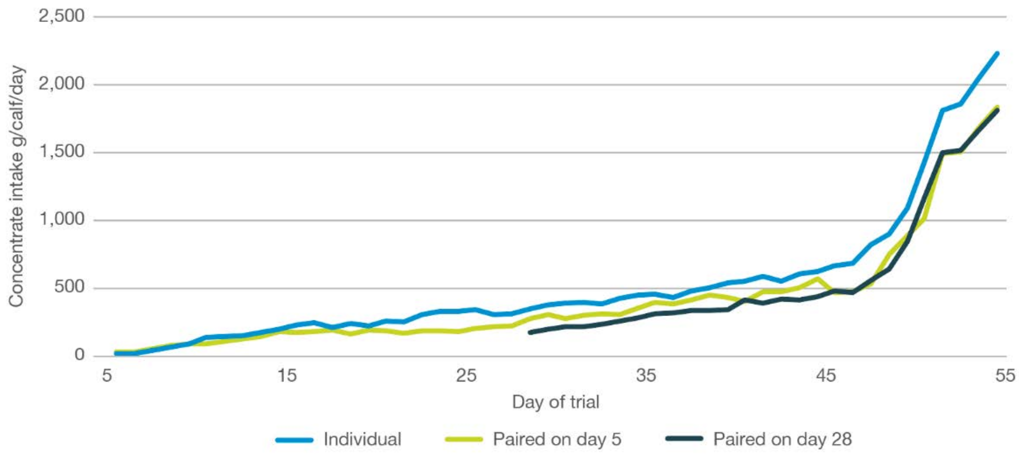


Figure 40. Daily concentrate intake

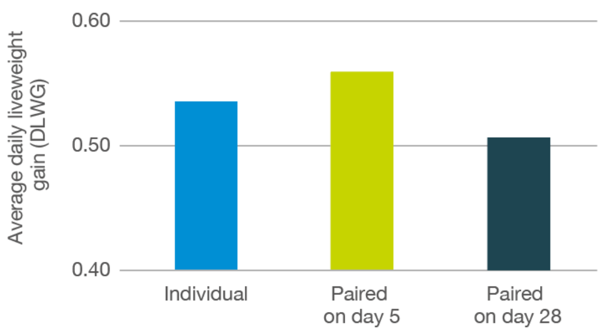


Figure 41. Average DLWG from birth to day 55

Sarah Bolt and Jenny Gibbons, AHDB Dairy

Darren Croft, The University of Exeter

Mycoplasma bovis (*M. bovis*)

What is *Mycoplasma bovis*?

Mycoplasma species are bacteria, but unlike many bacterial species, they do not have a cell wall. This has a significant effect on the choice of antibiotics available to treat them. It is important to have veterinary health planning in place to make sure that there is an appropriate diagnosis and treatment choice.

M. bovis does not cause disease in humans and is not a notifiable disease.

Common diseases

M. bovis causes a range of diseases in cattle in GB, examples listed below.

Pneumonia

The most common disease caused by *M. bovis* is calf and adult pneumonia. It is not uncommon to see poor response to treatment or relapses in individual cases. Remember, virtually all pneumonia cases and outbreaks will be as a result of mixed infections with bacteria, viruses and parasites, with *Mycoplasma bovis* part of this mix. An accurate diagnosis of cause and assessment of risk factors is very important.

Ear infections

Ear infections resulting in head tilt, head shaking or ear droop in milk-fed calves.

Mastitis

M. bovis can act as a contagious cause of mastitis on occasions, resulting in clinical mastitis outbreaks.

Arthritis

On occasions, outbreaks of infection can lead to arthritis, seen as joint and leg swellings, sometimes in multiple joints.

How does the disease spread?

M. bovis is usually introduced to the herd by a bought-in carrier animal, which may not show any signs of infection. It is mainly transmitted through the air from coughing or in the nasal discharge from infected cattle and calves. It can also be spread to calves in milk from infected cows. This milk may look normal and not be mastitic, but it can still contain *M. bovis.* In cases where it does cause contagious mastitis to the cow, it can spread from mastitis cows in the milking parlour.

If a herd has other ongoing problems with infectious disease, poor housing or poor nutrition, then the spread will be quicker and harder hitting. *M. bovis* outbreaks can be severe, both in terms of numbers of cows or calves affected and severity of clinical signs.

Diagnosis

Options for diagnosis should be discussed with your vet/diagnostic lab to consider the best sample types and diagnostic options, as specific cultures need to be requested and can take longer than those for more conventional bacteria. There are specific lab polymerase chain reaction (PCR) tests for *Mycoplasma bovis*, and identification of the Mycoplasma species is important as some species are more pathogenic than others.

Post-mortem samples, mastitic milk samples or joints samples from cattle with arthritis can also be used for diagnosis.

Prevention is better than cure

Some top tips for prevention include:

- Maintain a closed-herd policy
- If purchasing cattle, minimise risk by collecting a detailed history; only purchase from low somatic cell counts herds; screen the herd before purchasing or quarantine cattle before they enter the main herd
- Do not feed waste milk to calves. Pasteurise cow's milk and colostrum
- Disinfect feeding equipment, particularly in automatic-feeding systems
- Considering managing an 'all in and all out' calf system
- Isolate cattle and calves with pneumonia
- No commercial vaccines are licensed in Europe, but it is possible to produce an autogenous vaccine

Case study

John runs a herd of 300 New Zealand Friesian-Jersey crosses, yielding 6,000 litres. One evening, John noticed a couple of lame cows with swollen ankle joints. Within four days, the number had increased to 60 cows. They were not responsive to antibiotics, so John culled one cow and sent her for post-mortem. *Mycoplasma bovis* was confirmed and an isolate was cultured. An autogenous vaccine was produced within three weeks. First, the vaccine had to be tested for adverse effects, which took a further three weeks. John strongly recommends keeping a closed herd and sending a carcase to the lab for testing as soon as possible.

Youngstock

The cost of rearing dairy heifers

Key messages

- Rearing dairy heifers is the second largest cost on farm, after feed cost
- The average total cost of rearing is £1,8109.01 per heifer, although this fluctuates between farms
- Heifers pay back their cost of rearing at an average of 1.5 lactations. Only after this do they start generating profit

Background

Rearing heifers accounts for approximately 20% of a dairy system's production costs after feed. However, the direct and indirect cost of heifer rearing can be difficult to quantify due to the time lag between input costs occurring and production outputs.

Aims

The aims of the project were to record inputs and outputs of heifer-rearing practices on dairy farms in Great Britain to generate accurate data on the cost of heifer rearing, taking into account the cost of mortality. Furthermore, identifying critical factors that influence the cost of rearing heifers and estimate the break-even lactation number to cover the cost of heifer replacement.

What we did

During the project, 102 dairy farms in England, Scotland and Wales were visited between March and August 2013 (Figure 42). On each farm, the following were undertaken:

1. A detailed survey was completed
2. The cost of each input and total cost of rearing, on a per-heifer basis, was calculated
3. A gross-margin analysis was completed
4. The length of the repayment period to determine when heifers 'break even' was completed

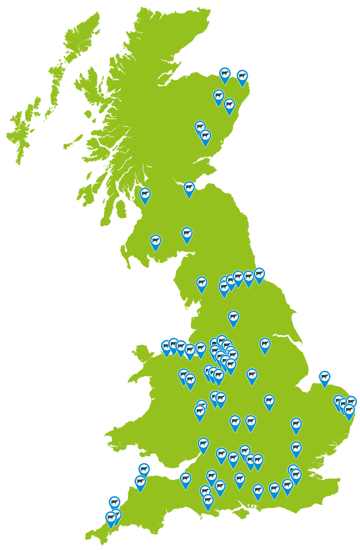


Figure 42. Location of study farms

Results

Figure 43 shows the expenses associated with dairy heifer rearing, with the largest expense being feed, followed by labour and bedding. The average total cost of rearing, including fixed, variable and opportunity costs, and interest on capital, was £1,819.01 (range £1,073.36 to £3,070.46). Daily costs per heifer are shown in Table 6.

Table 6. Daily cost per heifer for each of the heifer rearing periods

Rearing period	Average (£)	Min–max (£)
Birth–weaning	3.14	1.68–6.11
Weaning–conception	1.65	0.75–2.97
Conception–calving	1.64	0.56–2.86
Total rearing period*	2.31	1.47–3.35

Notes: *Includes fixed rate and variable costs, interest on capital, opportunity cost and cost of mortality

The average gross margin for the entire rearing period was £441.66 (range -£367.63 to £1,120.08), with average cost of mortality worked out as £139.83 per surviving heifer (range £103.49 to £146.19). On average, heifers paid back their cost of rearing by 1.5 lactations (range 1.4 to 6.4 lactations), but the age at first calving is strongly associated with the cost of rearing (Figure 44) and therefore has a strong influence on this.

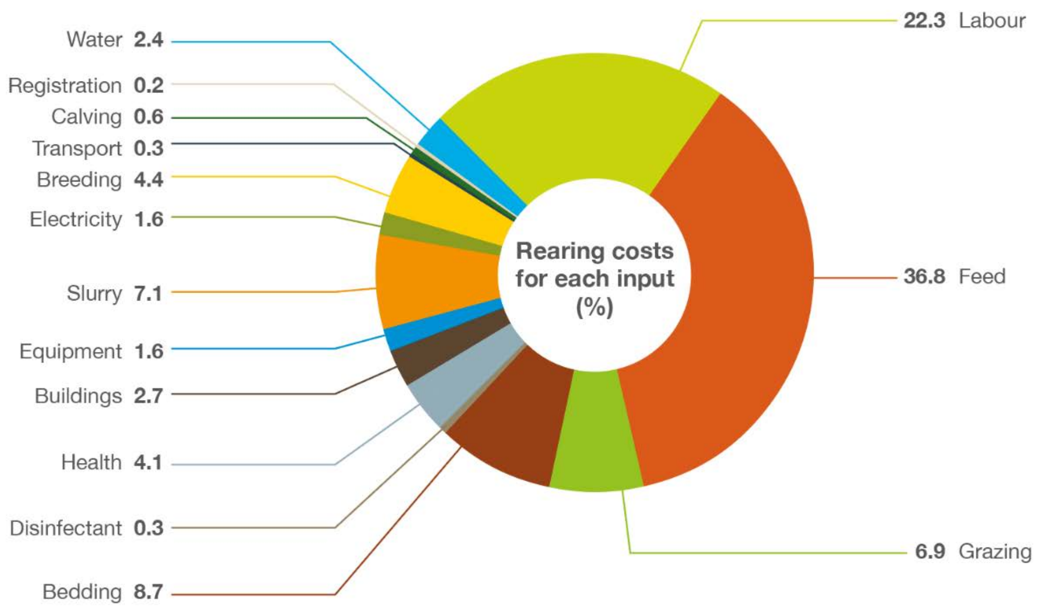


Figure 43. Proportion of rearing cost for each input (excludes interest and opportunity costs)

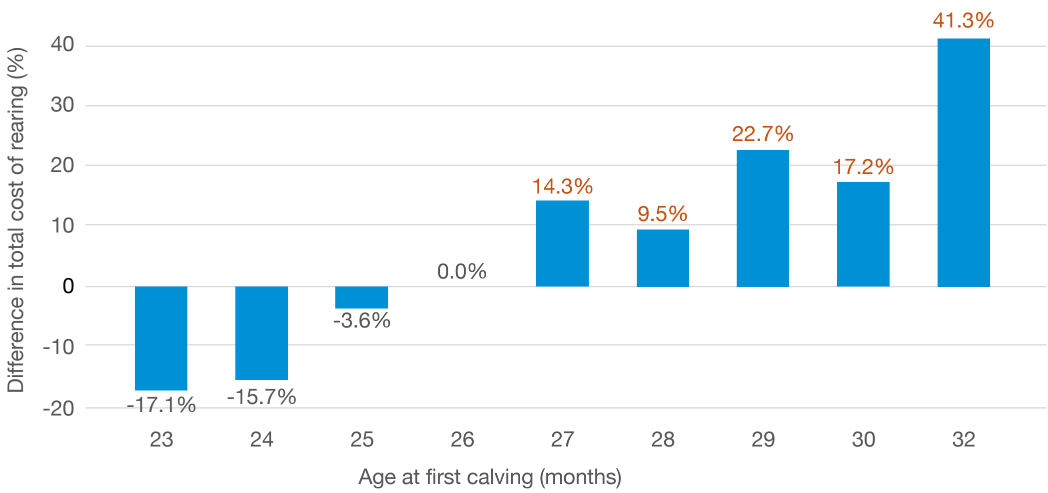


Figure 44. Percentage difference in total cost of rearing with 26 months as the base month (0%)

Conclusions

Throughout the study, there was large variation in costs between individual farms and also within similar calving systems. The results indicate that management decisions on key reproductive events influence the cost of rearing and while decisions surrounding nutrition during the birth-to-weaning period have a large impact on the cost of rearing, the period only accounts for, on average, 10.8% of total rearing costs.

Alana Boulton, Jonathan Rushton and Claire Wathes, The Royal Veterinary College

Optimum grazing systems for youngstock

Background

Rearing is the second largest cost to a dairy business. With the average total cost of rearing at £1,819, or >6 ppl of milk produced, optimising heifer-rearing practices to be repaid through higher milk production and a longer productive life is important. Improvement of rearing practices is an ongoing process, as there is always room for improvement. However, one way of improving is to better utilise grazing systems for youngstock.

Well-managed grass is the most cost-effective feedstuff for ruminants, and it is possible to get high youngstock performance levels during the and development on grazing is a good way to reduce costs.

Underutilisation of grass by youngstock leads to:

- Failure to meet target liveweight/ages
- Additional costs
- Sward deterioration
- Increased GHG emissions

Aims

The aim of this study was to provide a better understanding of the role and potential of grazed grass within heifer-rearing systems.

- Consider the strengths and weaknesses of grazing systems and practices
- Address the weakness through incorporating precision technologies, e.g. remote concentrate-feeding systems and possibility of weighing remotely (CIEL Investment)
- Establish the optimum pasture allowance for replacement heifers in order to both optimise animal performance and pasture growth and utilisation
- Develop grazing wedges for grazing dairy heifer replacements
- Better understanding of grazing strategies for heifers and how best to meet targets, leading to increased efficiencies and profits
- Improving rearing efficiency to enable heifers to fulfil their genetic potential will also directly impact sustainability and profitability

What we did

To determine the optimum pasture allowance, stocking rate and energy intake, 72 heifers have been given pasture allowance for three different body weights:

- 1.8%
- 2.4%
- 3.0%

Pasture will be measured on a complete body weight basis, and will be allocated on the basis of 100% utilisation. Heifers will be weighed every fortnight.

Outcomes

The outcomes of this study are still pending.

Robert Patterson, Steven Morrison and Katerina Theodoridou, Agri-food and Biosciences Institute, Northern Ireland

Outwintering replacement dairy heifers

Key messages

- Decisions on the most appropriate forage should be made on soil type and crop yield
- Performance targets are more likely to be met on farms that weigh and monitor animals regularly
- Supplementing with a mineral bolus has a marginal effect on BCS prior to calving, and increases milk fat content in early lactation, especially in herds grazing kale

Background

Why outwinter heifers? The trend towards expanding herd size creates extra accommodation requirements for youngstock. Options for expanding include:

- Constructing extra buildings (high capital investment)
- Purchasing in-milk heifers (biosecurity risk)
- Woodchip pads
- Outwintering replacement heifers

Little is known about the current practices of outwintering or the performance of these animals during the rearing period in comparison with housed heifers.

Figure 45. Dairy heifers grazing stubble turnips

A survey of current practice was undertaken. Seventy farmers participated in a survey in 2012. The participants each had an average of 9.7 years' experience in outwintering heifers.

70 farmers participated in a survey in 2012

The participants each had an average of **9.7 years'** experience in outwintering heifers

The top four reasons for outwintering heifers were:

1. To reduce the cost of heifer rearing.
2. To improve animal health and welfare.
3. To reduce labour input.
4. To alleviate pressure on buildings.

The most popular forages for outwintering heifers were:

1. Grass: 55% of farms / 4.4 t DM/ha average yield.
2. Kale: 42% of farms / 10 t DM/ha average yield.
3. Fodder beet: 32% of farms / 21 t DM/ha average yield.

The most common supplementary feed was baled silage (80%), which was commonly (66%) stored in the field. Supplementing with a mineral bolus was also most common (49%).

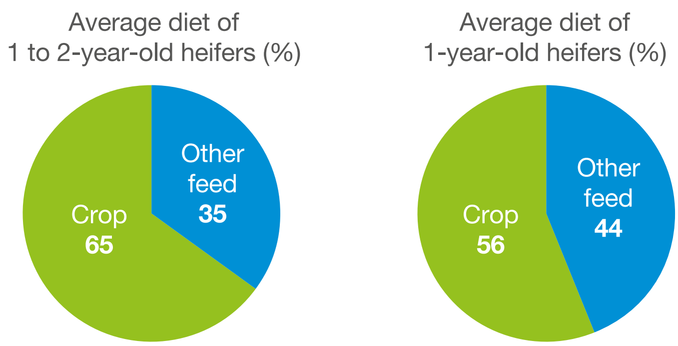


Figure 46. Comparison of an average diet for 1-year-old and 1- to 2-year-old heifers

Animal performance

Over the outwintering period, farmers estimated:

- Liveweight gain (LWG) of 0.54 kg per day
- 59% of heifers gained BCS
- 37% of heifers maintained BCS

Field selection

Choosing free-draining, dry soils was the primary criteria for selecting a suitable area to outwinter heifers. Field selection and soil type is also key to:

- Avoiding poaching
- Avoiding run-off
- Providing dry lying areas

On-farm monitoring

Outwintered heifer performance in the winter and first lactation was monitored. During the project, soil condition and the effect of a mineral bolus was being measured on low-input, spring-calving, cross-bred dairy herds in 2013.

- Nine farms – three grass, three kale, three fodder beet
- 360 heifers – 40 on each farm
- Half of the heifers were given a mineral bolus

Measurements included: forage quality and utilisation, LWG, milk yields, health and fertility.

Outcomes

A number of top tips for outwintering have been produced in video format and can be seen on the **AHDB Dairy YouTube** channel playlist.

Norton Atkins, Emma Bleach and Liam Sinclair, Harper Adams University

Outwintering replacement dairy heifers for high-input systems

Key messages

- In-calf Holstein heifers can be outwintered successfully on high-output dairy farms with careful planning and management
- Heifers outwintered on fodder beet with 35% of dry matter intake (DMI) as grass silage can obtain target liveweight gain (LWG) with accurate feed allocations and regular monitoring of animal performance
- Heifers outwintered on deferred grass and grass silage may have difficulty maintaining LWG and BCS, particularly from January and in very wet conditions
- Concentrate supplementation may be required to maintain animal performance when outwintered

Background

Heifer rearing is the second largest cost on dairy farms, after feed and forage. With outwintering providing a possible lower-cost option by reducing winter housing and feed costs, interest in its use is growing.

Deferred grazing, kale and fodder beet are the most common forages used for outwintering in GB, but there is little information on animal performance when outwintered on these forages in comparison with housed heifers.

Aim

Aims of this project were threefold:

- To evaluate heifer performance on fodder beet and deferred grazing systems
- To compare performance of housed and outwintered heifers
- To evaluate the suitability of outwintering systems for high-output farms

What we did

Forty-eight in-calf Holstein dairy heifers were assigned to either:

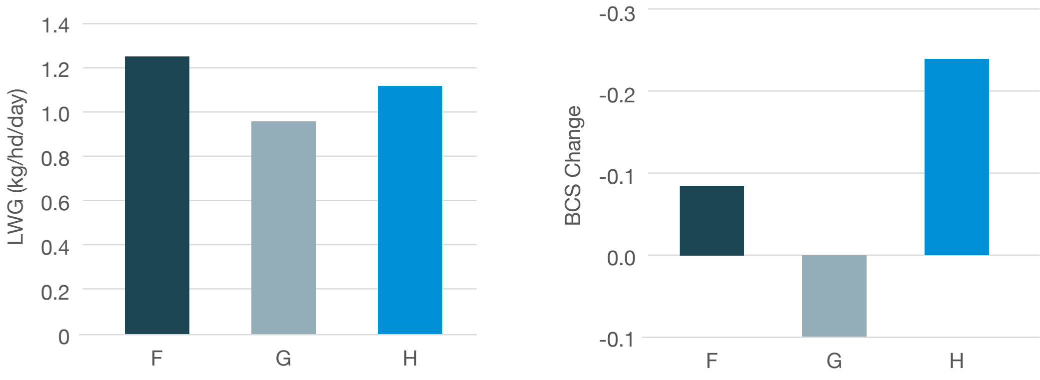
- Outwintered on grass and grass silage (G)
- Outwintered on fodder beet and grass silage (F)
- Housed and fed grass silage and concentrate (H)

The outwintered heifers received **35%** of their DMI as **big bale silage**

They were outwintered for **13 weeks** and then housed **six weeks** prior to calving.

Outcomes

Heifers outwintered on fodder beet obtained target LWG in winter conditions (Figure 47), while heifers outwintered on deferred grazing may have difficulty maintaining LWG and BCS. Heifer BCS change was lower at housing and parturition when fed grass and grass silage (G) (Figure 48).



F Outwintered on fodder beet and grass silage
G Outwintered on grass silage
H Housed and fed on grass silage and concentrate

Figure 47. Average daily LWG and BCS change during the outwintering period

Early-lactation milk yield was not affected by any of the outwintering treatments (Figure 48). Milk fat (g/kg) was lowest and milk protein (g/kg) highest in the heifer group outwintered on fodder beat and grass silage (F). Overall milk somatic cell count (SCC) was low but was less in the group outwintered on grass and grass silage (G) than the group on fodder beat and grass silage (F). None of the groups saw a negative effect of outwintering on subsequent fertility of Holstein heifers.

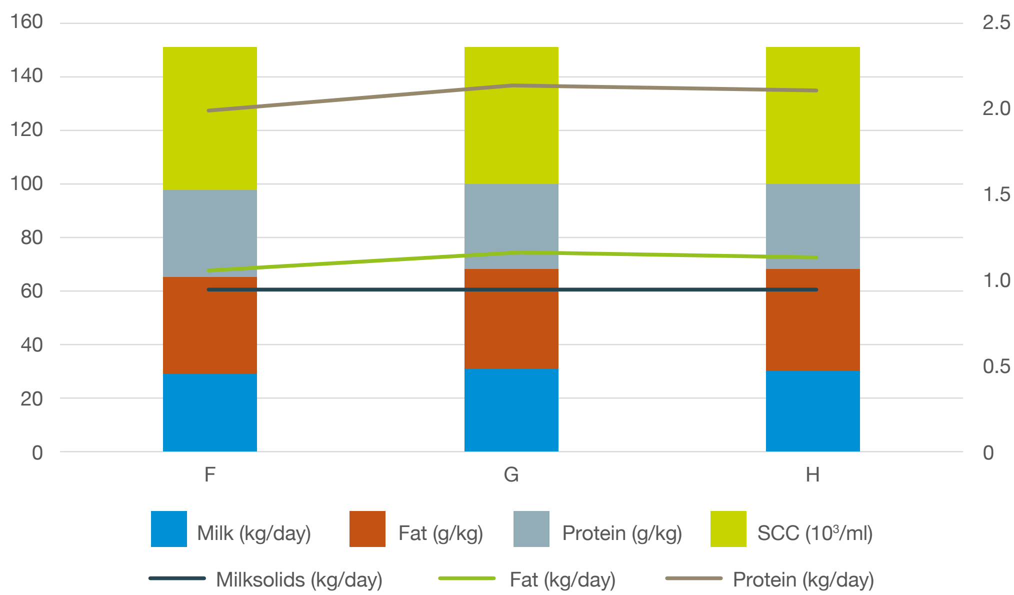


Figure 48. The effect of outwintering in-calf heifers on milk yield and quality during early first lactation

Check out the outwintering playlist on **AHDB Dairy YouTube channel** for further top tips on outwintering.

Norton Atkins, Emma Bleach and Liam Sinclair, Harper Adams University

Grass and forage

Making the most of grass and clover

Key messages

- Using the latest grass and clover varieties can increase nutrient use efficiency and improve sward quality and yield
- The Recommended Grass and Clover List (RGCL) outlines the top varieties for performance and disease resistance suited to GB conditions
- Select companion grasses carefully, depending on the required clover levels
- The current RGCL protocols are applicable for lower-input conditions

Use the RGCL online tool to identify suitable varieties: **ahdb.org.uk/tools**

Background

Low-input systems rely on good-quality sward to maintain production, therefore improving sward quality and yield is important. Currently, genetic potential is explored by testing varieties under high nutrient inputs, but little is known about how varieties perform under lower nutrient conditions.

Aim

The aim of this study was to evaluate the applicability of the RGCL to lower-input systems, and to assess how clover types performed alongside different grass varieties.

What did we do?

Plots were sown at three sites (Devon, Shropshire and Yorkshire), over three years, and managed under silage and simulated grazing protocols. Trials were conducted throughout 2015.

Rye-grass

Six perennial rye-grasses (PRG), (three tetraploid, three diploid), were managed under three rates of N application:

- 400 kg N/ha
- 200 kg N/ha
- 100 kg N/ha

Clover

Two medium-leaf white clover varieties were sown in a mixture with either PRG, cocksfoot or timothy. Plots received 200 kg N/ha.

Outcomes

Grass

Under silage management, there was an average 23 kg DM grass response to each kilogram of N applied (Figure 49). Initial analysis shows that there is no significant interaction between N input and the varieties, with all six varieties increasing in yield as nitrogen application rate increased. This shows that the RGCL system is representative for lower-fertiliser systems.

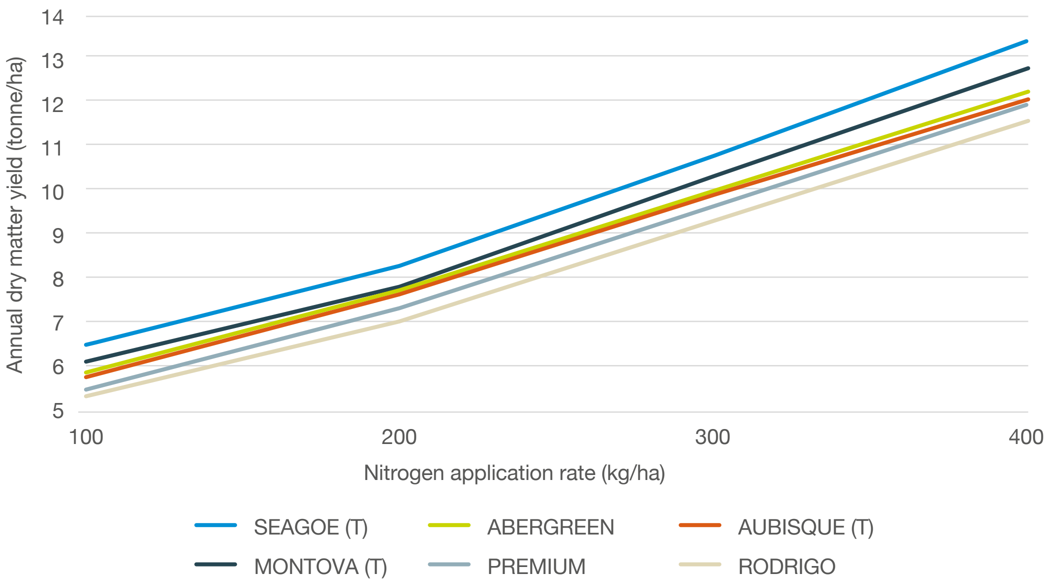


Figure 49. Annual DM yield of six PRG varieties grown under three nitrogen application rates

PRG varieties were ranked on a 1–6 scale on their total annual silage yield when grown under different applications of nitrogen (Table 7).

Table 7. PRG varieties ranked according to total annual silage yield under varying applications of nitrogen

PRG ranking	N fertilisation regime (kg N/ha)		
	100	200	400
1	Seagoe (T)	Seagoe (T)	Seagoe (T)
2	Aubisque (T)	Aubisque (T)	Aubisque (T)
3	Rodrigo	Rodrigo	Rodrigo
4	Premium	Abergreen	Abergreen
5	Abergreen	Premium	Premium
6	Montova (T)	Montova (T)	Montova (T)

(T) = tetraploid cultivar. All others diploid

Clover

The contribution of clover varied between grass species and accounted for 31–58.3% of total annual yield (Figure 50). The overriding factor that dictated the clover patterns was the growth habits of the different grass species in the same sward. When white clover was established with late-heading timothy, the clover contribution was highest, at 46%.

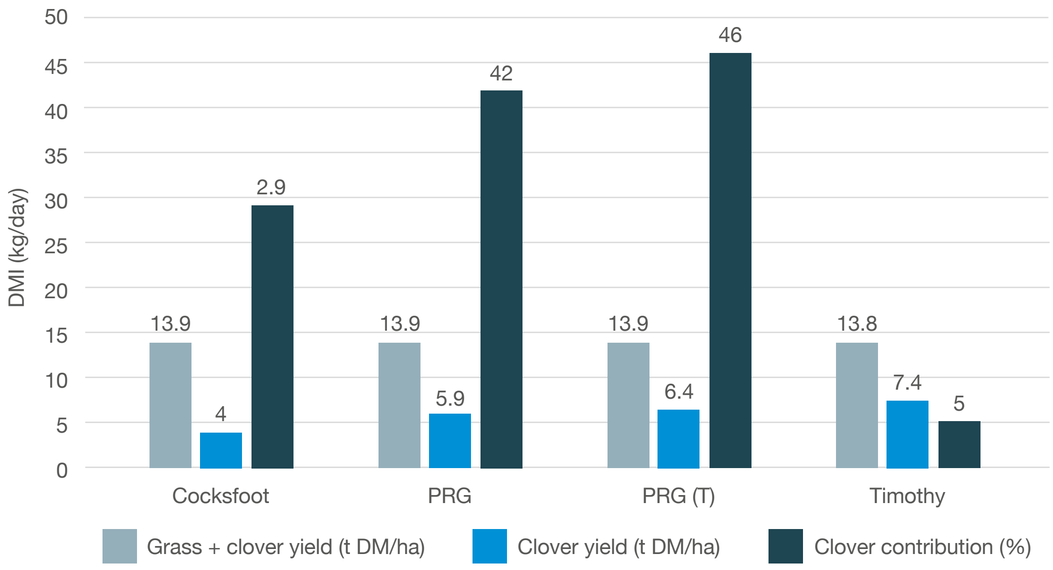


Figure 50. Impact of companion grass on white clover yield and contribution under silage management

Conclusion

The RGCL outlines the top varieties of grasses and clovers for performance and disease resistance which are suited to GB farms. However, when using the RGCL, it is important to choose the companion grasses carefully to suit the required clover levels in the field, as some companion grasses will limit the growth of clover and its contribution to the sward.

The current RGCL protocols and online tool are suitable to be applied to low-nutrient-input systems, where using the correct grass and clover varieties can improve sward quality and yield while increasing nitrogen-fertiliser-use efficiency.

Joanna Matthews and Simon Kerr, National Institute of Agricultural Botany

Debbie McConnell and Liz Genever, AHDB

Development of reliable NIRS equations for the prediction of grass-clover silages

Key messages

The production of better Near Infrared Spectroscopy (NIRS) equations for grass-clover silages will:

- Facilitate more accurate ration formulation for diets based on grass-clover silages
- Reduce diet costs
- Increase the efficiency of production

Background

NIRS is a rapid and cheap method of analysing the nutritional value of feedstuffs, including silages. Current NIRS analysis developed for grass silage does not take into account the clover content of the forage, which may alter the nutritional value. With rising cost and volatility of bought-in protein, accurate determination of the protein content of home-grown forages is key to reducing diet costs and increase the efficiency of production.

Purpose of work

To develop reliable equations using NIRS to more accurately predict the nutritive value of grass-clover silages.

What did we do?

Ninety grass-clover samples were collected across a range of clover contents, and samples were taken from both red and white clover (Figure 51).

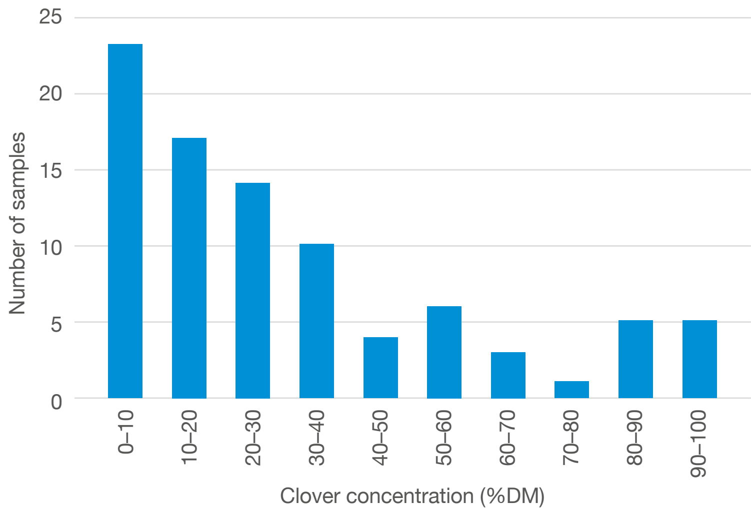


Figure 51. An overview of grass-clover samples and their relevant clover concentration

Samples were:

1. Logged, coded and analysed for DM%.
2. Aspeciated to determine clover content.
3. Analysed via wet chemistry and NIRS.

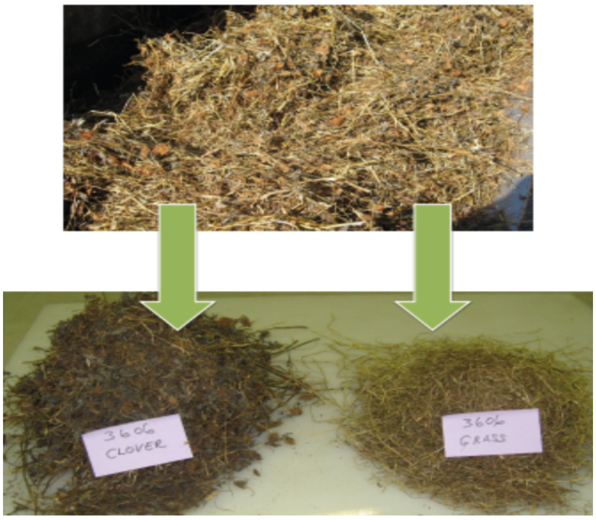


Figure 52. Sample pre and post separation of grass and clover

Digestibility assessments

Digestibility was measured using 12 sheep over a 21day feeding period. Faeces were collected over a 7-day period and analysed to determine organic matter digestion. Metabolisable energy (ME) was predicted from this.

Degradability assessments

Degradability parameters were determined for use in Feed into Milk and other ration programmes.
Dry matter, nitrogen and degradability were measured, with degradability estimated using three dairy cows.
Incubation time periods included: 0, 3, 6, 12, 24, 48 and 72 hours.

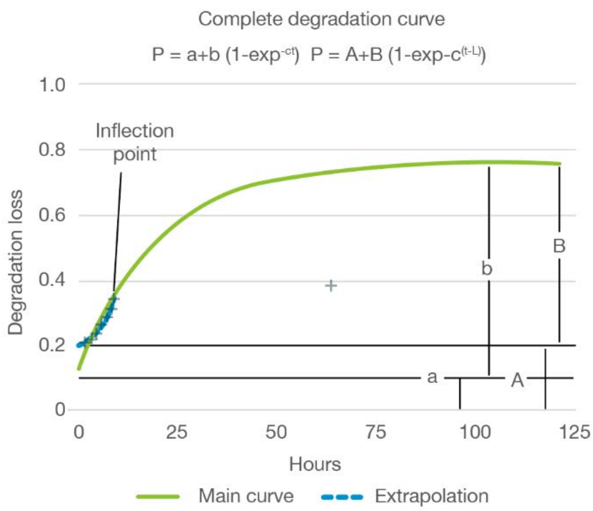


Figure 53. Complete degradation curve

Outcomes

When questioned, the majority of farmers could not estimate the concentration of clover in the crop to within ±10% DM. The current equations for grass NIRS gave a good prediction accuracy for some variables, including digestibility, but crude protein and protein degradability were not well predicted. As clover concentration increased, accuracy of variables decreased.

Conclusion

Understanding the nutrient content of forages produced on-farm allows more accurate rations to be formulated, which provide the correct nutrient balance required by the cow. This reduces the overfeeding of nutrients which are not required and then excreted, which in turn can reduce the diet cost. It is difficult to estimate the complete composition of mixed grass and clover silages by eye alone, but even when using NIRS, the current grass silage equations do not accurately predict crude protein content and protein degradability for grass-clover silages. Further improvements to the current grass NIRS equations are needed to make sure that accurate nutritional analysis is possible for grass-clover mixed silages.

David Humphries, Tom Burns-Price and Chris Reynolds, The University of Reading

From root to rumen: Nutrient-efficient grass and clover varieties

Key messages

- Approximately 70% of protein consumed by dairy cows is excreted in faeces and urine
- Phosphorus (P) is an essential macronutrient for cell growth and repair and for root development
- With extensive root nodulation, clovers are thought to display a high requirement for P
- Rainfall in the UK is now consistently lower than the 1961–1990 long-term average
- Perennial rye-grass production is reduced by 1 t/ha for every 50 mm increase in soil water deficit
- New varieties of Italian and perennial rye-grasses and clover hybrids, which show increased nitrogen- and water-use efficiency, have been developed to enter National List trials

Background

Nitrogen (N) pollution to water is a major problem in the UK, and with rising fertiliser costs and greater focus on reducing losses to the environment, improving nutrient-use efficiency is increasingly important in livestock systems. Changes to rainfall patterns have highlighted the need for deeper-rooting, more water- efficient varieties of grass and clover which are more resistant to changeable weather.

Development of genomic technologies for plant breeding may help identify genetic markers for grass and clover improvement, including improved nutrient- and water-use efficiency.

Aim

The aim of this study was to develop new varieties of grass and clover to enhance beef, sheep and dairy production while reducing the environmental impact of grassland agriculture in the UK.

What we did

New populations of forages with increased nitrogen-use efficiency were developed and then grown. The field testing assessed how much nitrogen-use efficiency could be increased and whether N losses to the environment could be reduced.

Clover plants from long-term low-input grassland sites were also gathered and polycrossed to develop plants with a lower P requirement. These were grown with perennial rye-grass (PRG) and their performance compared under restricted and normal P fertiliser application.

Outcomes

Nitrogen-use efficiency

Approximately 70% of protein consumed by dairy cows is excreted in faeces and urine, but this can be reduced by improving nitrogen use in the rumen by supplying higher amounts of rumen-degradable energy in the diet. Grasses with high water-soluble carbohydrates may provide a more rapid release of energy in the rumen, so high-water-soluble carbohydrate varieties have been developed and are now being tested in national trials to identify their agronomic performance.

Clovers

When grown with rye-grass, nitrate leaching from red clover is reduced due to uptake of N by the rye-grass plant. Red clover also contains an enzyme, polyphenol oxidase (PPO), that can reduce N losses, so a new variety of red clover with high PPO has been developed and is being tested under field conditions. Dietary proteins were bound by PPO to produce protein-bound phenol, which was protected during wilting.

Phosphorus-use efficiency

Under restricted fertilisation, total DM yield for the low-P-clover sward was 11% higher than the conventional clover (Figure 54). Although this process remains poorly understood, it is thought that white clover may be able to mobilise P from the surrounding soil, increasing PRG yield.

Under high P fertilisation, there was limited benefit to low-P clovers.

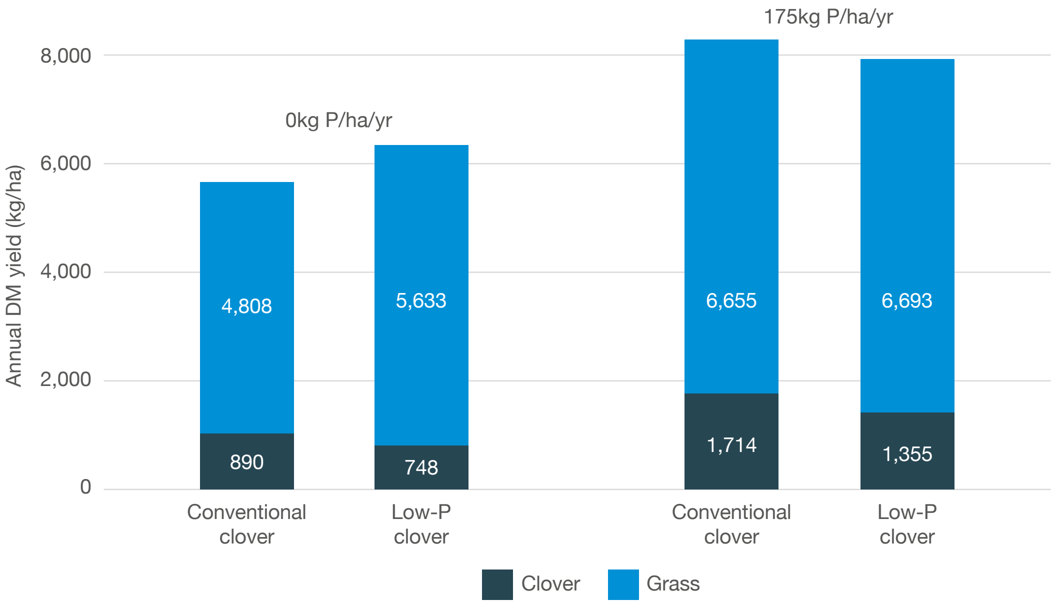


Figure 54. Annual DM yield for conventional and low-P clover-PRG swards at two P fertiliser levels

Water-use efficiency

Fescue genes have been introduced into Italian and perennial rye-grasses to give more rapid root growth and improved water-use efficiency. A number of perennial rye-grass varieties have had these genes introduced and these novel hybrids show a faster and higher amount of root growth than traditional varieties.

One new variety has been added into the National List testing after showing improved water-soluble carbohydrates, yield and 80% better water efficiency than the Italian rye-grass control.

A new white clover variety (Caucasian clover cross white clover) has also entered National List trials for its increased water-use efficiency.

Conclusion

Ongoing genetic testing and breeding has produced new varieties of Italian and perennial rye-grasses and clovers which have the capacity to improve performance, reduce N loss to the environment and have increased water-use efficiency. These could help provide higher yields with less maintenance and lower costs, both economically and environmentally.

Athole Marshall, David Lloyd and Jon Moorby, IBERS, Aberystwyth University

The Breeding LINK projects were sponsored by Defra through the Sustainable Livestock Production (SLP) LINK programme, with support from AHDB, British Grassland Society (BGS), Germinal Holdings Ltd, Hybu Cig Cymru, Livestock and Meat Commission of Northern Ireland (LMC) and Quality Meat Scotland (QMS).

Lucerne: Sowing date and under-sowing with spring barley

Key messages

- Spring sowing is more reliable than late-summer/autumn sowing in terms of successfully establishing a crop
- There is no effect on yield or quality in the establishment season if lucerne is planted with spring barley
- Late-summer sowings effectively take 12 months to match the productivity and quality of spring sowings

Background

Lucerne can be slow and difficult to establish with both spring and late-summer sowing taking place in GB. Weed control is another issue during establishment and a companion crop can help suppress weeds. However, little work has been done to establish optimum agronomy practices for British conditions.

Aim

The aim of this study was to establish optimum agronomy practices for British growing conditions.

What we did

Trial sites were established at HAU, SRUC (Dumfries) and in Berkshire. At the three sites), trial plots were established from 2012 to 2014. Randomised trials were conducted on the plots with 3 treatments:

- Late-summer-sown lucerne
- Spring-sown lucerne only
- Spring-sown lucerne with spring barley

Plots were harvested at early bud stage in the year of establishment and the following year.

Outcomes

Spring sowing was more reliable in terms of establishment across all three sites, with 100% of spring-sown crops making it through to harvest, in comparison with only 29% of crops established in late summer. Late-summer sowing resulted in lower dry matter yield in the following season in comparison with spring-sown crops, and the crude protein content was also significantly lower in crops sown in late summer (Figure 55).

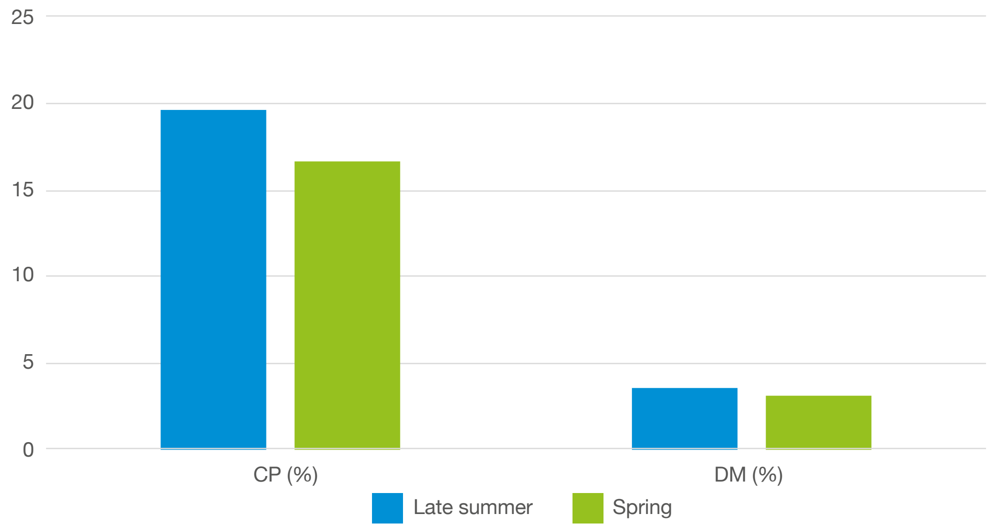


Figure 55. CP and DM of lucerne depending on sowing time

Across four sowings, there was only one occasion when spring barley significantly increased DM yield at first cut in the establishment year, and there was no consistent benefit seen in the CP or NDF levels across sites when sown with spring barley.

Conclusion

Sowing lucerne in the spring is more reliable than sowing in late summer or autumn, with late-summer sowings requiring a longer growing period of up to 12 months to catch up with the productivity and quality of the spring-sown crops. Growing spring barley as companion crop has no effect on the yield or quality during the lucerne establishment season.

Louisa Dines, Harper Adams University

Growing grass with nutrients from separated slurry

Key messages

- As fertiliser prices increase, slurry is an increasingly important source of nutrients on farm
- Slurry separation will have a significant effect on the chemical profile of slurry
- The nutritive value of slurry can vary from farm to farm and over time
- It is important to test separated slurry to get an accurate measure of nutrient content and availability
- Using slurry on grazing pastures can result in fertiliser savings of up to £25/hectare/rotation

Background

Mechanical separation of slurry involves the partitioning of slurry into a stackable fibrous fraction and a liquid fraction. There are a number of advantages and disadvantages to slurry separation.

Advantages:

- Reduction in slurry volume (Figure 56)
- Easier handling of the liquid fraction
- Lower DM content = lower sward contamination and greater window for slurry application
- Option to export the solid fraction (reduce nutrient loading)
- No closed period for solid application
- Higher available nitrogen in separated liquid fraction

Disadvantages:

- High capital cost of equipment ≈ £25,000
- Infrastructure requirements – reception, storage tanks and solid store
- Maintenance costs

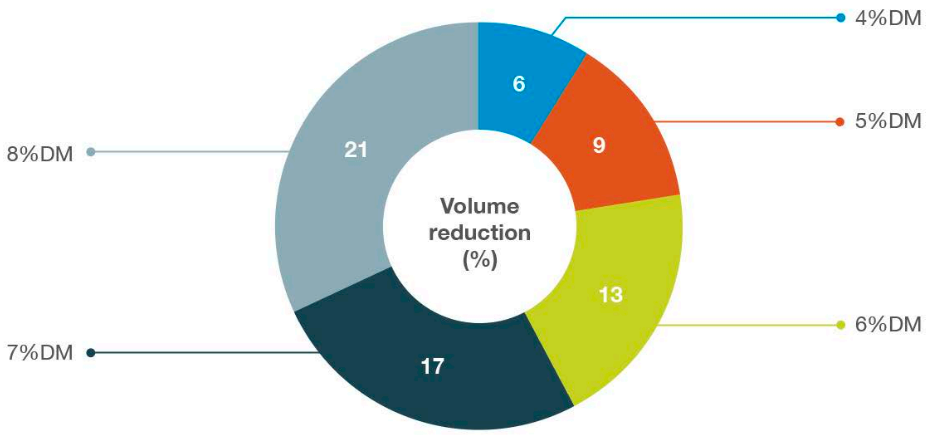


Figure 56. Reduction in the volume of cattle slurry by brushed-screen separation at varying slurry dry matter (DM) contents on dairy farms in Northern Ireland

Using separated slurry on grasslands

Higher ammonium-N and lower DM content of the liquid fraction may encourage better grass growth. However, little information is available on the performance of swards grown from separated slurry.

Two studies were used to evaluate:

1. Grass silage grown using separated slurry.
2. The use of separated slurry on grazed grass.

Study 1 – Separated slurry for grass silage

Question

How will the performance of grass swards grown using nutrients from separated slurry compare with those grown from other nutrient sources?

Outcomes

Grass grown with the liquid fraction of separated slurry exhibits comparable performance to whole slurry. On grass grown for silage, separated slurry results in similar performance as artificial N fertiliser application.

N recovery was similar from slurry spread via dribble bar and shallow-injection-spreading technologies.

Figure 57. Greater infiltration can be expected with separated slurries

Study 2 – Separated slurry on grazed grass

Question

Can separated slurry be used effectively on grazed grass to supply nutrients for grass growth and support the performance of mid–late-lactation dairy cows?

Outcomes

1. Grass growth and animal performance on grass grown with nutrients from separated slurry applied via dribble-bar technology are comparable to those with artificial fertiliser
2. Whole slurry can be used on grazed grass without impacting on DMI of grass
3. The N recovery and milk yield responses are lower when using whole slurry in comparison with separated slurry

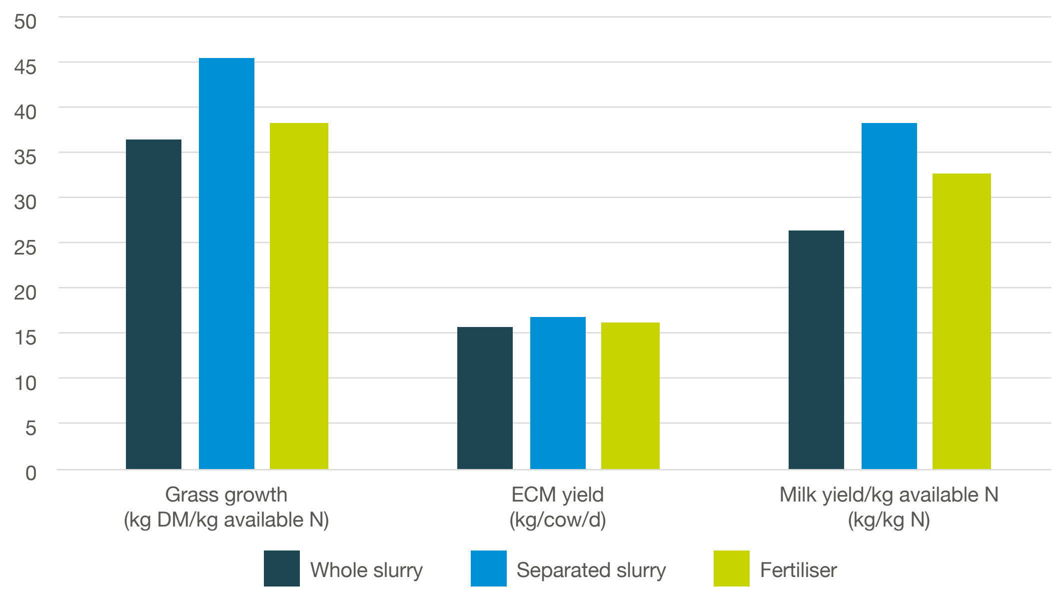


Figure 58. Comparison of grass sward and animal performance on pastures treated with whole slurry, separated slurry or artificial fertiliser

Conclusion

Using separated slurry as a fertiliser source can be a cost-effective way to increase the nutrient content of soils. Although there are primary costs associated with machinery and infrastructure to allow effective slurry separation and application, the use of slurry on grazing pastures can result in fertiliser savings of up to £25/hectare/rotation.

It is important to make sure that separated slurry is tested for its nutrient content before application, as the nutrient value is variable between farms. With animal performance and grass growth both comparable when fertilised with separated slurry to nitrogen fertiliser, using separated slurry is an effective way to maintain yields and reduce slurry volume on farm.

Chris Henry and Dave Roberts, SRUC Dairy Research and Innovation Centre

On-farm monitoring of outwintering systems

Key messages

- Decisions on the most appropriate forage should be made on soil type and crop yield
- Performance targets are more likely to be met on farms that weigh and monitor animals regularly
- Supplementing with a mineral bolus has a marginal effect in herds grazing kale

Background

Outwintering heifers can be cost-effective, but there are often concerns about their performance during this time. With the optimum age of first calving at 24 months, ensuring good growth during outwintering for optimum fertility is important.

Aim

The aim of this project was to measure outwintered heifer performance in the winter and first lactation by measuring the effect of outwintering on soil condition and to determine the effect of a mineral bolus.

What did we do?

Nine farms were selected with three different outwintering regimes – 3 on grass, 3 on kale and 3 on fodder beet. The study involved 360 heifers; 50% were given a mineral bolus and 50% did not have a bolus.

Outcomes

Growth performance was variable between and within farms during the outwintering period. With farms in different areas of the country, there was variation in weather between farms, but there was also a difference in the frequency of measuring growth rate. The three farms with highest daily liveweight gain (DLWG) were measuring animal performance regularly (Figure 59).

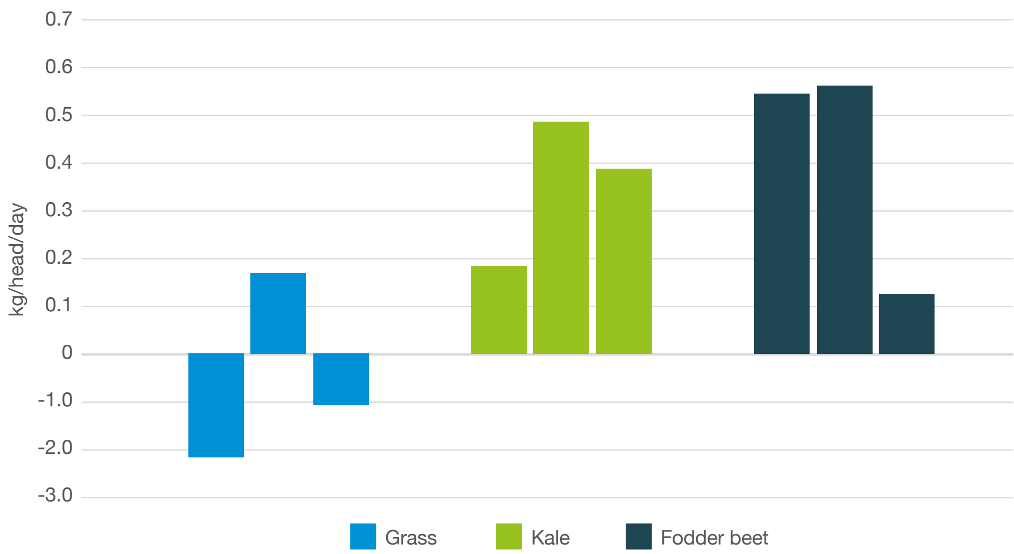


Figure 59. DLWG across farms

Supplementing with a mineral bolus has a marginal effect on BCS prior to calving and increases milk fat content in early lactation, especially in herds grazing kale (Figure 60).

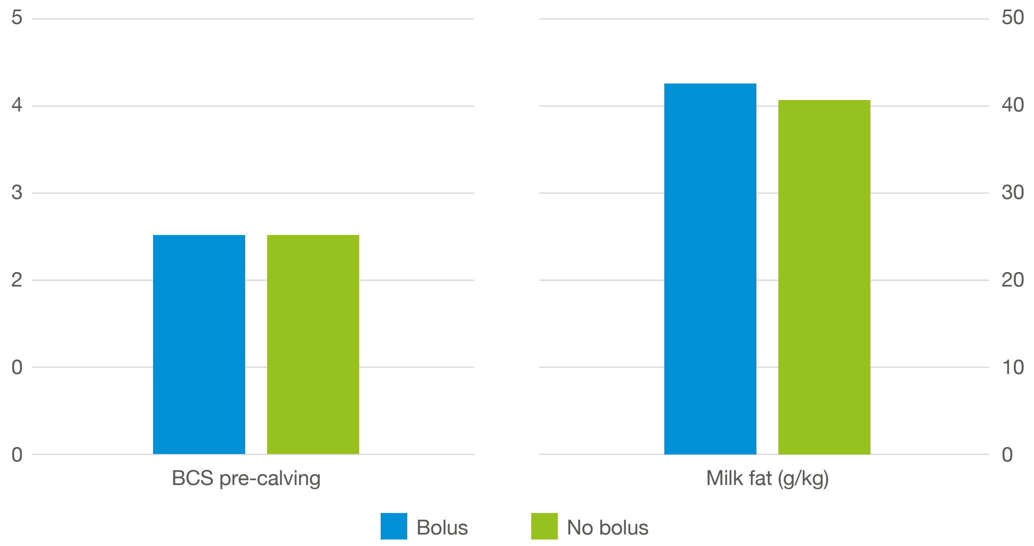


Figure 60. Effect on mineral bolus supplementation

Conclusion

There was no subsequent effect of outwintering forage type or provision of a mineral bolus during the outwintering period on the health or reproductive performance of first-lactation cows. If an appropriate choice of soil type is made for the outwintering field, there is little difference in soil conditions on farms outwintering on grass, kale or fodder beet. Soil compaction increased post-grazing on all of the three forage types.

Check out the outwintering playlist on **AHDB Dairy YouTube channel** for further top tips on outwintering.

Norton Atkins, Emma Bleach and Liam Sinclair, Harper Adams University

The effect of sample handling and storage on the nutritional value of fresh grass

How to take a grass sample for analysis

1. Take samples early in the week.
2. Aim to cut samples immediately before posting.
3. Using scissors, cut a large handful of grass to your target residual at a minimum of six locations across the paddock.
4. Place into a bucket and mix gently.
5. Take a subsample from the bucket and place into the sample bag, avoiding overfilling the bag.
6. Gently squeeze the air out of the bag and seal.
7. Send to the lab via first-class post.

Note: Samples which are taken more than two hours before posting should be stored in the refrigerator in a sealed bag.

Background

Fresh grass analysis, by supplying information on grass dry matter (DM), crude protein (CP), water soluble carbohydrate (WSC) and metabolisable energy (ME) content, can be an important tool in managing grazing cow diets throughout the season.

Near infrared reflectance spectroscopy (NIRS) is a cheap and reliable laboratory technique for analysing the nutritional value of fresh grass. However, between the time of sampling and analysis, plant degradation may take effect, resulting in inaccurate analysis results.

Aim

The aim of this study was to examine the effect of harvesting technique and storage conditions on the nutritional value of fresh grass.

What did we do?

An established perennial rye-grass sward was managed under a simulated grazing regime during summer 2015. Grass quality was analysed at four of the eight grass harvests throughout the season. At each harvest, various treatments were studied:

- Harvesting technique (pluck or cut)
- Storage duration (immediate, 24-hour or 48-hour analysis)
- Storage temperature (ambient (15.2°C average) or chilled (4°C))

- Storage conditions (air present, air excluded or breathable)
- The effect of storage duration, temperature and conditions was also examined for silage samples

Outcomes

Hand-plucked samples tended to have higher CP (8 g/kg DM) than samples that had been cut. Changes in grass quality due to storage were small. However, storing samples under ambient temperatures, in breathable bags for 48 hours, led to the greatest sample deterioration (Figure 61). This was seen where samples stored for 48 hours had a lower WSC (9 g/kg DM) and ME content (0.12 MJ/kg DM), and samples stored at ambient temperature had a lower WSC of 12 g/kg DM and ME content of 0.17 MJ/kg DM.

There was limited effect of sampling or storage on the CP content of the sample. Grass from silage swards did not deteriorate if stored for 48 hours but had a higher WSC (18 g/kg DM) and ME content (0.26 MJ/kg DM) when stored chilled, as opposed to at ambient temperatures.

Dry matter content of grass samples was also affected by storage conditions, with ambient and breathable storage resulting in samples with lower dry matter g kg (Figure 61).

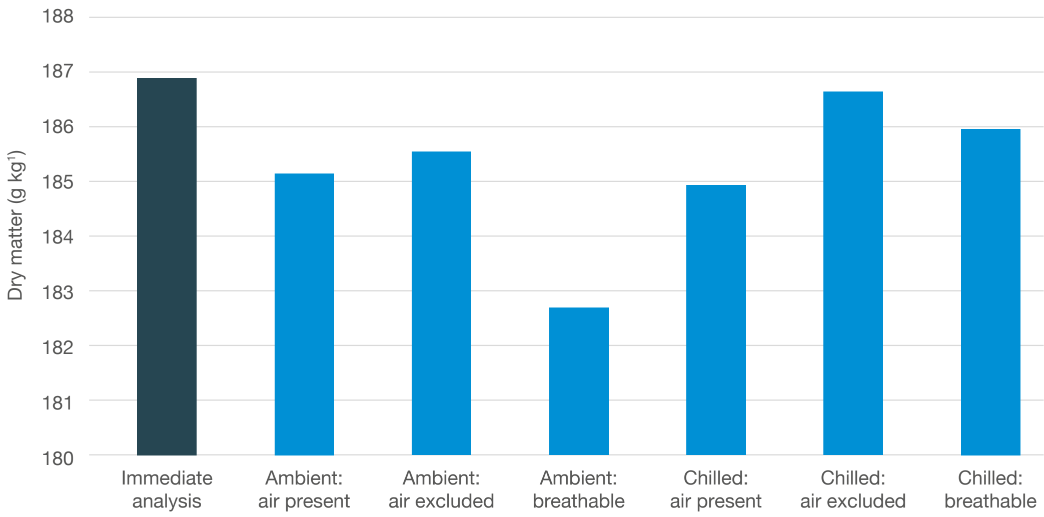


Figure 61. The impact of storage type on grass dry matter content

Conclusion

The most accurate nutritional analysis is of samples taken immediately before analysis, but if equipment is not immediately available, on-site samples must be sent on to laboratories for near infrared reflectance spectroscopy. These samples are commonly posted, and therefore storage of the samples is important to prevent as much nutritional degradation as possible. The least sample degradation comes from storing grass in a chilled (4°C) environment in non-breathable bags.

Andrew Dale, Alan Gordon, John Archer and Conrad Ferris, Agri-Food and Biosciences Institute, Northern Ireland

Controlled traffic farming in silage systems

Key messages

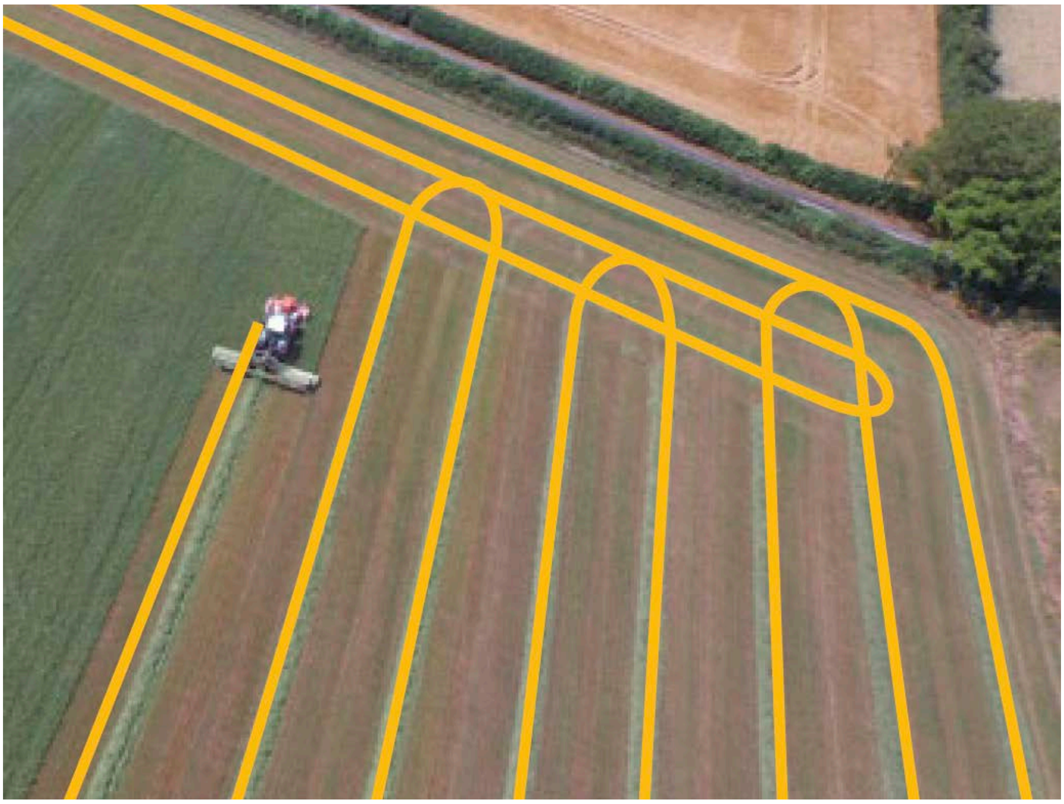
- Decide on a working width that is compatible with all machinery used on the farm
- Permanent field markers at the edge of the field ensure the GPS can be aligned for each field operation
- The numbers and accuracy of navigation systems should be based on the size of fields and the area of the farm to be cut
- Over 50% of soil damage can be done by the first pass of machinery and the reduction of soil compaction through controlled traffic farming (CTF) can increase dry matter yield by 13%

Background

Grassland fieldwork on dairy farms is generally conducted in an ‘ad-hoc’ manner with no conscious attempt to use tramlines as they use in the arable sector. In a single year, 90% of a field can be covered by wheelings at least once, with a number of areas within the field repeatedly trafficked. Recent studies reported 65% of the field was covered during a single grass-harvesting operation for both forage chopper and baling operations, which can reduce yields and negatively affect soil structure.

Controlled traffic farming (CTF)

CTF is a management tool used to reduce the damage to soils caused by heavy/repeated passing of farm machinery. Real-time kinematic and GPS positioning is likely to be the best way to control traffic movement because grass will grow over tramlines established during fertiliser application.



Aim

The aim of this study was to determine the effect of implementing a CTF system on grassland on silage yield.

What did we do?

A 7 ha field with a newly established perennial rye-grass ley with relatively uniform soil type and management history was divided in two. One half was managed under a normal traffic silage operation and the other under a CTF regime.

Outcomes

The area of the field covered by wheelings was reduced by 57%, from 87.4% for the normal field to 30.4% for the field under CTF management (Figure 62).

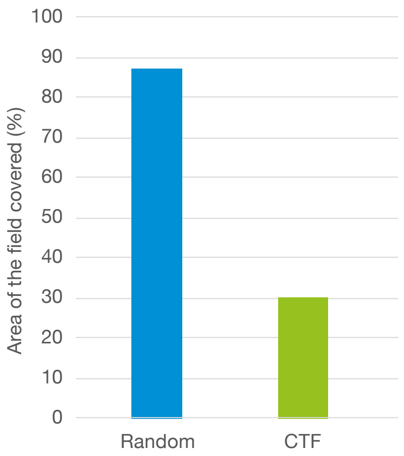


Figure 62. Area of the field covered by wheelings

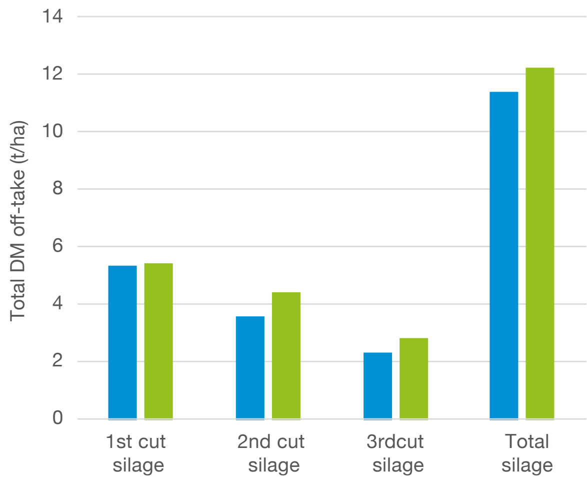


Figure 63. Silage DM yield

CTF management use over three silage cuts increased DM yield by 13.5% (0.8 t/ha) compared with the normal system (Figure 63).

Conclusion

Using CTF can reduce soil compaction, which can increase dry matter yield by 13%. GPS use allows CTF to provide field guides for machinery to use, but making sure that the GPS is correctly aligned to the fields in question may require permanent field markers at the edges of the fields. To make sure that CTF is used as efficiently as possible, the tramline width decided should reflect a measurement that will work for all machinery used on farm. Using the largest field machinery wheel width that is on site will make sure that smaller wheels can work within the tramlines as well.

Paul Hargraves, SRUC Dairy Research and Innovation Centre

Check out the Controlled traffic farming in grassland video on the **AHDB Dairy YouTube channel** for more information.

Grassland soil management

Assessing the impact of soil compaction

Key messages

- Compaction increases soil bulk density, reducing pore space and leading to poor root growth, which restricts the movement of air, water and nutrients through the soil layers
- Compaction also increases water retention, potentially impacting on soil trafficability
- Grass yield at first cut can be significantly reduced by compaction

Background

Soils are compacted when soil particles are compressed into a solid, impermeable layer, either at the surface or within the topsoil. Compaction leads to poor root growth, which in turn restricts the movement of air, water and nutrients down through the soil profile.

An estimated 60% of grassland soils in England and Wales show signs of compaction (ADAS, 2013). Compaction in soil can be identified by large, blocky angular aggregates, mottling and poor smells.

Figure 64. Soil compaction: Loose, friable soil (left); Compacted soil (right)

Aim

The aim of this study was to:

- Assess the impact of soil compaction on grass yield and soil health
- Investigate how compaction from animals and machinery differs

What did we do?

A grassland field at both Harper Adams University (HAU) and SRUC was subdivided into three treatments:

1. No compaction.
2. Tractor compaction.
3. Animal trampling (Figure 65).

Compaction was applied in spring (SRUC) or autumn (HAU) each year. Plots were managed as a three-cut silage system, and measurements were taken of:

- Sward performance
- Soil health
- Nutrient efficiency

Figure 65. Types of compaction: Cattle trampling (left); Tractor compaction (right)

Outcomes

A greater number of large, angular aggregates were found in the compacted plots. These extended deeper into the soil profile with the tractor compaction compared with the animal compaction (Figure 66). The compaction resulted in an increase in soil bulk density by 20% (Figure 67) and also increased water retention in the soil by up to 14% throughout the season (figure 69).

There was a significant impact on the grass yield at first cut on compacted soil, with trampling compaction reducing grass DM yield by 14% and tractor compaction reducing grass DM yield by 22% (Figure 68).

Figure 66. Soil profile following different compaction: Trampling compaction (left); Tractor compaction (middle); No compaction (right)

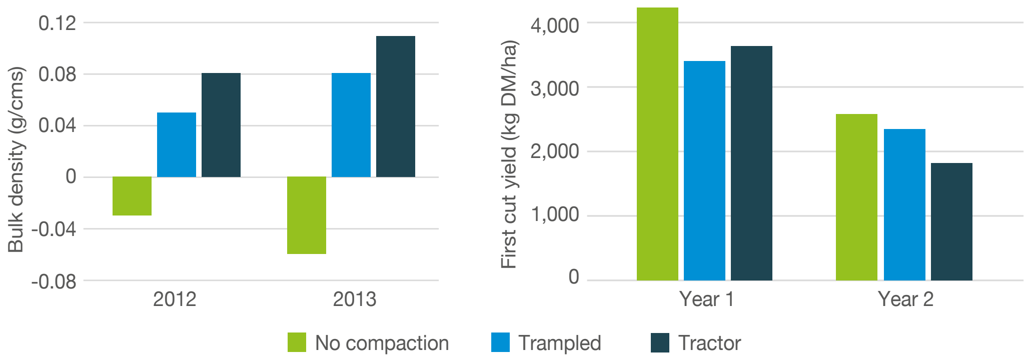


Figure 67. Impact of compaction on the change in soil bulk density

Figure 68. Impact of compaction on first-cut-grass DM yield at SRUC

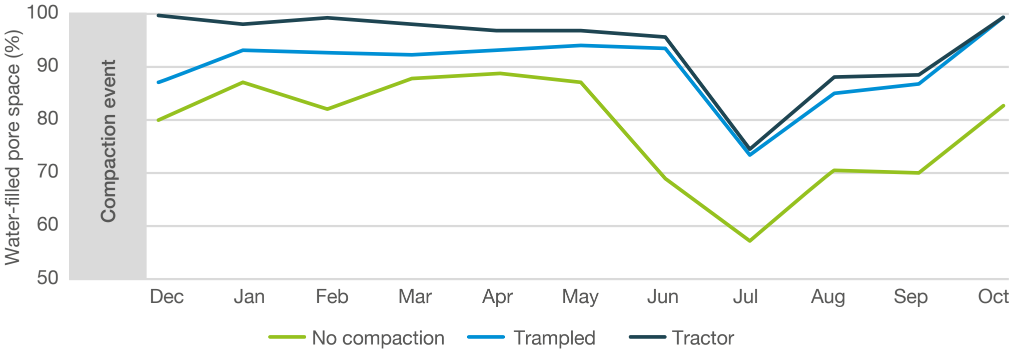


Figure 69. Impact of compaction on soil water retention (%) at 0–10 cm from December 2012–October 2013 at SRUC

Conclusion

Soil compaction has a significant impact on first-cut-grass DM yields, reducing yields by up to 500 kg DM/ha in year 1. Compaction directly affects the soil density, with compaction from tractors extending deeper into the soil profile than from animal sources. The greater soil compaction seen from tractors is directly linked to lower grass DM yields than animal compaction sources, although soil that is not compacted, with no large, aggregate clumps, is able to produce the highest grass DM yields.

Paul Hargreaves, Bruce Ball and Dave Roberts, SRUC Dairy Research and Innovation Centre

Alleviation from soil compaction

Key messages

- Natural recovery showed an increase in yield from not being re-compacted. This suggests that good grassland management can help reduce the effects of compaction on yield. Sward lifting is best carried out as the soil starts wetting up in the autumn, rather than waiting until the soil is dry enough in the spring. This would provide extra time for the grass roots to recover over the winter period and help minimise any yield loss
- Review the four easy steps to assess soil compaction found in the Healthy grassland soils pocketbook
- Ensure ground conditions are optimal for using machinery. Avoid ground conditions that are too wet or dry

Background

Soil compaction is a side effect of animals grazing and machinery use, and causes the soil to clump into large, impermeable aggregates which have restricted air, nutrient and water movement. Soil compaction cannot always be avoided, therefore methods to reduce the effects and allow roots to recover, and reduce yield loss, are important.

Aim

The aim of this study was to determine the effect of machinery alleviation on soil compaction on heavy silt, clay loam at SRUC and lighter, sandier soils at Harper Adams University.

What did we do?

Grazed pasture found to have compaction caused by either animals or machinery (tractors) was treated using a sward-lifting machine and aeration machine to see if any effect was seen. Sites were chosen on heavy silt, clay loam at SRUC and on light, sandy soils at Harper Adams University.

Outcomes

Soil aggregates from trampling compaction had smaller, more crumb-like aggregates in comparison with no alleviation (Figure 70).

Figure 70. Soil structure from HAU: trampled area with no alleviation (left); trampled with surface alleviation (right)

The use of soil-alleviation methods introduced structure back into the soil (Figure 71).

Figure 71. Soil structure from SRUC with machinery-compacted area with: sward lifting (left); surface aeration (right)

Table 8. Machinery alleviation effect on DM yield

	No compaction		Trampled		Tractor	
	SRUC	HAU	SRUC	HAU	SRUC	HAU
Sward lifting (%)	⇩ 27.4	⇧ 3.3	⇩ 22.4	⇧ 12.0	⇩ 19.8	⇧ 5.4
Sward aeration (%)	⇩ 19.4	⇩ 4.3	⇩ 18.3	⇧ 0.6	⇩ 13.5	⇧ 1.7

Conclusion

A sward lifter can occasionally increase DM yield, especially for the more compacted, lighter, sandier soils. The surface aeration increased yield on light soils compacted by animals and machinery. Using a sward-lifting machine on a soil that has not been compacted reduces DM yield in second- and third-silage cuts. Lighter, sandier soils showed a more favourable response to the use of surface aeration (see Table 8). Ensuring ground conditions are optimal for using machinery, such as avoiding ground conditions that are too wet or dry, can help reduce compaction in the first place. If sward lifting is essential, it is most effective when carried out in the autumn when the soil beings to wet up, instead of when it is dry in the spring. Finally, ensuring the correct depth of tine is set on the sward lifter will avoid worsening the compaction problem.

Paul Hargreaves, Bruce Ball and Dave Roberts, SRUC Dairy Research and Innovation Centre

Using nitrate soil sensors to increase sustainability

Key messages

- Continuous monitoring of soil nitrate concentration may allow more accurate application of nitrogen (N) fertiliser
- Nitrate sensors improve our knowledge of nitrate dynamics in a range of agricultural systems and fertiliser regimes
- This may allow improvements to be made to fertiliser recommendations used by farmers

Background

Nitrate is the most important source of nitrogen (N) for crop plants, and it is a dynamically important molecule. Its concentration in the soil changes quickly in response to fertiliser and manure applications, changes in the weather patterns and the uptake of crops.

Current methods of testing soil nitrate concentrations are costly, time-consuming and involve a delay from sampling to when results become available, leaving room for changes between what is happening in the soil and the results that are presented. This can make accurate calculation of fertiliser requirements more difficult, leading to over- or under-application.

Nitrogen is a concern to the environment and its application should be carefully considered. A large proportion of N in fertilisers and manures is lost to the environment during and following application. This is both an economic loss to the farmer and an environmental risk, as loss of N to groundwater as nitrate is a significant pollution risk. Emissions of gaseous N from soil are also increased by fertiliser additions and can contribute to global warming. Combined, these concerns mean that farmers in Nitrate Vulnerable Zones (NVZs) face restrictions on fertiliser and manure use.

Aim

The aim of this study was to investigate how real-time, in-situ nitrate sensors may improve the efficiency of nitrogen inputs (Figure 72).

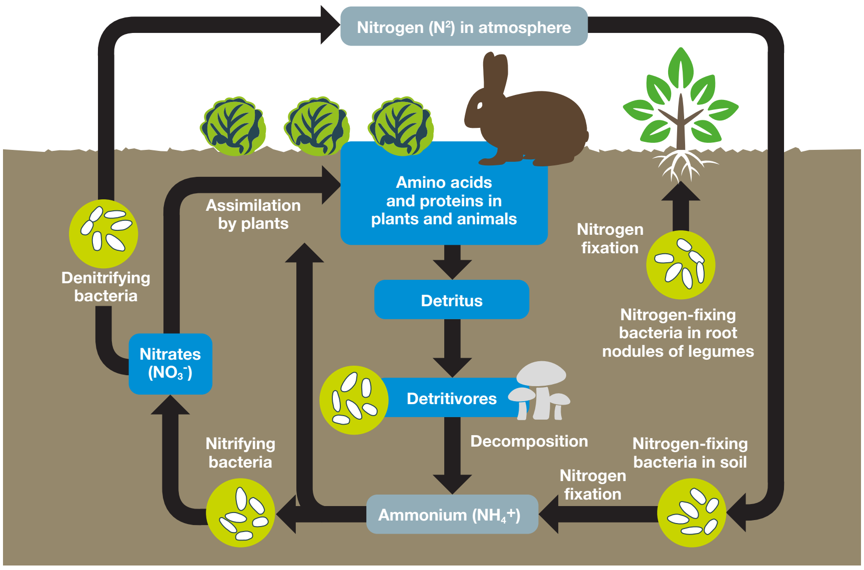


Figure 72. The nitrogen cycle

What did we do?

An in-situ nitrate sensor consisted of an electrode attached to a data logger. This was placed into soil or water and the nitrate concentration recorded continuously over a period of time. The sensor may be coupled with a wireless device to allow remote monitoring.

The nitrate electrode is an ion-selective electrode and works just like a pH probe.

The electrode gives an output in volts, which is related to the concentration of nitrate in the soil solution.

Calibration of the electrodes before use allows the voltage output to be converted into nitrate concentration.

Figure 73. Soil nitrate sensor

Next steps

Next steps are to investigate the effect that different clover densities have on the nitrate dynamics of the soil. Prototypes are currently being tested and characterised in the lab.

Check out our short video Measurement of soil nitrates – brought to you by **AHDB Dairy on YouTube**.

Rory Shaw, Davey Jones and Prysor Williams, School of Environment, Natural Resources and Geography, Bangor University

Tony Miller, John Innes Centre, Norwich

Nutrition

Mineral requirements of dairy cows

Key messages

- Minerals are a small but key component of the diet, affecting cow performance, health, fertility and welfare
- Some minerals are required in g/kg and some in mg/kg. The amount needed does not reflect their importance to the cow
- Minerals interact with each other, making correct feeding levels more complex
- Overfeeding minerals is a common practice in Great Britain, but it is unnecessary: it can be very costly and sometimes even unsafe for the cows and the environment
- Copper can be fatal if fed above requirements
- Farmers, nutritional advisers and vets should all be involved in mineral nutrition, but one person should have overall responsibility
- Assessing mineral requirements on a farm should start with a forage analysis
- All sources of mineral supply (e.g. water, bolus, free access) should be considered

Background

Minerals are essential in the dairy cow diet, but they are only required to be fed in specific amounts. Overfeeding minerals to dairy cows can be both an unnecessary cost and dangerous, with some, such as copper, causing death when as-fed levels are too high.

Aims

The aim of this project was to investigate if GB dairy farms were overfeeding minerals in the diet.

What did we do?

Fifty dairy farms in the Midlands and North of England were selected for analysis (Figure 74). Mineral intake of both high- and low-yielding groups was calculated by sampling:

- TMR
- Concentrate
- Forage
- Water
- Additional sources, including boluses and any free access to minerals

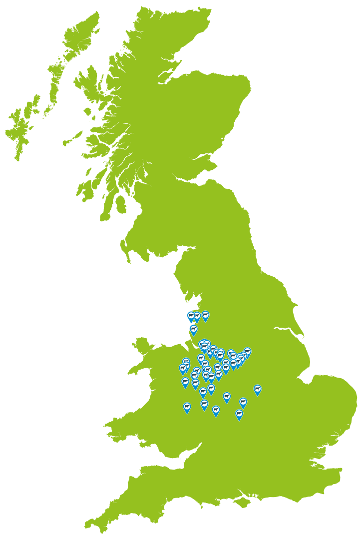


Figure 74. Distribution of 50 farms selected for mineral intake analysis

Outcomes

On average, cows are fed minerals well above the requirements set by the Nutritional Research Council (NRC) (Figure 75). In some cases, the average level fed was over twice that required, with copper the most commonly overfed and at the highest levels.

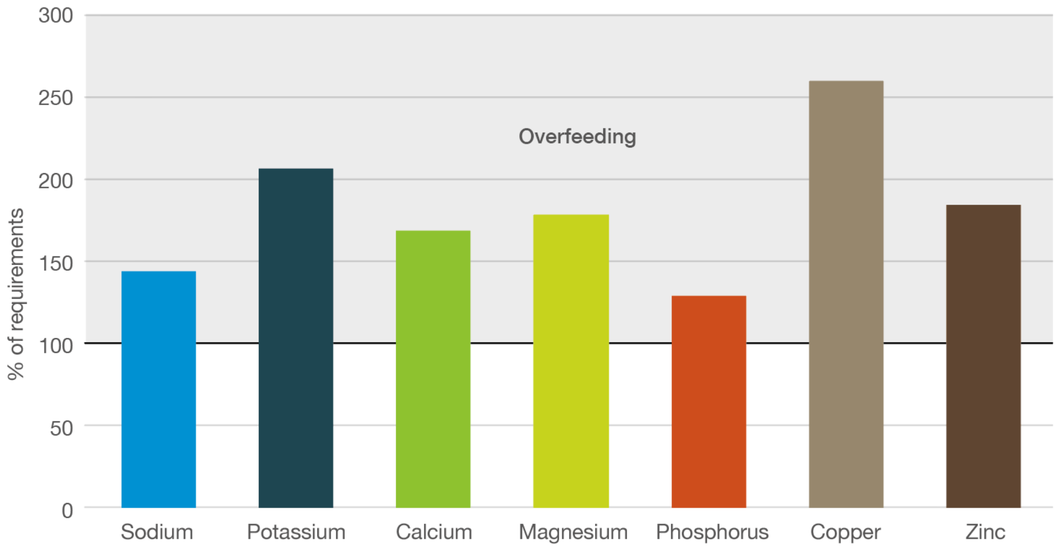


Figure 75. Average intake of some major and trace minerals on 50 dairy farms, expressed as a percentage of NRC (2001) requirements

The majority of farms surveyed supplemented their animals with minerals in the form of blocks, while very few (less than 5%) supplemented minerals through water (Figure 76).

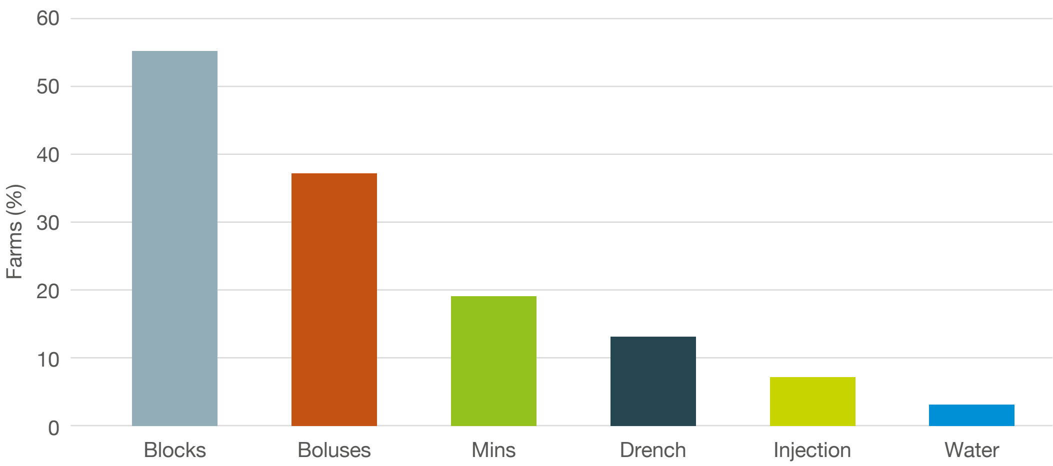


Figure 76. Supplementary sources of minerals in addition to that in the concentrates or TMR on 50 dairy farms

One of the main findings from this investigation was that copper is the mineral that is most often overfed under normal conditions. Copper deficiency is one of the most common mineral issues seen at Vet Investigation Centres. However, feeding too much copper can be fatal for dairy cows. With a recommended feeding level of 20 mg/kg DM, this study found that 62% of farms surveyed were feeding above this regularly, and 8% were feeding above the maximum permitted level of 40 mg/kg DM.

Copper availability can be reduced by naturally occurring mineral antagonists in feed, such as molybdenum, sulphur and iron, which can result in copper deficiency.

However, the farms in this study who fed high levels of copper were not those with high molybdenum levels, so the copper excess in the diet was not justified by the presence of antagonists. Feeding a supplement on top of feed naturally sufficient in copper caused excess intakes.

Conclusion

Mineral requirements on farm should be calculated by first assessing the natural mineral content of the forage, and supplementation should then be considered from these results. This can help avoid serious health consequences.

Liam Sinclair, Harper Adams University

Copper status and milk production: Effect of copper antagonists and forage source

Key messages

- Copper (Cu) is an essential trace mineral for normal animal productivity, health and fertility
- Feeding too little Cu results in symptoms of deficiency, but feeing too much can affect health and, in many instances, be fatal
- Other minerals in the diet, especially sulphur (S) and molybdenum (Mo), interact strongly with Cu and reduce its availability to the animal (antagonists)
- Forage source in early-lactation diets (grass silage – GS or maize silage – MS) also plays a key role in these interactions
- High dietary S and Mo in GS-based rations can lead to a reduced intake, higher milk cell counts and a lower Cu status
- For dairy cows fed a MS-based ration, high dietary levels of S and Mo have much less of an effect on performance or liver copper levels
- The mechanism for this effect is not clear: AHDB is currently funding other work to understand the reasons and provide practical advice
- When formulating a diet, it is therefore essential to take into account the forage source and the mineral content of all feeds to provide a correct supplementation of Cu
- Blood Cu is often not very useful in determining Cu status unless very deficient: a better practice is measuring liver Cu level in cull cows

Background

Copper is an essential dietary mineral that is required in trace amounts to ensure normal animal productivity and fertility. Maintaining the balance of copper fed in the diet is important: too little results in symptoms of deficiency, but too much can negatively impact health and cause fatality. Naturally occurring antagonists, minerals such as sulphur (S) and molybdenum (Mo), can reduce the availability of copper in the diet to the animal, and so understanding the role that these antagonists play in different forages can help reduce copper deficiency.

Aims

The aim of this study was to investigate whether feeding maize silage (MS) or grass silage (GS) during early lactation affected the copper status of dairy cows.

What did we do?

Fifty-six early-lactation cows which were all 35 days in milk were randomly assigned to one of four feeding groups (Figure 77):

1. MS: Maize silage based.
2. MS+: Maize silage, plus additional antagonists (Mo and S).
3. GS: Grass silage based.
4. GS+: Grass silage, plus antagonists (Mo and S).

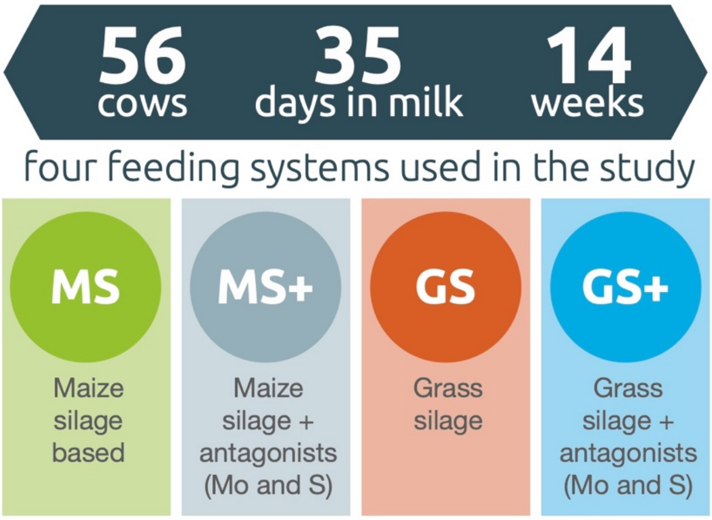


Figure 77. Four feeding groups (all received approx. 20 mg Cu/kg DM)

Each diet was tailored so that all groups received approximately 20 mg Cu/kg DM. The trial lasted 14 weeks.

Outcomes

Feed intake and milk production

The study showed that the source of Cu (bolus or free as Cu sulphate) had no effect on milk yield. However, adding antagonists reduced dry matter intake regardless of the source of Cu (Figure 78).

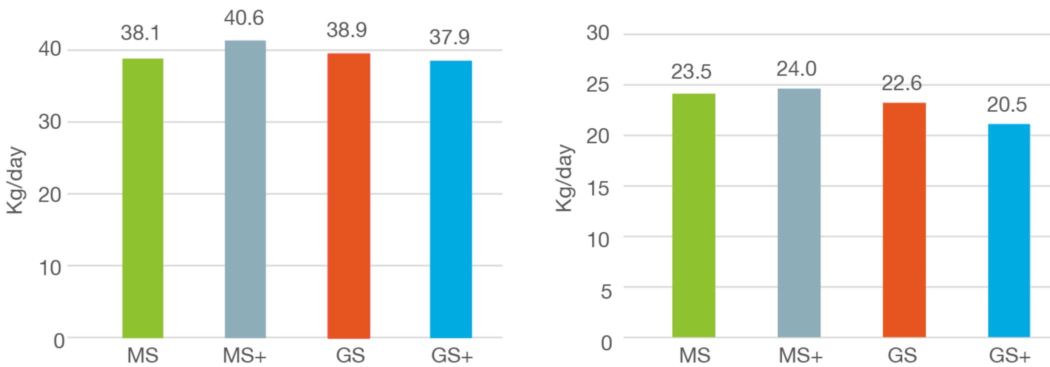


Figure 78. Effect of diet on milk yield (left) and dry matter intake (right)

Animal mineral status

Blood Cu concentration was not affected by the antagonists during the study. Adding antagonists progressively increased blood molybdenum concentrations (Figure 79). Liver Cu decreased across all treatments, because S and Mo levels were high (Figure 80), and this decrease was higher in the cows fed additional S and Mo.

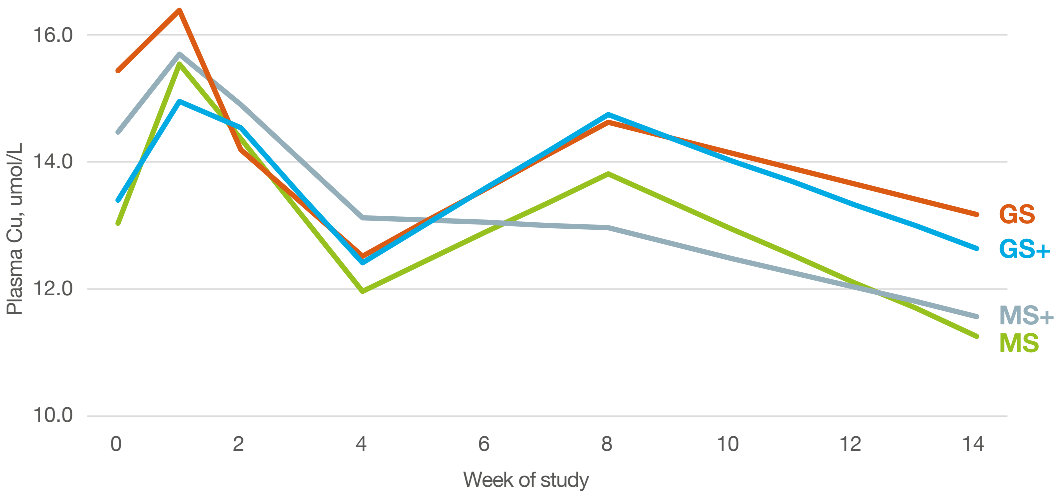


Figure 79. Effect of dietary treatment on blood Cu levels over time

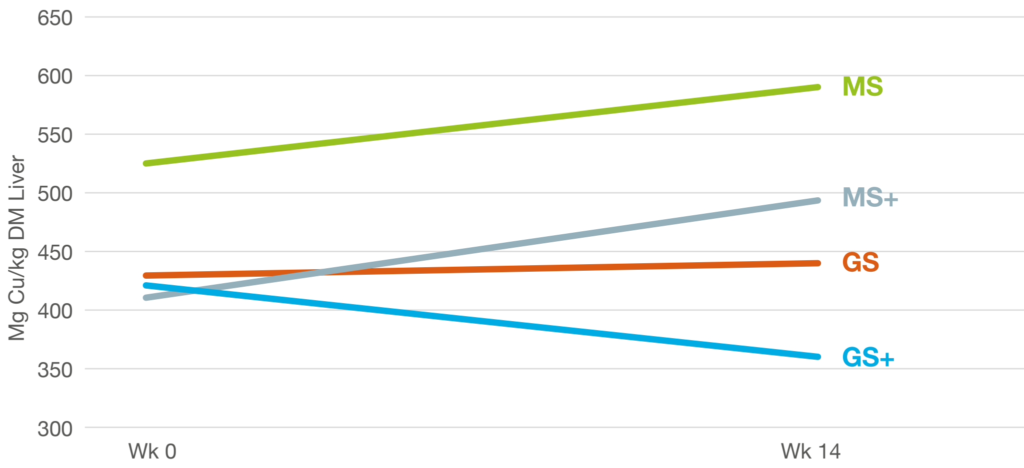


Figure 80. Effect of diets on liver Cu concentrations at week 0 and 14

Conclusion

Diets which have high levels of antagonists, Mo and S, can cause reduced feed intake regardless of the source of copper in the diet. The decreased dry matter intake did not have an effect on milk yield, with no drop in production.

Measuring copper status of the herd by using blood copper levels is not accurate, as blood copper did not change throughout. A more sensitive measure of blood copper is from a liver sample, which can be taken from cull cows and the results applied to the herd.

Liam Sinclair, Sandy MacKenzie and Steph Wilson, Harper Adams University

Copper status and milk production: Effect of copper source and antagonist level

Key messages

- Copper (Cu) is an essential trace mineral for normal animal productivity, health and fertility
- Cu interacts with sulphur (S) and molybdenum (Mo) in the diet, reducing its availability to the animal
- High dietary S and Mo can lead to reduced intake regardless of the source of Cu (dietary copper sulphate or a copper bolus)
- This decrease in dry matter intake (DMI) did not result in a drop in milk production
- Blood Cu is not affected by the source of Cu or by the presence of antagonists
- However, liver Cu is a more sensitive indicator of Cu status and decreased in the animals fed the diets supplemented with antagonists (-23.6% for the Cu bolus and -30.7% for the dietary Cu)
- Measuring liver Cu in cull cows is a practical alternative to biopsies
- Neither of the Cu sources was more effective at the higher levels of antagonists in the diet

Background

Copper is an essential mineral in the diet that is required for normal animal productivity, health and fertility. The availability of copper from the diet to the animal is impacted by antagonist minerals sulphur (S) and molybdenum (Mo), but it is not known if there is an impact of the source of copper.

Aims

The aim of this study was to investigate the effect of copper source on feed intake, milk production and animal mineral status.

What we did

Fifty-six cows which were 35 days in milk were randomly assigned to one of four feeding groups, each with a different copper source:

1. B: Copper added in the diet as a bolus at 19 mg/kg DM, with no additional antagonists.
2. B+: Copper added in the diet as a bolus at 19 mg/kg DM, plus additional antagonists.
3. C: Free copper in the diet as copper sulphate at 20 mg/kg DM, with no additional antagonists.
4. C+: Free copper in the diet as copper sulphate at 19 mg/KG DM, plus additional antagonists.

The cows were involved in the study for 14 weeks (Figure 81).

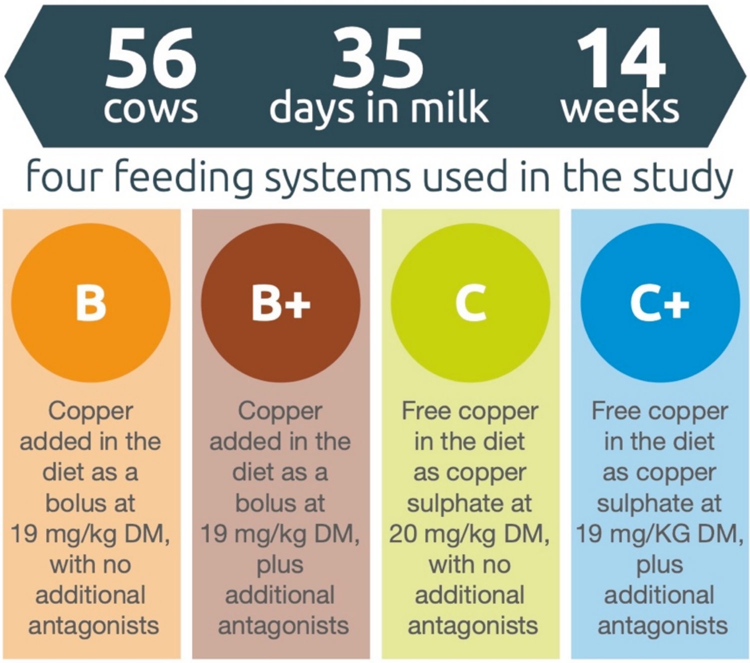


Figure 81. Four feeding groups

Intake, milk production and animal mineral status were measured for all feeding groups, with the mean values presented in Figure 82. Animal mineral status was measured both as copper concentration in the blood and in liver samples.

Outcomes

Milk production and feed intake

The source of copper in the dairy cow diet, either as part of a bolus or as free copper sulphate, had no significant effect on milk yield, regardless of additional antagonists. Animals in all feeding groups produced between 33.9 and 34.3 kg of milk per day. However, the study showed that adding antagonists into the diet (in diets B+ and C+) significantly reduced dry matter intake, regardless of the copper source in the diet (Figure 82). The decrease in dry matter intake did not cause a drop in milk production.

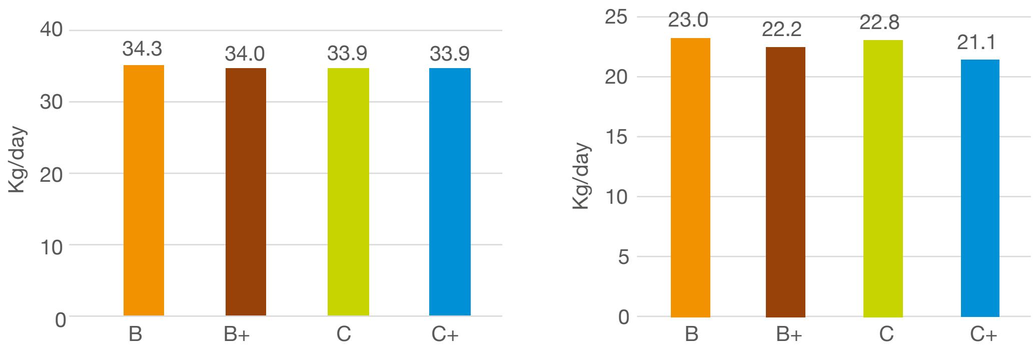


Figure 82. Effect of diets on milk yield (left) and dry matter intake (right)

Animal mineral status

Animal mineral status was measured against two factors in this study: copper status, and sulphur and molybdenum. The concentration of copper in the blood was not affected by either the source of copper (bolus or free) or the presence of antagonists in the feed (Figure 83). However, when liver copper concentration was measured, there was a significant decrease in animals fed diets supplemented with antagonists (diets B+ and C+). The decrease in liver copper, -23.6% in B+ diet and -30.7% in C+ diet, shows that liver copper concentration is a more sensitive indicator of copper status in dairy cows (Figure 84).

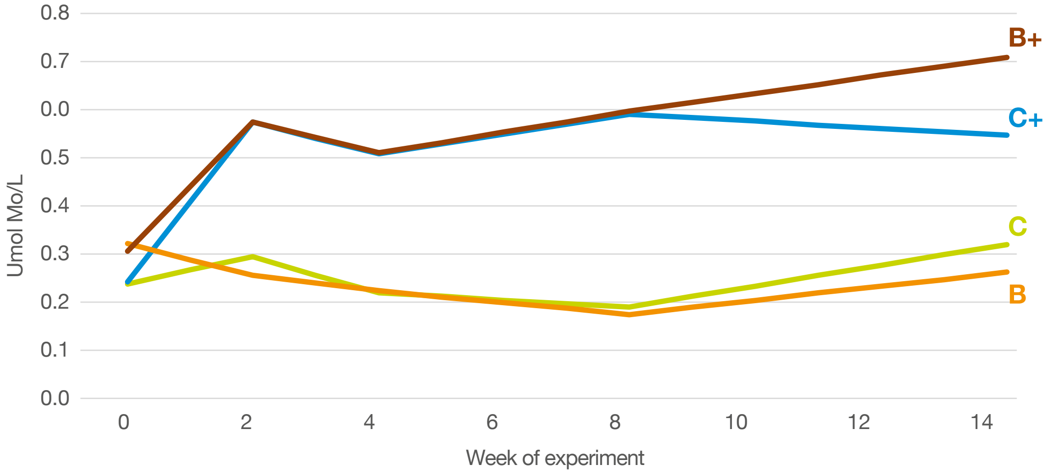


Figure 83. Effect of dietary treatment on blood Cu levels over time

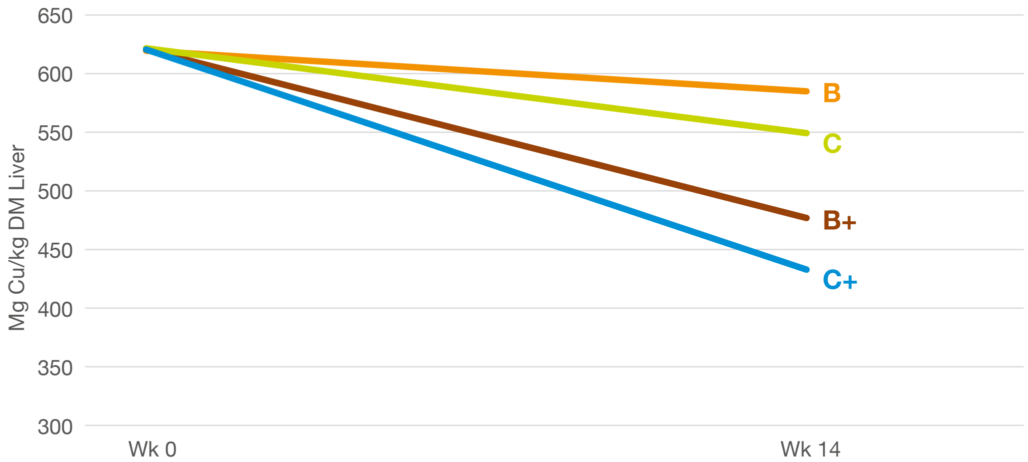


Figure 84. Effect of diets on liver Cu concentrations at week 0 and 14

Conclusion

Copper source in the diet, either as a bolus or as free copper sulphate, has no significant effect on the copper status of dairy cows. Liver copper concentration is a more sensitive measure than blood copper concentration, and a practical alternative to biopsies is to measure the liver copper of cull cows before applying findings to the whole herd.

High levels of antagonists in the diet will decrease copper status regardless of the original source of copper, therefore assessing the antagonist mineral status in forage should be the first step when calculating the copper status of a herd.

Liam Sinclair, Sandy MacKenzie and Steph Wilson, Harper Adams University

Cobalt and vitamin B12: Is supplementation in the transition period necessary?

Key messages

- Cobalt (Co) is essential for vitamin B12 synthesis in the rumen
- Vitamin B12 is required by the cow for energy and protein metabolism, particularly during the transition period
- Insufficient Co may also reduce diet digestibility and intake
- Co supplementation is now limited to 0.3 mg/kg DM
- This study has shown that supplementing the diet with Co or vitamin B12 or injecting with vitamin B12 has little effect on intake, performance or diet digestibility
- Providing additional Co or vitamin B12 also had no effect on the incidence of ketosis or fatty liver
- Under normal feeding conditions, background dietary levels of Co are often adequate to meet the needs of rumen microorganisms to synthesise vitamin B12

  The new limit of 0.3 mg/kg DM of added Co is unlikely to have a negative effect on dairy cow performance or health

Background

Cobalt (Co) is an essential mineral required for the cow to produce its own vitamin B12 in the rumen, using rumen microorganisms. Vitamin B12 is needed by the cow for energy and protein metabolism, and these processes are particularly important during the transition period. Previous research suggests that too little Co in the diet can reduce diet digestibility and intake. Recent European legislation has restricted dietary Co supplementation to 0.3 mg/kg DM.

Aims

This study investigated the effect of feeding different dietary cobalt levels and vitamin B12 supplementation, through feed or injection, during the eight weeks before and after calving.

What we did

Fifty-six high-yielding dairy cows were randomly split into four different feeding groups prior to calving (Figure 85):

1. N: No added Co or vitamin B12
2. Co: Co added at 0.2 mg/kg DM; no added vitamin B12
3. IVB: Vitamin B12 injection at 0.71 ml/d pre-partum and 1.42 mg/d post-partum
4. VB: Vitamin B12 added into the diet as a supplement at 0.68 mg/kg DM; no added cobalt

All four diets were formulated to make sure there were similar levels of protein and digestibility. Feed intake, milk production and metabolic status were measured.

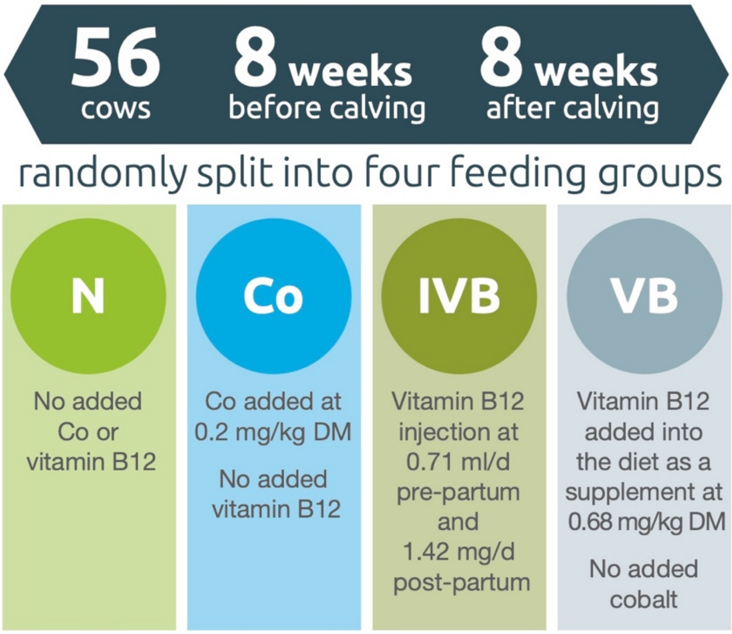


Figure 85. Four feeding groups

Outcomes

Dry matter intake and milk production

The study showed that there was no significant difference between feeding any of the diets in the study on dry matter intake or milk yield after calving (Figure 86). There was also no difference between diets on average mean milk fat, at 4.0%, and milk protein, 3.3%.

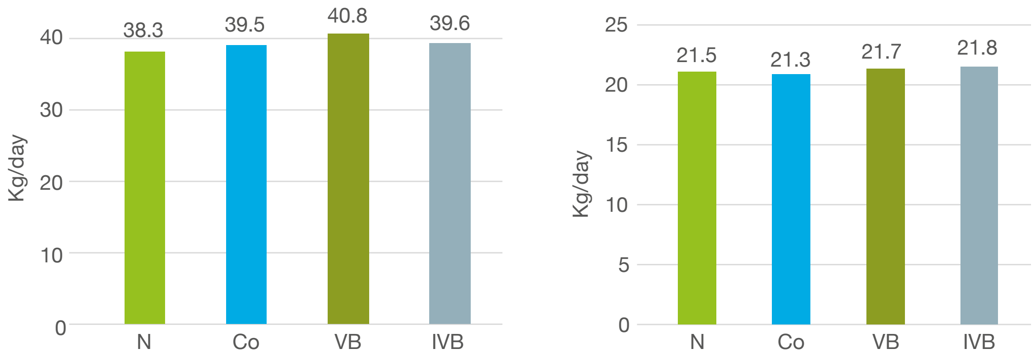


Figure 86. Effect of diets on milk yield (left) and dry matter intake post-partum (right)

Metabolic status

Blood concentrations of non-esterified fatty acids (NEFA) and beta-hydroxybutyric acids (BHBA) were used to measure metabolic status of cows in different feeding groups. These were not affected by either Co or vitamin B12 supplementation (diets Co and VB). Diets Co and VB similarly had no effect on body condition score, blood glucose or liver fat content (Figure 87 and 88).

Metabolic status of cows was not affected by diets Co, VB and IVB; adding Co or vitamin B12 to the diet or injecting vitamin B12 had no impact on the metabolic status of the cow.

Figure 87. Effect of supplementation on blood NEFA levels

Figure 88. Effect of supplementation on BHBA blood levels

Conclusion

Supplementing the diet of transition cows with Co or vitamin B12, or injecting with vitamin B12, has a minor effect on intake, performance or diet digestibility, and under normal feeding conditions, the levels of dietary Co are enough to meet the needs of the cow to synthesise its own vitamin B12 in the rumen from rumen microorganisms. There could be an opportunity to reduce diet costs by not supplementing Co or vitamin B12, without a loss of performance.

Liam Sinclair, Dammika Achchilage and Sarah-Jayne Williams, Harper Adams University

Amey Brassington, Wing Yee Kwong and Kevin Sinclair, The University of Nottingham

Protein nutrition of the contemporary dairy cow

Key messages

- The level of crude protein (CP) in the diets of dairy cows in GB is often higher than 18% DM
- However, research has shown no benefit to production from feeding diets over 16% DM
- Excessive or inadequate levels of dietary protein may worsen negative energy balance and reduce fertility
- The non-utilised protein is excreted through faeces and urine and can damage the environment
- Our findings show that dietary CP of 15% DM is sufficient to meet the requirements of cows producing around 40 kg/day, with no detrimental effect on cow health or fertility
- Careful consideration of forage type and its contribution to MP (metabolisable protein) supply is required
- Diets with high inclusion of maize silage in our study allowed for high levels of concentrate CP and likely promoted intake. Such high inclusions are not always possible on dairy farms
- Alternative forages to maize silage need to be studied further

Background

Formulating a ration is one of the greatest costs to dairy farmers. Rations should be balanced to provide correct levels of all essential nutrients, including protein. Lack of protein in the diet can have an impact on high-yielding dairy cows and restrict yield, health and fertility and so protein is sometimes added into the diet in high amounts. However, both too little and too much protein in the diet can cause problems with negative energy balance and reduced fertility. Crude protein (CP) is often found in diets at levels higher than 18% dry matter (DM), even though previous research has shown no benefit to production from feeding diets with CP levels over 16% DM. When protein is fed at levels higher than the animal needs, any that is not utilised is excreted through faeces and urine and can have a negative impact on the environment.

With large changes to the price of soya bean meal and traditional protein concentrates in recent years, reducing the need to supplement would reduce feed costs and reliance on volatile markets. Forage type within the diet should also be considered, as different forages can contribute significant levels of metabolisable protein (MP) to the diet.

Aim

The aim of this study was to assess the impact that a high (18% DM) CP or a low (15% DM) CP diet has on production, health status and fertility.

What we did

Ninety early-lactation dairy cows were randomly allocated between three diets over a trial period of 14 weeks (Figure 89).

The three diets were:

1. High protein (HP): High CP at 18%, ME at 11.9 MJ/kg DM.
2. Low protein (LP): Low CP at 15%, ME at 12.0 MJ/kg DM.
3. Low protein, high starch (LPHS): Low CP at 15%, ME at 12.3 MJ/kg DM.

Feed intake, milk yield and composition, nitrogen (N) efficiency and fertility were measured.

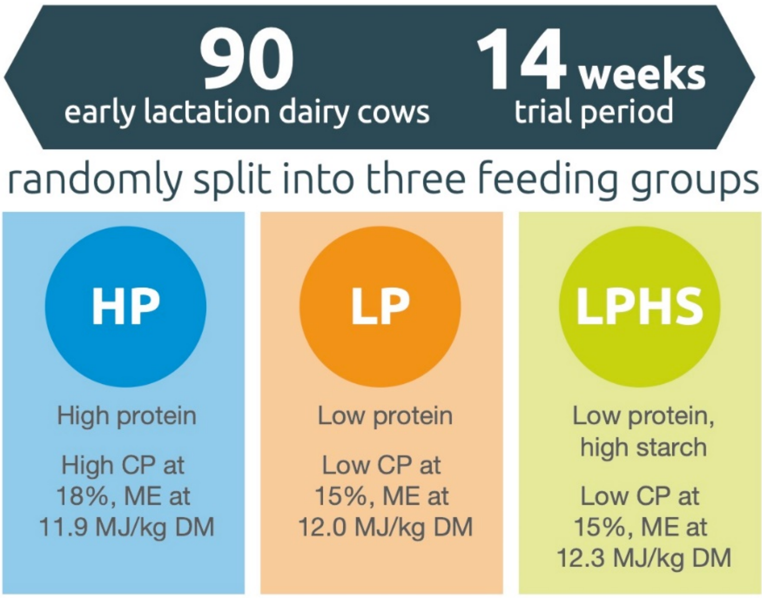


Figure 89. Three feeding groups

Outcomes

Intake and milk production

Feed intake, milk yield and milk composition were similar regardless of the diet fed, with the metabolisable protein supply from the diets providing 1.05, 0.95 and 0.95 of the production requirements of the cow for HP, LP and LPHS diets respectively. Cows fed a low CP diet at 15% CP were able to maintain the same levels of production as those cows fed a diet at 18% CP (Figure 90).

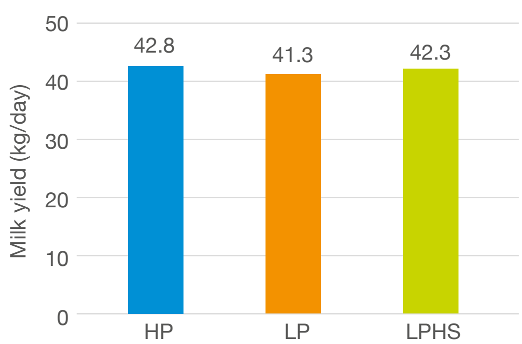


Figure 90. Effect of diets on milk yield

Nitrogen (N) efficiency

The cows fed HP diets were less efficient in converting dietary N into milk protein and lost a higher proportion of N through urine than cows on diets LP and LPHS (Figure 91).

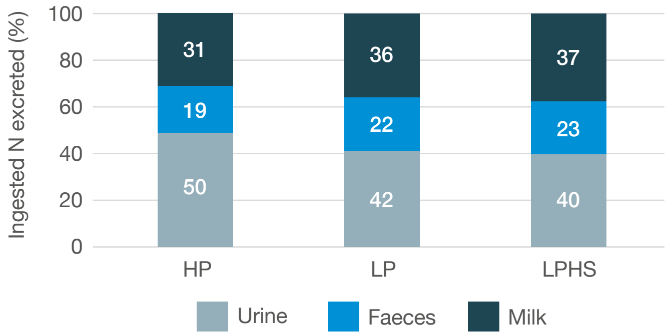


Figure 91. Portion of ingested N excreted in urine, faeces and milk

Fertility

The days from calving to first oestrus, and therefore first service, were measured as a guide to fertility (Figure 92). Animals on different CP diets showed no difference between energy balance or metabolic status, which in turn meant that there was no impact on reproductive performance or fertility.

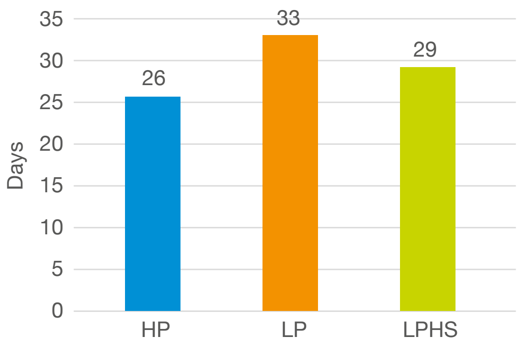


Figure 92. Days from calving to first oestrus

Conclusion

Reducing the CP levels of a high-yielding dairy cow diet to 15% DM has no negative effects on cow health or fertility and is sufficient to meet the demands when producing yields around 40 kg/day. At this level, there is minimal protein that is not utilised and wasted.

Different forages can contribute different levels of MP to the diet, and so it is important to account for the protein available from forage sources before considering concentrates. Maize silage was shown, at high inclusions in the diet, to allow high levels of concentrate CP to be fed to encourage feed intake, but these high inclusions are understood to not always be possible on dairy farms. Alternative forages to maize silage need to be studied further to understand the role they play in contributing MP to the diet.

Kevin Sinclair and Phil Garnsworthy, The University of Nottingham

Liam Sinclair, Harper Adams University

Lucerne as a replacement for grass silage in the diet of the dairy cow

Key messages

- At both sites, the requirement for purchased protein was reduced when lucerne was included in the diet, but concentrate was purchased to satisfy energy requirements at SRUC
- The effect of including lucerne silage in the diet is largely dependent on the forage quality and the quality of the forage it replaces
- Farmers looking to incorporate lucerne silage in their diet should base their decision on the ability of the farm to grow the crop and likely fertiliser savings, rather than improvements in yield or milk quality

Background

The costs of protein feeds in recent years have increased, so many farmers are aiming to reduce their reliance on imported protein feeds. The use of home-grown forages like lucerne silage can help offset both these factors.

The purpose of this study was to test the effects of including lucerne silage (LS) on animal performance when diets contained either grass (GS) or maize silage (MS).

What did we do?

During the study, 20 dairy cows at Harper Adams (HAU) and 16 at Scotland's Rural College (SRUC) were used. The cows received various levels of lucerne, grass and maize silage in their diet (Table 9), with animal intake and production being monitored.

Table 9. Ratios of grass, lucerne and maize in each diet

	HAU			SRUC	
	Grass	Lucerne	Maize	Grass	Lucerne
Control	0.40	0.00	0.60	1.00	0.00
LS 1	0.20	0.20	0.60	0.75	0.25
LS 2	0.00	0.40	0.60	0.50	0.50
LS 3	0.00	0.60	0.40	0.25	0.75

Outcomes

1. Including LS at 50% or more increased DM intake (DMI) by 3.5 kg/day at SRUC (Figure 93).
2. LS did not affect DMI at HAU, except at the highest level (60%) of inclusion, where it was reduced by 1.2 kg/day.
3. Milk production and quality were not affected by treatment at either site (Figure 94).
4. Feed costs per kg milk produced increased as LS inclusion increased at SRUC (Figure 95).
5. This was achieved due to the higher DMI as LS replaced GS with no improvement in milk production.

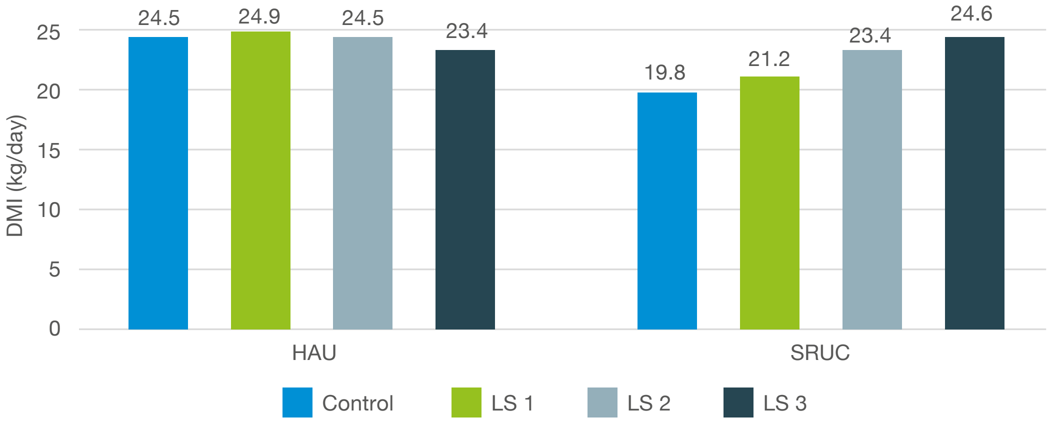


Figure 93. Dry matter intake at HAU and SRUC

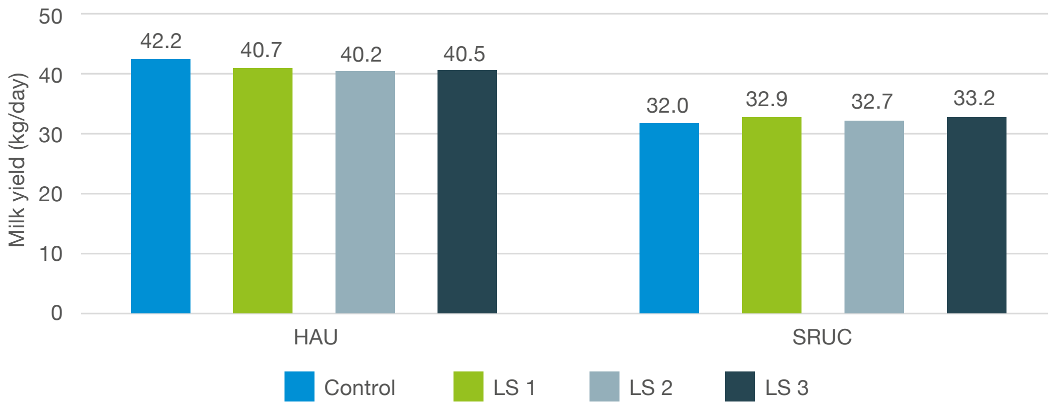


Figure 94. Milk production at HAU and SRUC

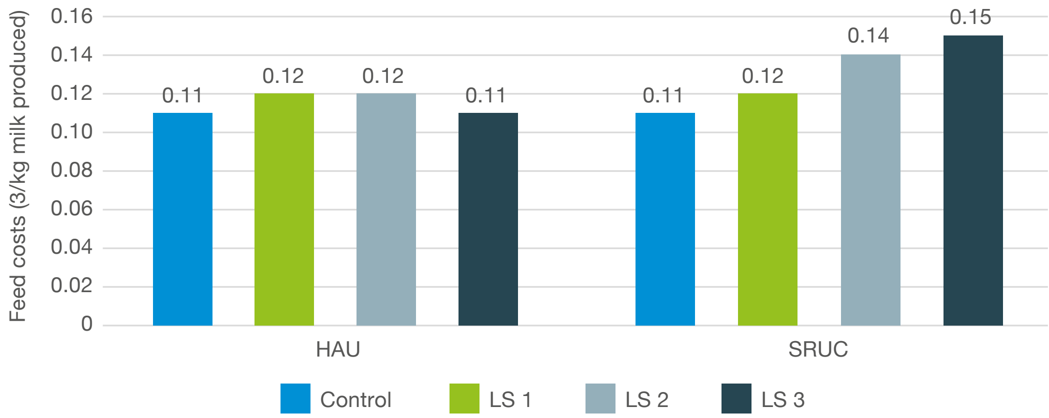


Figure 95. Total feed costs (£/kg milk produced)

Conclusion

Incorporating lucerne silage into the dairy cow diet can reduce the need for additional protein concentrate to be purchased as opposed to feeding a ration based on just grass or maize silage. However, it is important to remember that the effect of adding lucerne silage into the diet is dependent on the quality of the forage and, additionally, the quality of the forage that it is replacing from the original diet. While there is little improvement in milk yield or quality when feeding lucerne, there could be savings on fertiliser expenses and feed costs if the farm has the ability to grow the crop.

Liam Sinclair and Stephanie Wilson, Harper Adams University

Dave Roberts and Jennifer Flockhart, SRUC Dairy Research and Innovation Centre

Effect of lucerne inclusion level and chop length on performance of dairy cows

Key messages

- The decision to grow lucerne as a replacement for grass silage to feed along with maize silage should be based on the ability to grow the crop and potential savings in fertiliser and feed costs, rather than for an improvement in milk yield or quality
- Including lucerne in the diet reduced the amount of purchased proteins needed
- Where high levels of lucerne need to be included in the diet (75% of forage), then short chop lengths are advisable
- In high-yielding cows receiving a maize-silage-based diet, the inclusion of between 20–60% of lucerne had little benefit in comparison with a good first-cut silage

Background

With fluctuations in the cost of imported protein feed in recent years, the alternative use of home-grown forages like lucerne can reduce the import of protein feeds and chemical nitrogen (N) fertiliser. However, there is little known about how inclusion level or chop length affects milk yield and rumination parameters of dairy cows.

Figure 96. Lucerne crop (left); Penn State Separator (middle); Cow in feed efficiency trough (right)

Aims

The aim of this study was to test the effect of replacing maize silage with lucerne silage on:

- Production
- Digestion and rumen function

What did we do?

Lucerne was harvested at the 10% flowering stage and cut to two chop lengths (short and long).

These were included either at 25% or 75% of the forage DM to give four diet treatments:

1. HLS: 75:25 lucerne: maize silage, short chop length.
2. HLL: 75:25 lucerne: maize silage, long chop length.
3. LLS: 25:75 lucerne: maize silage, short chop length.
4. LLL: 25:75 lucerne: maize silage, long chop length.

Outcomes

Intake and milk production

Intake was lower for cows offered higher levels of lucerne and also with longer chop length. Milk production followed a similar trend (Figure 97), while milk fat average (3.76%) was not affected by diet. Milk protein was higher where lucerne was included at 75% of the forage average (3.11 vs 3.04%).

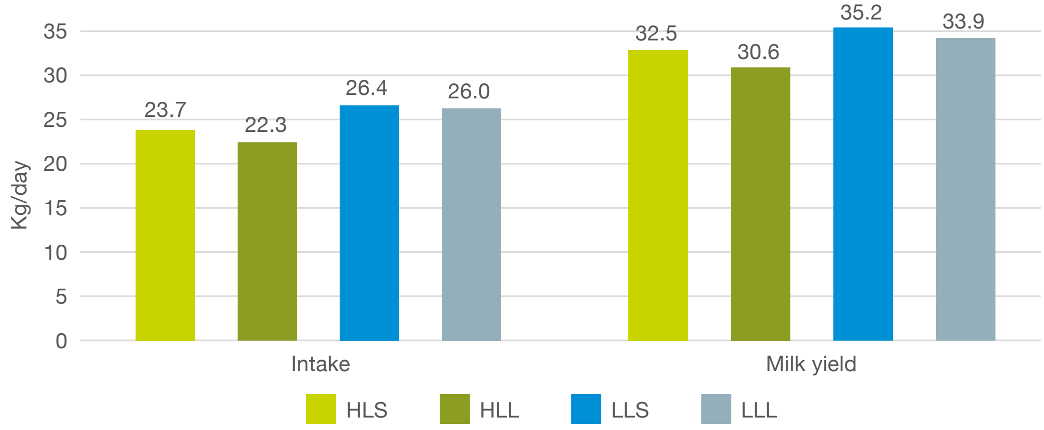


Figure 97. Dry matter intake and milk production

Rumen function

Rumen pH and ammonia were higher at higher lucerne inclusion levels, with HLL having greatest effect on both (Figures 98 and 99). The HLL diet had the lowest volatile fatty acid (VFA) concentrations, and the lowest intake and digestibility among the treatments. Shortening the chop length (HLS & LLS) improved diet digestibility and VFA concentrations and also reduced diet sorting.

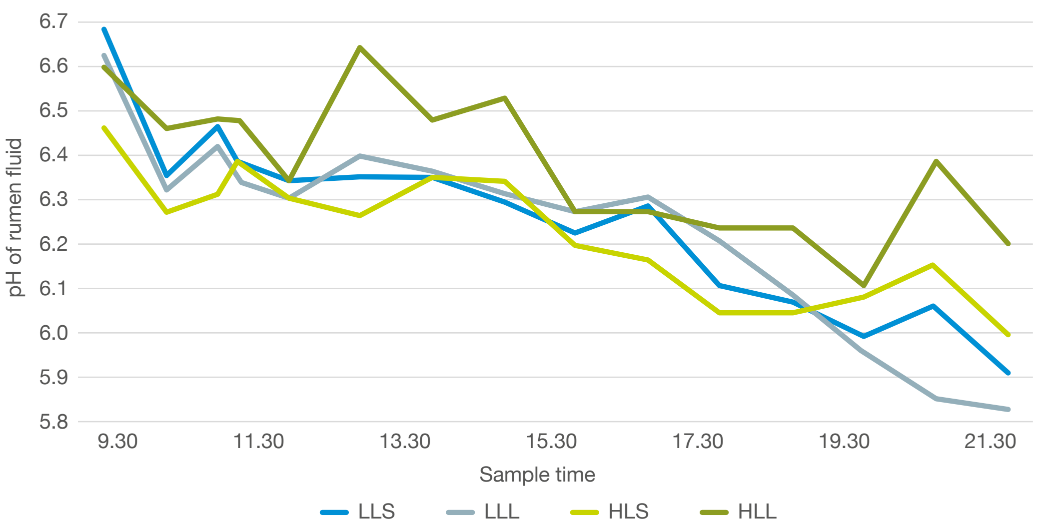


Figure 98. Rumen pH taken at various time points

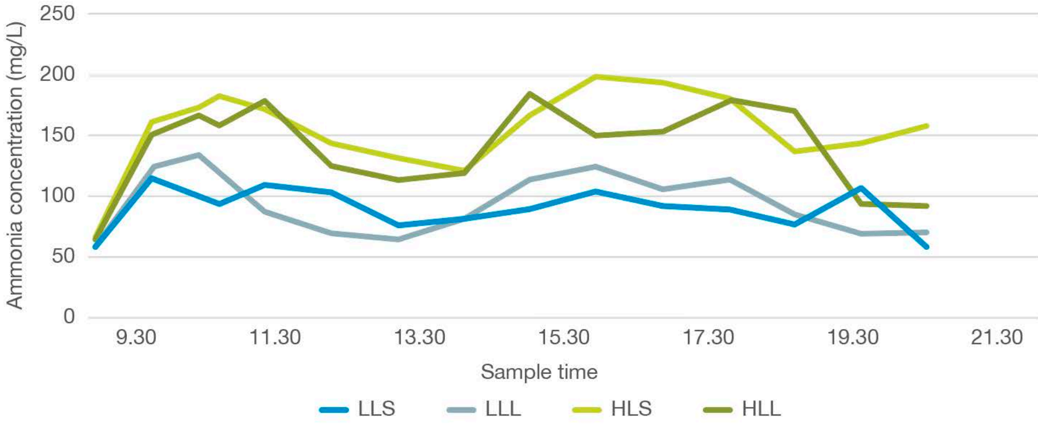


Figure 99. Rumen ammonia concentration

Conclusion

Lucerne inclusion can reduce the amount of purchased proteins required. However, if lucerne silage is to make up to 75% of forage in the diet, then short chop lengths are advised to encourage high intake. Growing lucerne on farm should be based on the ability of the farm to grow the crop. It is important to note that there is little benefit when including lucerne at 20–60% of the forage in comparison with a good first cut of maize silage.

Anna Thomson and Chris Reynolds, The University of Reading

Milk production from dairy cows with varying access times to mixed ration and pasture

Key message

- For cows yielding approximately 45 kg/day, providing access to pasture for 6 hours per day with TMR fed ad lib will not affect milk production but will reduce feed costs by £0.20–£0.30/cow/day

Background

Processor requirements, government legislation and the economics of dairy farming are creating a heightened interest in the role of grazed pasture in the diet of the high-yielding dairy cow. However, there is a requirement to understand what effect grazing these high-yielding cows will have on their performance.

Aim

The aim of this study was to test the effect of limiting access to TMR by either time and/or feeding level on animal performance.

What we did

Fifty-six dairy cows were offered one of four diets for 28 days, with regular monitoring of performance and behaviour.

Diets were:

1. Housed (H): no access to pasture, TMR offered at 100% of intake potential.
2. Grazed (G): 6 hours of access to pasture, then TMR offered at 100% of intake potential.
3. Delayed grazing (DG): TMR for 1 hour, then access to pasture for 6 hours, then housed with TMR offered at 100% of intake potential.
4. Limited TMR (LT): 6 hours of access to pasture, then TMR offered at 75% of intake potential.

Outcomes

Intake and production

Intake of TMR was lowest for cows in LT and highest in the H (Table 10). Total DMI was also lower for cows in LT compared with those in other treatments, although pasture DMI was greatest in this group.

Cows in LT also had lower milk production compared with those in H, but G and DG were not different from either H or LT. There was no impact on milk fat or protein between the feeding groups.

Table 10. Effect of diet treatments on DMI and cow performance

	Housed	Grazed	Delayed grazing	Limited TMR
TMR intake (kg)	26.9	23.7	24.4	20.3
Pasture intake (kg)	0.0	2.4	2.0	3.5
Milk yield (kg)	45.7	44.2	44.9	41.7
Fat + protein (kg)	2.80	2.73	2.65	2.62
Milk fat (kg)	3.1	3.3	3.1	3.4
Milk protein (kg)	3.0	2.9	2.9	2.9

Economics and cow behaviour

1. At milk prices of 23 ppl or more, providing cows with 6 hours of grazing (G and DG) gave the highest margin over feed costs (Figure 100)
2. At milk prices of 22 ppl or less, the LT treatment gave the highest margin over feed costs
3. Cows in H lay down for longer and walked less, but there were no other behavioural differences noted

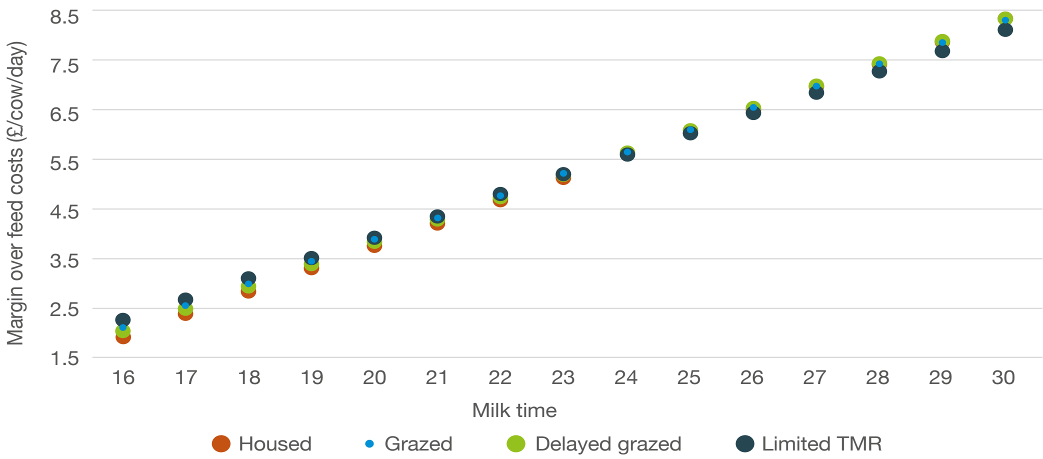


Figure 100. Effect of diet on margin over feed costs (£/cow/day), TMR costs £200/t and pasture £100/t

Conclusion

Utilising grazed pasture can be a cost-effective way to reduce feed costs, but there can be concern that the feed cost saving will be outweighed by a drop in milk production. This study showed that for high-yielding dairy cows, producing approximately 45 kg/day, providing access to pasture for 6 hours per day alongside a TMR fed ad lib will not affect milk production but will reduce feed costs by £0.20–£0.30/cow/day. Housed cows were seen to lie down for longer and walk less, but the increased exercise shown by cows in the grazed groups (G and DG) did not affect their ability to maintain production. These costs are especially shown when milk prices exceed 23 ppl.

Liam Sinclair, Norton Atkins, Mark Rutter, Claire Cianchi, Carrie Gauld, Sarah Williams and Gemma Charlton, Harper Adams University

Phosphorus feeding in dairy cows

Key messages

- Phosphorus (P) is an essential mineral for dairy cows and for plants as well
- For this reason, recommended levels have been set up for matching the requirements of dairy cows in all physiological stages
- The dietary P recommendation for early-lactation cows is 0.35% DM; for late-lactation cows, the NRC (2001) recommends a dietary P level of 0.32% DM
- A recent survey of UK dairy farms has shown that P overfeeding is a common practice
- On average, P is fed in excess of 20% of the recommended level: early-lactation cows were fed in excess of 30%. In some cases, however, P was found to be underfed
- When overfed, the unused P is excreted with the faeces: the application of P-rich manure/slurry on the fields, especially if associated with an inaccurate inorganic fertilisation, is a high-risk practice for the environment
- Assessing mineral requirements on a farm is key in a precision-feeding approach: forages are the most variable ingredient in terms of mineral content, so a periodical mineral analysis is necessary to formulate properly
- Mineral soil testing is another key practice to avoid/limit negative impact on environment

Background

Phosphorus (P) is an essential mineral required by dairy cows and it is required at different levels depending on the stage of lactation. In early lactation, the recommended feeding level is 0.35% DM, and in late lactation, P in the diet is recommended to be fed at 0.32% DM. Despite these recommendations, in a recent survey of UK dairy farms, P was commonly found to be overfed by around 30% in early lactation (Figure 101) and by an average of 20% across the whole lactation. Overfeeding dietary P has multiple negative impacts (Figure 102), including leaching of P into the soil and then water, called eutrophication.

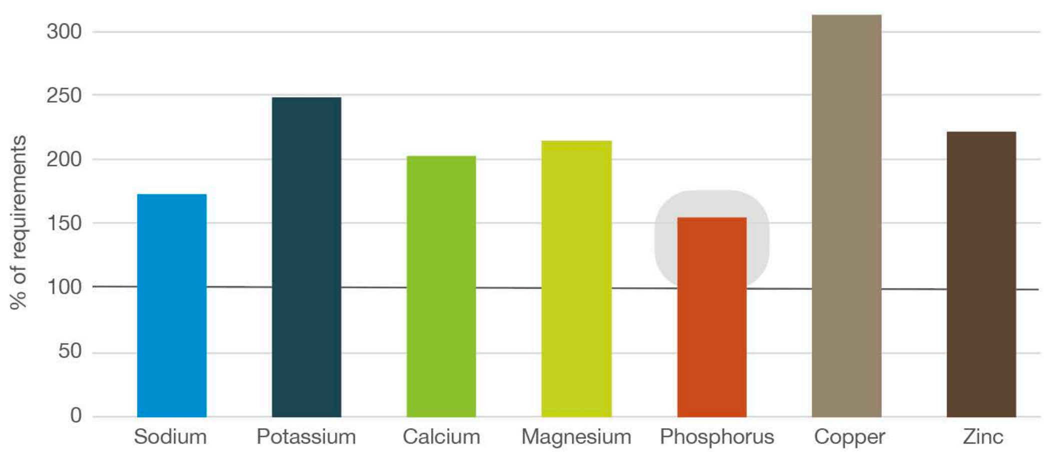


Figure 101. Average intake of some major and trace minerals on 50 GB dairy farms, expressed as a percentage of NRC (2001) requirements

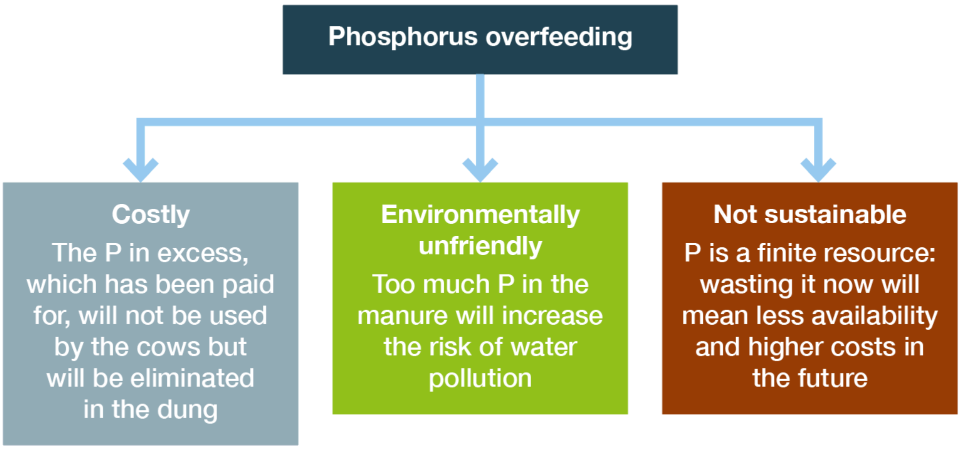


Figure 102. Negative impacts associated with overfeeding phosphorus

Eutrophication

Overfeeding P to dairy cows will result in P-rich manure, which can then be spread on fields. Spreading high amounts of P-rich manure or using too much P fertiliser increases the P content of soils, and erosion and run-off then allow this P to reach particular surface waters. Excessive amounts of nutrients (P and N) in the water can lead to an undesirable overgrowth or bloom of algae (also called eutrophication). Eutrophication is not just damaging for the ecosystems of the aquatic environment, some algae can also be toxic for animals and human beings. With most drinking water in the UK coming from surface water sources, P pollution can also put the availability of clean drinking water at risk.

Monitoring P in the diet

Overfeeding P can be a serious cost and assessing mineral requirements on farm to only feed P to the correct levels could save money. Forages are the feed ingredient which are most likely to vary in their mineral content, so regularly analysing their mineral content can help to formulate a diet with a correct mineral balance.

Testing the soil for its mineral content is also good practice to limit the negative impact that spreading slurry can have on water supplies and the wider environment. This is now a requirement by law every five years on cultured fields and using the results of the soil test can help slurry and fertiliser application be more efficient.

Current AHDB projects

AHDB will fund a three-year PhD Studentship, starting from October 2017, at the University of Reading, School of Agriculture, Policy and Development. The project aims to identify barriers to, and facilitators for, reducing P losses from UK dairy farms. The results of this project will contribute to the establishment of guidelines for the best management practices to improve on-farm P-use efficiency, and these guidelines will be valuable for limiting the avoidable costs associated with overfeeding P and for reducing the environmental impact of this practice.

Partha Ray and Chris Reynolds, The University of Reading

Liam Sinclair, Harper Adams University

Effect of forage peas with varying tannin content on the performance of high-yielding dairy cows

Key messages

- Spring-grown forage peas are a rapidly growing crop that can produce over 7 t DM/ha in 12 weeks, with a crude protein content of 200 g/kg DM
- Compared with grass silages, cows fed forage peas will have a marginally lower milk yield and milk protein content
- There is little effect of the tannin level in forage peas on intake, milk production and N efficiency
- Feeding spring-sown forage peas can reduce feed cost by up to 0.5 ppl, due to savings in both purchased feed costs and the lower growing costs of forage peas

Background

High-yielding cows have a greater requirement for metabolisable protein and by-pass protein to meet their requirements for production. However, protein in ensiled forages, such as grass, peas, red clover and lucerne, is low in by-pass protein.

One way of reducing protein degradation in the rumen is making use of tannins, which are compounds that naturally bind to protein and protect them from breaking down in the rumen.

Aim

The aim of this project was to determine the effect of the inclusion of forage peas differing in their tannin content in the diet of high-yielding dairy cows on performance, N efficiency and diet cost.

What we did

Fifty-four high-yielding cows were randomly allocated to three feeding groups with different tannin contents:

1. Control: 33% grass, 66% maize silage
2. Low tannin (LT): 33% low-tannin peas, 66% maize silage
3. High tannin (HT): 33% high-tannin peas, 66% maize silage

Their dry matter intake, milk yield, N efficiency and overall diet cost were measured.

Outcomes

In a maize-silage-based ration, replacing grass silage with forage peas reduced DMI, milk yield and quality. However, including forage peas resulted in a saving in soya bean meal of approximately 0.4 kg/cow/day and reduced feed costs by 0.3 to 0.5 ppl.

The inclusion of low-tannin or high-tannin pea silage did not affect intake, milk or milk components yield and had little effect on diet digestibility or the efficiency of dietary N use for milk production (Figure 103).

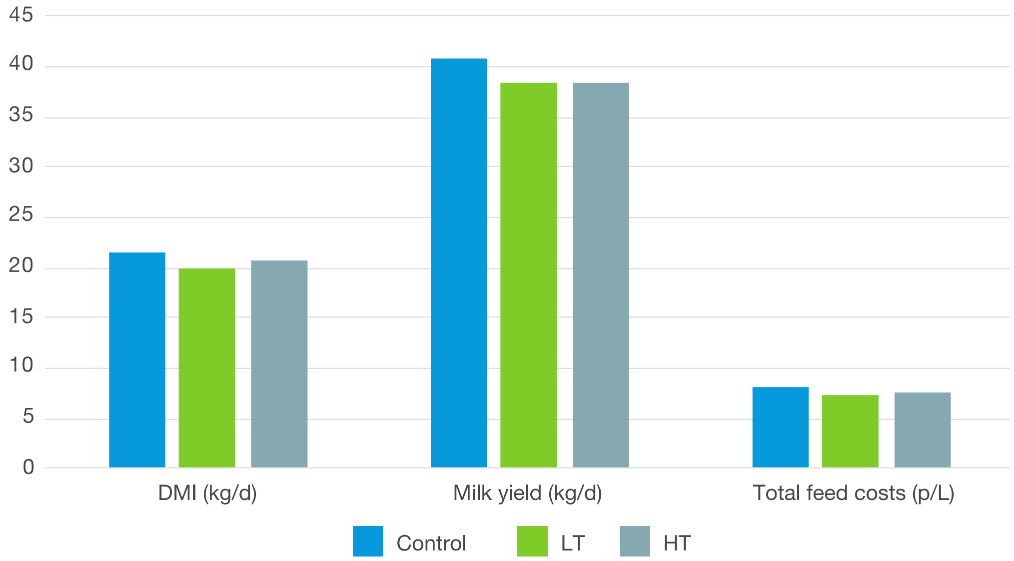


Figure 103. Animal performance and diet cost

Conclusion

The addition of forage peas and tannins into the diet reduces the degradation of protein in the rumen, allowing them to bypass the rumen and be used for their essential components by the cow. Although there is a slight reduction in milk yield and protein content in comparison with diets of grass silages, there is little impact on dry matter intake, milk production and N efficiency. This is additionally offset as the inclusion of forage peas in the diet of high-yielding dairy cows is a cost-effective method of reducing feed costs by up to 0.5 ppl.

Cara Campbell, Sarah-Jayne Williams, Jim Huntington and Liam Sinclair, Harper Adams University

Functional fibre in dairy cow nutrition: Particle size distribution in UK forages and diets

Key messages

- The increased milk production of UK dairy cows has required feeding more concentrates and higher-quality forages, resulting in lower dietary fibre levels
- Particle size (PS) of the diet and its fibre content are key factors in maintaining a healthy rumen function and productive performance
- The Penn State Particle Separator (PSPS) is commonly used on-farm to estimate PS and physically effective NDF (peNDF)
- Current PSPS recommendations are based on drier North American diets that contain lucerne haylage and maize silage and may not be suitable for wetter UK grass and maize silage diets
- UK grass silage and grass-silage-based diets have a much higher % of long particles than maize silage or maize-silage-based diets

Background

UK milk production has increased over the past decade and maintaining this has led to diets with high levels of concentrates and higher-quality forages. However, this has resulted in lower dietary fibre intake. This can increase the risk of ruminal and metabolic disorders, including sub-acute ruminal acidosis (SARA).

Particle size (PS) recommendation of the diet and physically effective NDF (peNDF) content are currently based on North American diets, where diets tend to be drier and based on maize silage and lucerne haylage. This is not necessarily representative of UK diets, which are typically wetter, and based on grass and maize silage.

Aim

The aim of this study was to better characterise the PS of UK forages and diets using a modified Penn State Particle Separator (PSPS).

What did we do?

PS distribution of TMR/PMR, grass silage (GS) and maize silage (MS) was investigated on 50 farms throughout GB (Figure 104). The study used a modified PSPS separator with additional sieves (33 to 44 mm) to better fit wetter UK diets and grass silage (Figure 105).

Figure 104. Distribution of GB farms that samples of TMR/PMR, GS and MS were taken from

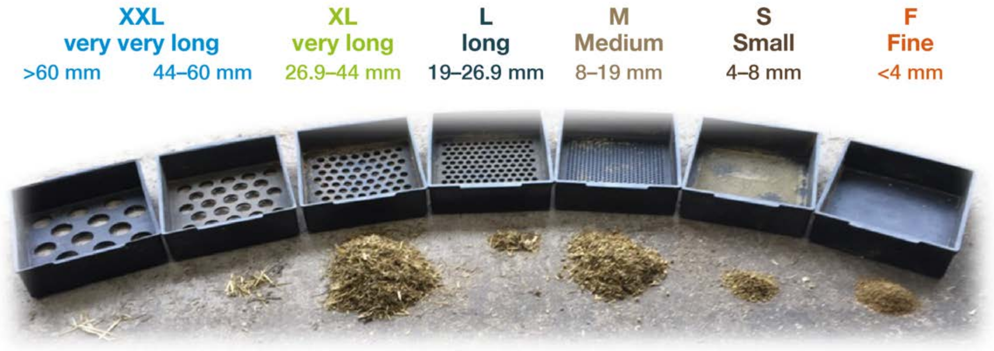


Figure 105. Modified PSPS used in the study (the two top sieves have been cropped into the XXL fraction)

Outcomes

UK diets differ from North American (NA) standards, with a greater proportion of long particles and fewer short particles (Figure 106). NA PS recommendations (Figure 107) for lucerne haylage and MS differ from UK GS and MS forages, and between the UK forages, PS distribution differs, with GS containing a higher percentage of long particles than maize silage (Figure 108).

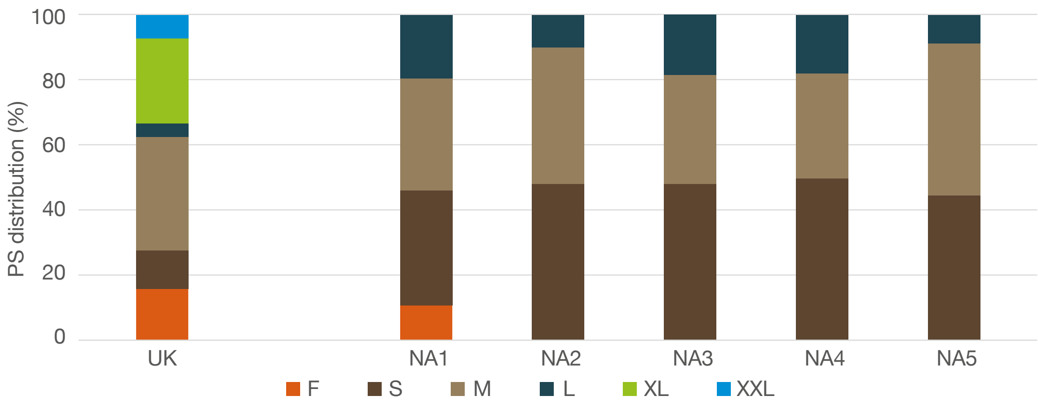


Figure 106. PS distribution of TMR/PMR in the current study (UK) with additional sieves and in five North American studies (references available on request)

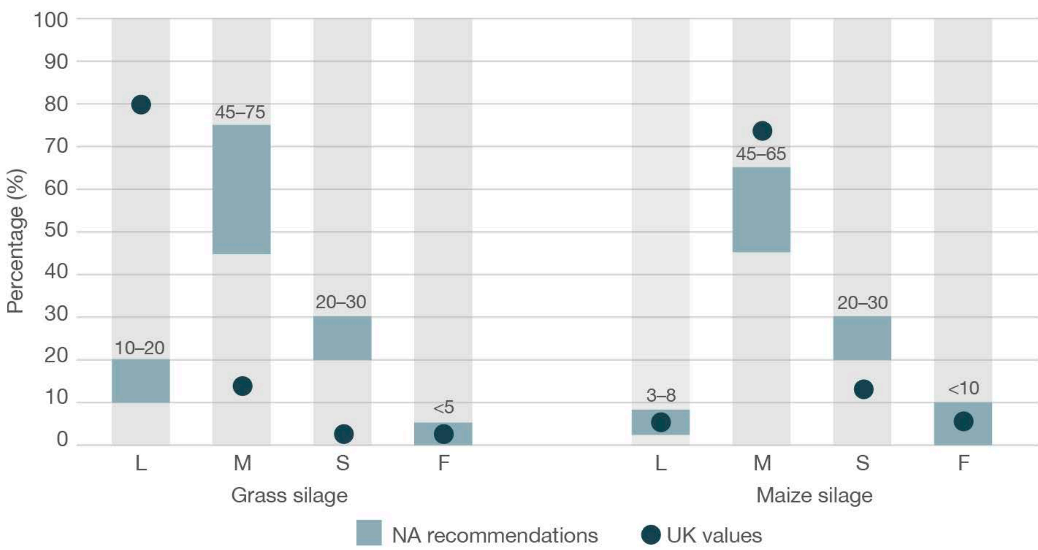


Figure 107. PS distribution in UK grass and maize silage compared with North American recommendations for lucerne haylage and maize silage. For maize silage, no additional sieves were used. Long (L) = XXL+XL+L

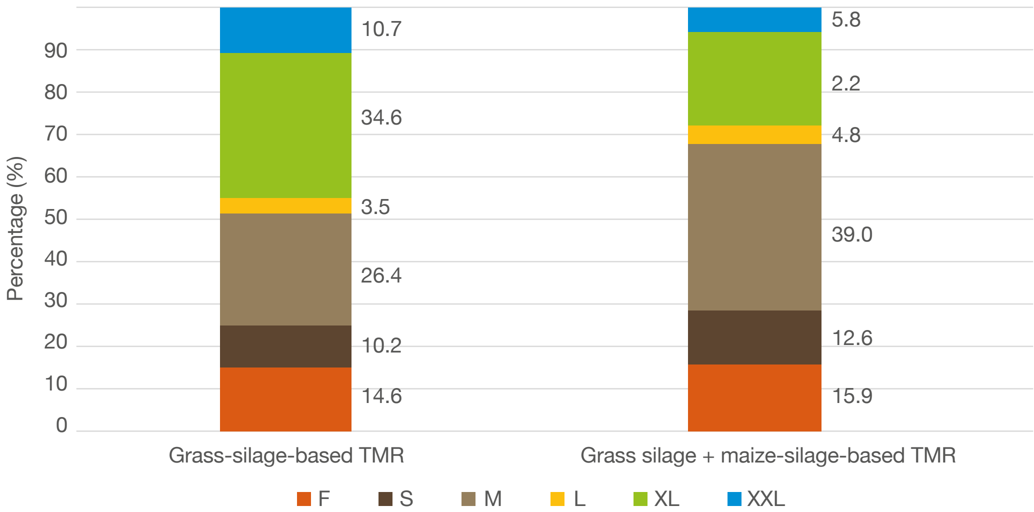


Figure 108. PS distribution in TMRs containing grass silage or a mixture of grass and maize silage

Conclusion

The distribution of PS changes with forage type, so measuring all types of forage on farm can give a clearer understanding of where the long PS will come from in the diet. Grass silages and grass-based diets have a much higher percentage of long particles than maize or maize-silage-based diets, and with grass silage commonly used in UK diets, the NA recommendations of dietary PS are not necessarily suitable. Further research to identify UK-specific methods of assessing PS and recommended levels in the diet is needed.

Usama Tayyab, Liam Sinclair and Robert Wilkinson, Harper Adams University

Chris Reynolds, The University of Reading

Functional fibre in dairy cow nutrition: Effects on rumen function, performance and health of UK dairy cows

Key messages

- An adequate particle size (PS) of forages and mixed rations is necessary to stimulate chewing activity and saliva production, which is required to maintain a ruminal pH above 5.8
- Adequate particle size is also necessary to produce a fibre mat in the rumen which retains smaller forage and feed particles, thus increasing their digestion
- A short forage chop length is often desired by farmers and contractors to improve compaction in the clamp, reduce aerobic spoilage at feed out and limit sorting
- When fed a short-grass silage (shortest 5% length fed commercially, i.e. 31 mm), early-lactation cows will eat more regardless of the main forage base
- The positive effect of a short length on milk yield is seen only when cows are fed grass silage as the sole forage. Milk fat percentage (not yield) will decrease, but protein content and yield will increase
- Grass silage chop length has little effect on rumen pH. Regardless of grass silage chop length, adding maize silage decreases pH but at levels higher than those indicative of SARA

Background

In the high-yielding dairy cow, keeping rumen pH above 5.8 is important, as below this level it will induce sub-acute ruminal acidosis (SARA). Adequate forage particle size (PS) plays a part in maintaining this, as it firstly stimulates chewing, and then saliva production, which helps to buffer the rumen and keep the pH above 5.8. The correct PS also helps to maintain the fibre mat in the rumen, allowing smaller forage and feed particles to be captured and thoroughly digested.

The role of silage chop length in the diet can be determined by the ability of the forage to ensile, rather than the benefits to the animal, so the role of silage chop length on rumen function, performance and health was investigated.

Aim

The aim of this study was to investigate the role of grass silage chop length on rumen function, performance and health.

What we did

Sixteen multiparous early-lactation Holstein-Friesian cows, producing 42 kg milk/day, were randomly allocated to one of four diets, with four different forage bases (Figure 109).

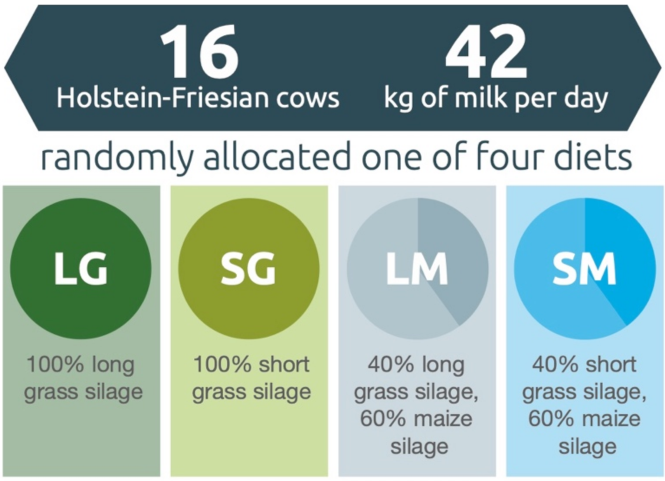


Figure 109. The four diets used in the study with the different forage bases labelled

The grass silage within the study was cut into two chop lengths of 31 mm (short) and 44 mm (long). All diets were supplemented with concentrates at a ratio of 54:46 forage to concentrate (DM basis) to provide a similar metabolisable energy (ME) and metabolisable protein (MP) content.

Outcomes

Chop length has a significant effect on dry matter intake, with higher dry matter intake with diets containing short-chop silage (Figure 110). A short chop length can increase milk yield (Figure 111), but this trend is only seen when the sole forage in the diet is grass silage. Chop length has a significant impact on milk fat percentage, with decreases seen with a short chop length (Figure 112), but total yield is not affected (Figure 113). However, reticulo-rumen pH is not significantly affected by chop length (Figure 114).

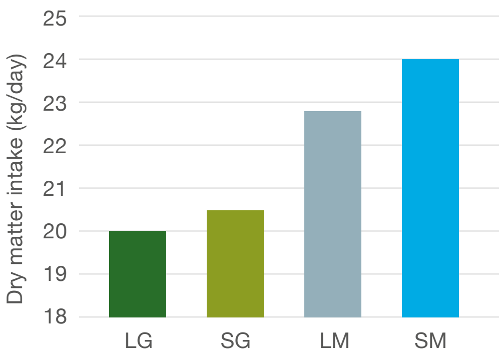


Figure 110. Diet type effect on DM intake

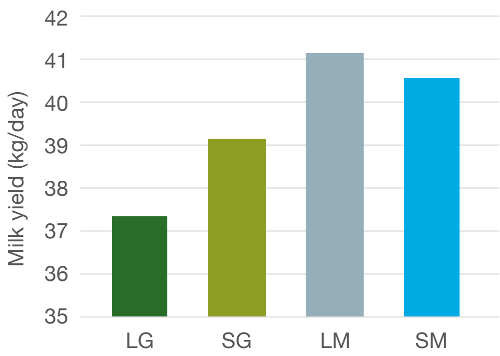


Figure 111. Diet type effect on milk yield

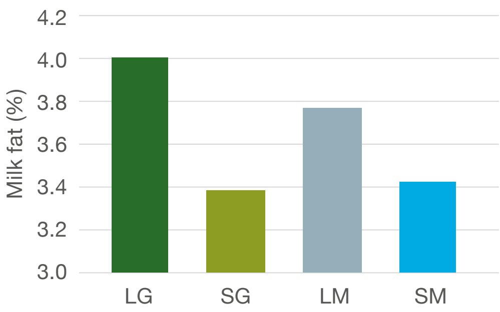


Figure 112. Diet type effect on milk fat

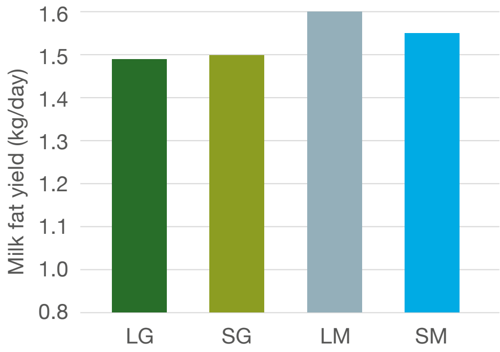


Figure 113. Diet type effect on milk fat yield

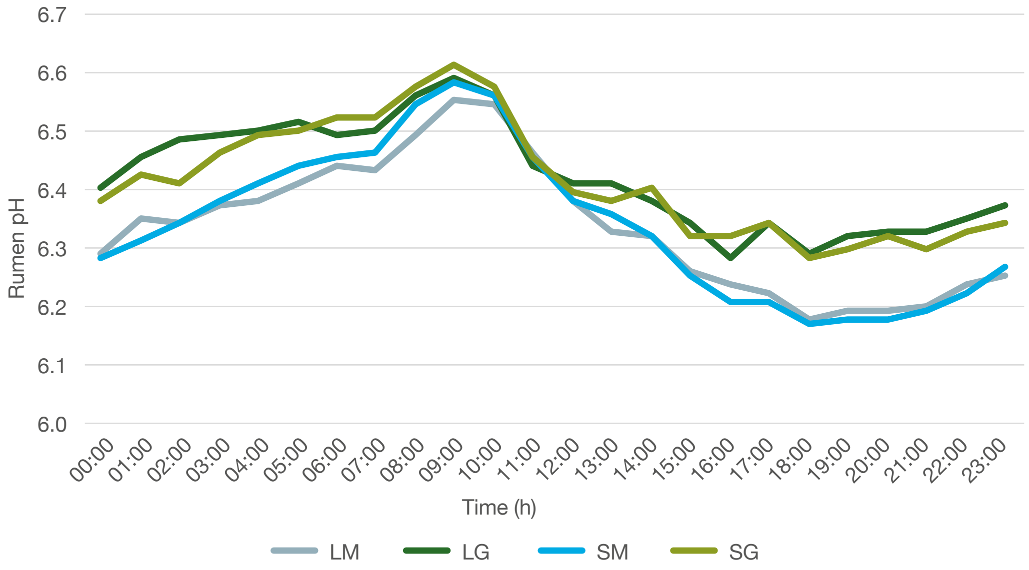


Figure 114. Diet type effect on daily rumen pH

Conclusion

Changing the chop length of silage can significantly increase the dry matter intake of cows, but early-lactation cows will especially eat more silage that is a short (31 mm) chop, regardless of the forage base. However, the positive effect of consuming more short-chop silage on milk yield is only seen when grass silage is the sole forage, rather than mixed grass and maize. There is a slight effect on milk fat percentage, but protein content and yield are seen to increase, so production is maintained overall. There is little effect of grass silage chop length on rumen pH, but if trying to maintain pH at 5.8 or above, then adding maize silage can significantly decrease the pH.

Usama Tayyab, Liam Sinclair and Robert Wilkinson, Harper Adams University

Chris Reynolds, The University of Reading

Functional fibre in dairy cow nutrition: Effects of fibre-to-starch ratio on performance, rumen function, nitrogen balance and acute phase proteins

Key messages

- In the UK, dietary starch levels are generally lower than in North America, but the higher inclusion of wheat and barley that are rapidly degraded in the rumen increases the risk of SARA (sub-acute ruminal acidosis)
- The dietary inclusion of sufficient fibre helps to maintain rumen pH, increase particle retention time in the rumen and improve diet digestibility
- The dietary proportions of fibre and starch can also affect animal performance by altering the rate of production and proportion of ruminal volatile fatty acids (VFA)
- The composition of rumen-fermentable carbohydrates and physically effective fibre (peNDF), their ratio and interaction should be considered when formulating diets
- If care is taken to ensure that the diet is correctly formulated, well mixed and that there is no diet selection, high-starch diets may be fed without negatively affecting rumen pH
- Feeding concentrates with different starch and fibre contents can alter milk quality but are unlikely to have a major effect on milk yield if SARA is avoided

Background

Fibre inclusion within the diet can maintain rumen pH, increase particle retention time in the rumen and improve diet digestibility. The ratio of fibre to starch in the diet can affect the production and proportion of volatile fatty acids (VFA) in the rumen, which can affect performance. When formulating rations, it is important to consider the ratio and interaction between rumen-fermentable carbohydrates and physically effective fibre (peNDF), to make sure that a high-starch diet does not negatively affect rumen pH.

Aim

The aim of this study was to investigate the role of diets containing different levels of starch on rumen function, performance, nitrogen balance and acute phase proteins.

What we did

Four early-lactation (61 ± 0.1 DIM), rumen-fistulated Holstein-Friesian dairy cows (milk yield: 44 kg/day) were assigned one of four dietary treatments over a 16-week period. The cows were fed individually, ad lib, and there was no evidence of feed selection.

Four treatments:

1. GF: 82%* short-grass silage, 40% NDF, 12% starch.
2. GS: 82% short-grass silage, 29.5% NDF, 24% starch.
3. MF: 82% maize silage, 35% NDF, 21.5% starch.
4. MS: 82% maize silage, 27% NDF, 32% starch.

*% of forage on a DM basis. All diets were formulated with a forage:concentrate ratio (F:C) of 50:50 (DM basis)

Outcomes

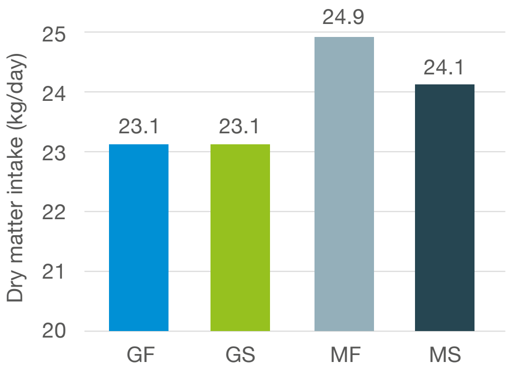


Figure 115. Diet type effect on DM intake

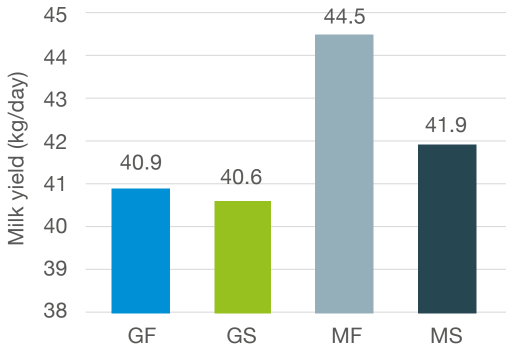


Figure 116. Diet type effect on milk yield

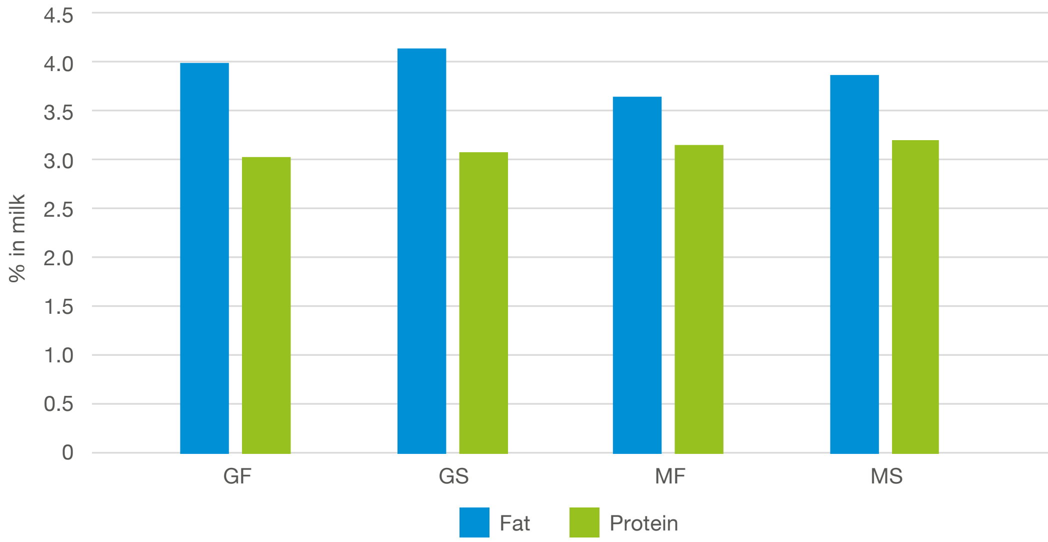


Figure 117. Diet type effect on fat % and protein % in milk

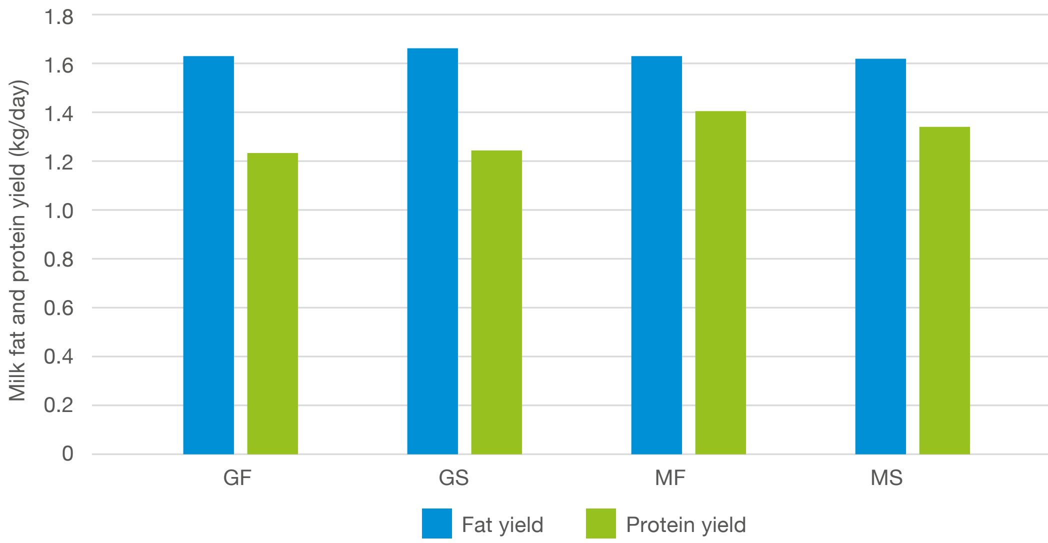


Figure 118. Diet type effect on fat and protein yield

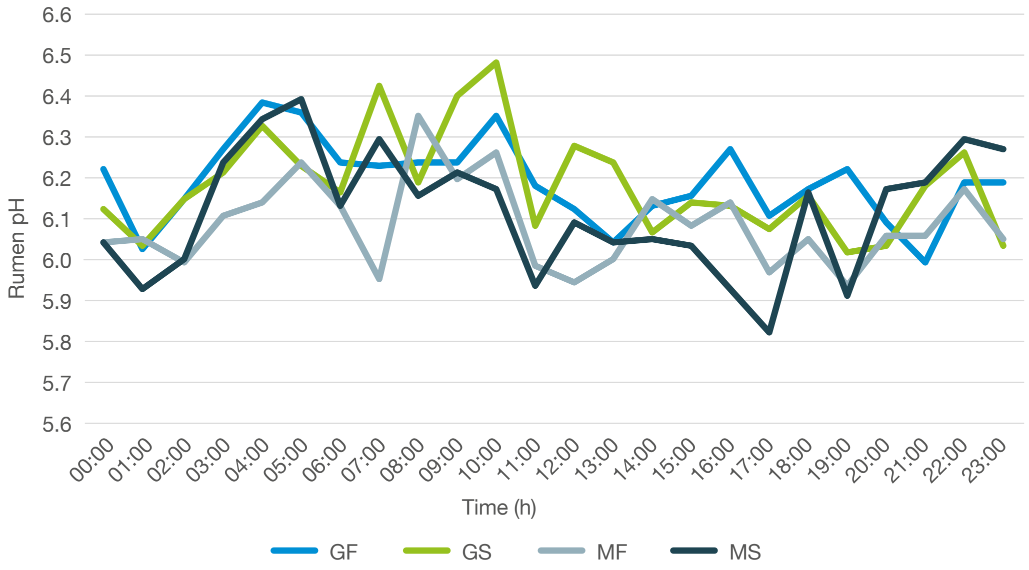


Figure 119. Diet type effect on rumen pH

Feeding maize-silage-based diets increases dry matter intake (Figure 115) and milk yield (Figure 116) over feeding a grass-silage-based diet. Milk fat % decreases with maize silage, but total yield is not affected. Milk protein % and yield increase with maize silage (Figures 117 and 118).

Reticulo-rumen minimum pH is not affected by forage or starch levels. However, when MF and MS diets were fed, the reticulo-rumen had a longer time below pH 5.8 (Figure 119).

Further findings show rumen ammonia concentrations were higher in cows fed maize-silage-based diets, but also nitrogen use efficiency was higher in these cows. Haptoglobin levels (acute phase protein) were also higher in cows fed the high-starch diets, but values were in the normal range, and high-starch diets were associated with lower rumination times.

Conclusion

Feeding high-starch diets is possible when they are correctly formulated with the correct ratio of starch to fibre. If SARA is avoided by keeping the rumen pH close to 5.8, feeding concentrates with different starch and fibre contents are unlikely to impact milk yield, although milk quality could be affected.

Usama Tayyab, Liam Sinclair and Robert Wilkinson, Harper Adams University

Chris Reynolds, The University of Reading

Functional fibre in dairy cow nutrition: Sorting and TMR mixing consistency

Key messages

- Estimating PS (particle size) can predict the occurrence of unwanted feeding behaviours that can impair health and milk performance
- When there is a high proportion of long particles, the cows are able to perform a dietary selection towards certain components (sorting)
- Sorting activity is an undesirable event that will result in some cows eating excess concentrates and others insufficient, with consequences on butterfat and milk yield
- Another aspect that needs to be taken into account is the consistency of TMR mixing
- There is a high between-herd variation in the consistency of mixing, estimated by sampling the TMR in five different points of the feed fence

Background

When presenting a diet with different-sized ingredients mixed, there is the potential for cows to sort for the feeds that are most appetising. Particle size is a good predictor of sorting ability, as those diets that have a high proportion of long particles are more likely to be sorted. Sorting is a negative event as diets are carefully formulated as a whole. Consuming only certain ingredients can result in consuming excess concentrates, leaving less for the rest of the herd and impacting the milk quality produced.

How long is a UK TMR?

Min	Average	Max
6.2 mm	**19.5 mm**	44.9 mm

A high PS is positively correlated with milk butterfat due to the higher rumination activity and the buffering effect of the saliva on rumen pH (Figure 120).

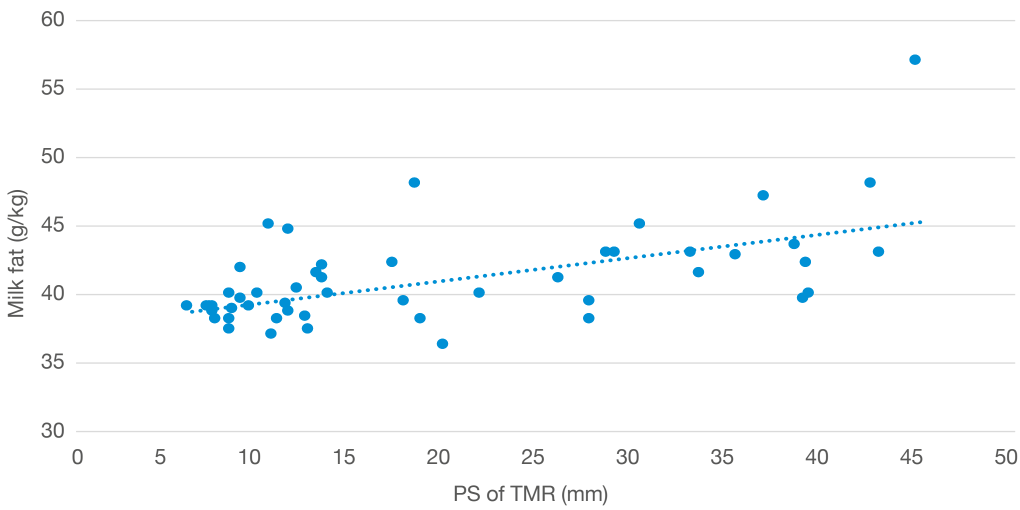


Figure 120. Relationship between PS of TMR and milk fat (dots represent herds)

A too high PS is negatively correlated with milk yield, because of the reduced feed intake consequent to the filling effect of fibre and to rumen imbalance due to sorting (Figure 121).

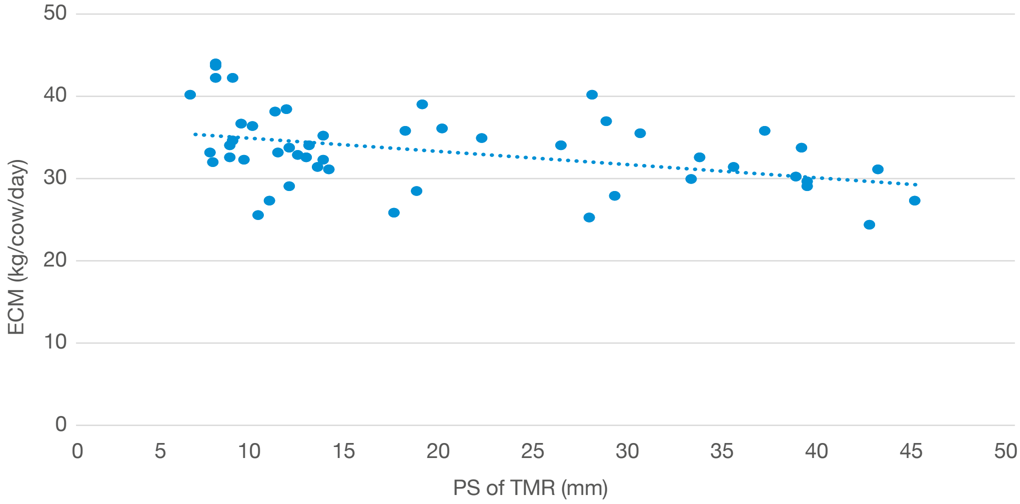


Figure 121. Relationship between PS of TMR and energy-corrected milk – ECM (dots represent herds)

Aim

The aim of this study was to investigate the role of mixing consistency on TMR sorting.

Outcomes

Are UK cows sorting?

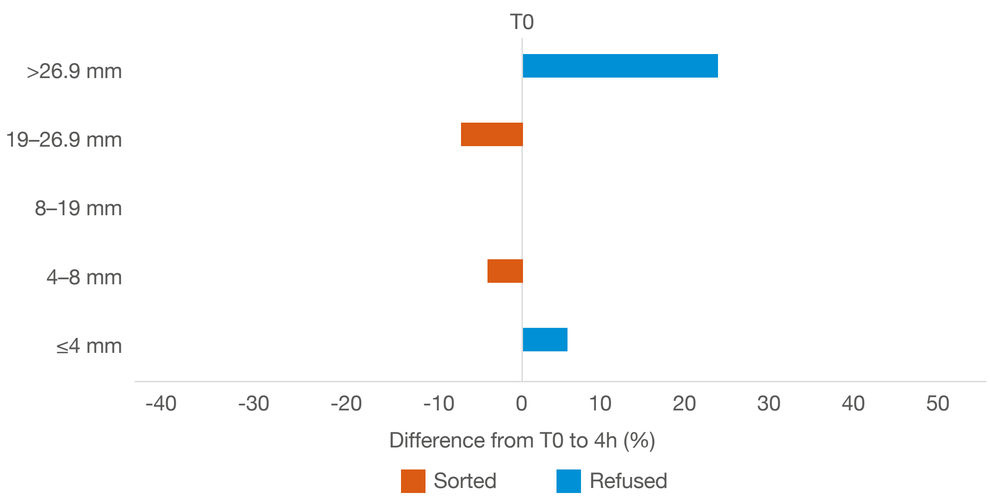


Figure 122. Sorting of the TMR particle size fractions after 4h

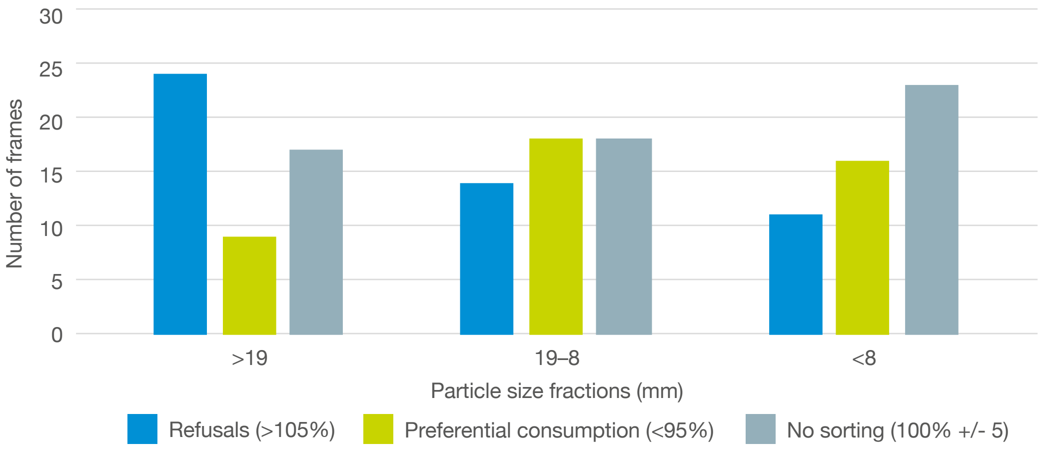


Figure 123. Number of farms sorting for each particle size fraction

After four hours, the PS distribution in the TMR has changed since fresh delivery (T0), indicating a certain degree of sorting (Figure 122).

Not all herds sorted a specific fraction and there was a high level of variation between herds (Figure 123).

How well are UK TMRs mixed

Only 42% of the farms had a well-mixed TMR (coefficient of variation <5%). The type of mixing wagon had no effect on the consistency of mixing (Figure 124).

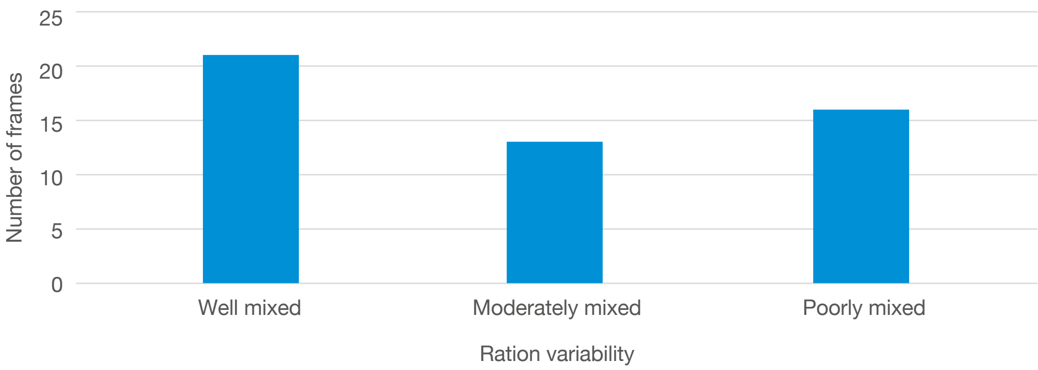


Figure 124. Number of farms and quality of TMR mixing

Conclusion

PS has a significant impact on the level of sorting observed in herds. In diets with a range of PS, there is a greater level of sorting, with the ration consistency changing within as little as four hours. In a system where fresh TMR is delivered once per day, this has the potential to leave an unappetising ration for the herd for the remainder of the day, which could cause reduced intake and ultimately yield. TMR mixing across the country is highly variable, which suggests that even if different herds are fed the same ration ingredients, there is the potential for different levels of performance as a result of sorting.

Liam Sinclair and Usama Tyyab, Harper Adams University

General management practices

Whole-farm feed efficiency

Key messages

- Feed conversion efficiency (FCE) is the ratio of milk output to feed input
- FCE is usually expressed as milk volume or solids yield per unit of dry matter intake (DMI)
- When translated into monetary terms, milk output and feed input determine margin over feed costs (feed is more than 70% of milk production costs)
- Improvements in FCE are generally associated with increased profits and reduced environmental impact
- FCE is normally considered only for the milking cows in a herd
- However, efficiency gains in milking cows might be offset by inefficiencies in other areas that influence overall feed use and profit
- Whole-farm FCE (WFFE) is defined as total milk output divided by total feed produced or purchased for all animals on the dairy farm
- As well as FCE of milking cows, therefore, factors such as fertility, health, replacement rate, heifer rearing, dry cow management and feed wastage have to be included in the calculations
- Another aspect that needs to be investigated is drivers and targets for FCE in different farming systems (e.g. grazing vs housed)

Background

Feed costs make up more than 70% of milk production costs, and so feed input and milk output are the two factors that determine the margin over the feed costs. Whole-farm feed conversion efficiency (WFFE) is defined as the total milk output divided by total feed produced or purchased for all animals on farm.

Feed conversion efficiency (FCE), which is the ratio of milk output to feed input, is normally considered for just the milking cows, but inefficiencies in other areas of the farm can also influence the overall feed use and profit, so these should be considered as well. Areas that should be thought about include:

- Fertility
- Health
- Replacement rate
- Heifer rearing
- Dry cow management
- Feed wastage

Different farming systems, including grazed vs housed, will have different key targets for FCE, which will need to be investigated for their impact on WFFE.

Aim

The aim of this study is to identify and quantify components of feed efficiency at the whole-herd level.

What we are doing

AHDB is funding a five-year project that started in 2016 and will end in 2021, with the research being conducted by the University of Nottingham. The factors that impact feed efficiency at a whole-herd level are being investigated on 25 farms which represent a range of production and feeding systems, spread throughout GB. Once the factors have been identified and analysed, the results will be translated into guidelines and practical tools for use on farms.

A panel of industry stakeholders will be engaged throughout the project.

Outcomes

This project is still ongoing, but once complete, the results will be valuable for helping to increase margin over feed costs, by enabling WFFE to be calculated on farm. This can then be benchmarked against similar farming systems, allowing farms to identify aspects that will lead to greatest economic improvements in WFFE and reviewing management practices.

Phil Garnsworthy, Jean Margerison and Emma Gregson, The University of Nottingham

Control of starlings

Key messages

- Simple changes in daily routine can reduce the impact of infestations
- Starlings consume around half their body weight in food each day
- They are ‘selective’ feeders, which means they sort rations, selecting out the parts they want to eat and, in doing so, changing the overall nutrient balance of the intended diet
- The average daily cost of a starling infestation from feed and milk yield loss is £106 per 100 cows
- Starlings can spread bacterial infections

Most effective control methods and approaches include:

- Implement preventative measures completely and persistently before and during the migration period (October/November)
- Exclusion: using <28 mm hole netting, mesh, fitted roller blinds and doors, ventilated wall cladding
- Disturbance from farm labour, shooting to scare, etc. particularly early in the morning, and random gas guns or rockets
- Fly a bird of prey (Harris hawk or Sparrowhawk)
- Use several methods of mitigation simultaneously or sequentially

Background

Starlings are a major problem on farms, spreading bacterial infections and consuming up to half their body weight in food every day. With the average cost of a starling infestation from feed and milk loss at £106 per 100 cows, it is important to control starling infestations.

Exposed feed (TMR with grain, in particular maize) attracts starlings to feed storage buildings and cow housing. Access to water sources, open feed stores and accessible perching sites, such as trees for roosting, will also make certain farms (or areas of farms) more attractive. It has also been shown that starlings have been known to return to the same farm year after year.

Aim

The aim of this study was to understand if changing feeding fresh TMR from morning to afternoon would impact the amount of feed lost per day.

Outcomes

This study showed that simply switching from morning to afternoon feeding lowers feed losses by 14–22% (Figure 125). Feeding in the afternoon, after the birds have left the farm to roost, means the cows have up to 16 hours' access to uncontaminated feed before the birds return the next morning and cows will rapidly adapt to any changes in their routine.

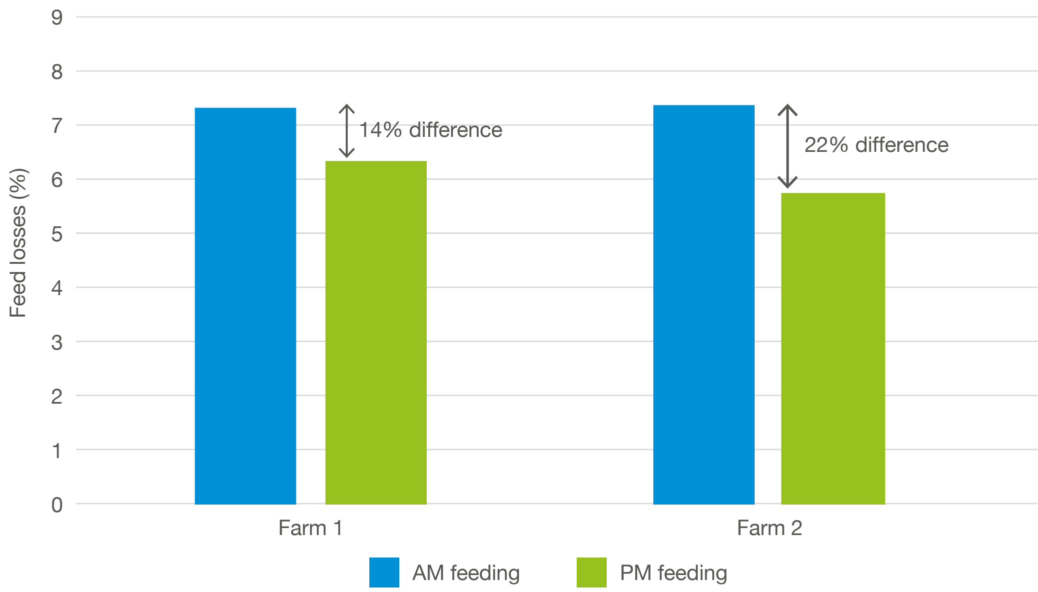


Figure 125. Difference in feed losses between morning and afternoon feeding

Conclusion

The simple, inexpensive change of providing fresh TMR to cows in the afternoon instead of the morning is a successful way to reduce feed losses up to 22%. A noticeable increase in lying and cudding time was also observed during the day when cows were fed in the late afternoon. Starting this feeding regime early in the autumn before starlings arrive could reduce the attractiveness of the farm to starlings from the onset. Reducing feed losses can also potentially increase milk yield.

Alternative methods to control sparrows that do not involve changing feed times include preventative methods, such as exclusion netting with holes <28 mm combined with fitted roller blinds and doors, disturbance from farm staff, including random gas guns and shooting to scare in the early mornings, and flying a bird of prey.

Jo Shipton, Peter Shipton and Duncan Forbes, Kingshay Farming & Conservation Ltd

Dairy in the human diet

Dairy in the diet – effect on nutritional adequacy, environmental impact and cost per nutrient

Key messages

- Based on actual (rather than idealised) dietary patterns, the analysis shows that excluding dairy foods, particularly milk, from the diet has important negative nutritional consequences
- Dairy products, milk in particular, can be part of a dietary pattern that does not increase GHG emissions beyond that of the current UK average male and female diets
- Dietary patterns that include dairy products provide lower financial cost per nutrient compared with those that are free from, or low in, dairy

Background

Dairy products are a valuable source of dietary protein, calcium, phosphorus, iodine and vitamin B12. However, diets that are rich in dairy products are often perceived to have a greater environmental impact by increasing greenhouse gas (GHG) emissions, but there is no published information currently available to analyse the relationships and trade-offs between the nutritional, environmental and value-for-money aspects of dairy in the GB diet.

Experimental approach

Information on UK dietary patterns for 1,655 males and females (aged 19–64 years old) was obtained from the National Diet and Nutrition Survey (NDNS, 2014). From this data, 58 food groups were identified for inclusion in the analysis.

For GHG emissions, published life cycle analysis data (primary production to retail) were used and financial costs of 3,423 foods (premium and own brand products) were obtained from two multiple retailers: Asda and Waitrose.

This resulted in a predictive model being created to quantify the impact of varying the amount and type of dairy consumed on nutrient composition, financial cost and GHG emissions.

Results – dietary pattern and GHG emissions

GHG emissions, as a percentage of emissions from the average daily male diet (5,261 g CO_2 eq.), were:

- Dairy-free – 93%
- High dairy consumption pattern – 108%
- Low dairy consumption pattern – 93%
- Replacement of milk with soya milk – 96%
- Diet containing three portions of dairy – 112%
- A ‘healthy’ diet containing dairy – 90%

Objective

The overall objective of this desk study was to determine the role of dairy products in sustainable diets, by modelling:

- Nutritional adequacy
- Financial cost
- Environmental impact of diets containing varying amounts of dairy product (milk, cheese, yogurt and ice cream)

Dietary patterns

For men and women, the average diet contained 160 and 136 g milk, 17 and 15 g cheese and 25 and 31 g yogurt, respectively.

Comparing high (267–1,429 g dairy/day) and low (0–99 g dairy/day) quartiles for total daily dairy consumption, high-dairy-pattern consumers:

- Had significantly higher total energy, fat, saturated fat and sugar intakes
- Were significantly younger, smoked less, consumed less alcohol and ate more fruit
- Had significantly lower female body mass index
- Met most (but not all) nutrient recommendations

Scenarios were modelled for the average male diet, dairy-free, high and low dairy pattern, replacement of milk by soya milk, a diet containing three portions of dairy and a 'healthy' diet containing dairy.

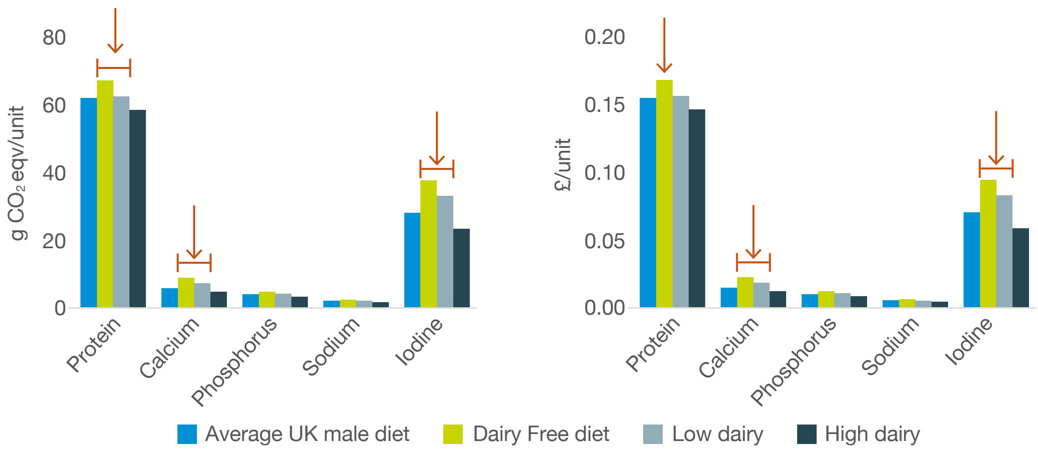


Figure 126. Carbon and financial cost per unit

Funded by AHDB Dairy in collaboration with The Dairy Council

Other current projects

Title	Institution	Area				Completion date
		Health & Welfare	Nutrition	Genetics	Systems	
Low-protein diets based on high-protein forages	Harper Adams University		✓			Sept 2020
Whole Farm Feed Efficiency	University of Nottingham		✓		✓	May 2021
Profitable, effective and sustainable environment for dairy cattle; The future of dairy cow housing	University of Nottingham, Harper Adams University and SRUC	✓				May 2021
Continued analysis of the AHDB heifer cohort to evaluate the importance of early life management on the risk of Johne's disease and support farm-level decisions	RVC and University of Nottingham	✓				May 2021
Improving foot health on British dairy farms – furthering our understanding of the prevention of the lesions of claw horn disruption	University of Nottingham	✓				May 2021
Soil biology and health	Newcastle University				✓	Dec 2021
Dairy4Future: increase the competitiveness, sustainability and resilience of the dairy sector in the Atlantic region of Europe	Duchy College				✓	Dec 2021

Studentship – PhDs and MRes

Who	What	When	Where	Additional funding
Ed Hayes	Evidence-based farm decisions to improve dairy herd fertility	Sep 15–Sep 21	University of Nottingham	
Robert Patterson	Optimum grazing systems for youngstock	Oct 16–Sep 20	Agrifood and Biosciences Institute	DARD, AgriSearch
David Bell	Preventing respiratory disease in calves	Sep 19–Feb 20	SRUC	SRUC
Hayley Crosby-Durrani	Bovine ischaemic teat necrosis	Oct 16–Sep 20	University of Liverpool	BBSRC
Laura Shewbridge Carter	Improving production efficiency and promoting positive welfare in housed dairy cows by facilitating choice	Oct 17–Sep 20	Harper Adams University	Harper Adams University and SRUC
Jake Thompson	Evaluation of the impact of loafing space on cow health, welfare, physiology, production and farm economics	Oct 17–Sep 20	University of Nottingham	University of Nottingham
James Wilson	Understanding the structure and function of the digital cushion and the role of inflammation in the development of lameness	Oct 17–Sep 20	University of Nottingham	
Sara Pederson	Evaluation of claw trimming practices	Jan 17–Dec 20	University of Nottingham	
Amy Jackson	Evaluation of public perceptions of dairy cow welfare and the housed environment	Oct 17–Sep 21	University of Nottingham	University of Nottingham
Amy Gillespie	Preventing digital dermatitis transmission on farms	Oct 17–Sep 21	University of Liverpool	BBSRC
Brad Harrison	Reduction in diffuse phosphorus loss from dairy farms	Oct 17–Sep 20	University of Reading	
Robert Hyde	Optimising the health and welfare of dairy and dairy cross-bred calves	Oct 19–Aug 23	University of Nottingham	AFCP
Emma Middleton	Use of precision tech for mobility scoring to objectively measure lameness in dairy herds	Oct 19–Aug 23	University of Nottingham	BBSRC
Bethany Griffiths	Aethiopathogensis and genomic architecture of resistance to claw horn disruption lesions in dairy cattle	Oct 19–Sep 23	University of Liverpool	BBSRC
TBC	Evaluating strategies to reduce net Carbon emissions from dairy production systems	Completion – 2023	University of Nottingham	

Research through Partnership

The research reported in this booklet would not have been possible without the collaboration of industry and universities. AHDB acknowledges the contribution of the following partners to the research programme.

AB Agri

Aberystwyth University

AgriSearch NI

ADAS

Agri-Food and Biosciences Institute: AFBI

Ayrshires Cattle Society

Bangor University

Biotechnology and Biological Sciences Research Council

University of Bristol

Brown Swiss Cattle Society

Centre for Ecology and Hydrology: CEH

Centre for Evidence-Based Veterinary Medicine

Cattle Information Service: CIS

Dale Farm

Dairy UK

Department for Environment Food and Rural Affairs: DEFRA

Evidence Group: EBVC

English Guernsey Cattle Society

University of Exeter

EGenes

Harper Adams University

Holstein UK

Hybu Cig Cymru: Meat Promotion Wales

Jersey Cattle Society of the United Kingdom

Langford Trust for Animal Health and Welfare

University of Liverpool

LINK Collaborative Research

Montbeliarde UK

Moredun Research Institute: Moredun Group

NIAB TAG

National Milk Records: NMR

The University of Nottingham

Quality Meat Scotland: QMS

University of Reading

The Royal Guernsey Agricultural and Horticultural Society

Royal Jersey Agricultural and Horticultural Society

Royal Veterinary College: RVC

Dairy Shorthorns: Shorthorn Society

SRUC: Scotland’s Rural College

Appendix

Genetics

Health and welfare

Youngstock

Grass and forage

Grassland soil management

Nutrition

General management practices

Dairy in the human diet

Photographic credits

Pages 38–44 and 134 University of Nottingham

Pages 46–48 University of Liverpool

Page 49 RVC

Pages 64 and 86 Agri-Food and Biosciences Institute, Northern Ireland

Pages 65–76 Harper Adams University

Pages 74, 113 and 123 University of Reading

Pages 76–78 IBERS, Aberystwyth University

Pages 81, 87, 89, 90, 92 and 93 SRUC Dairy Research and Innovation Centre

Page 95 Bangor University

Page 136 Kingshay Farming and Conservation LTD

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