Precision Farming projects

on the demonstration network

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Foreword

Precision farming equipment and technology can help improve the performance, profit and efficiency of day to day work routines of farming businesses. Farming Connect has helped a range of farming enterprises evaluate the value of investing in precision farming tools and technology across Wales.

Precision farming is often associated with arable cropping, via GPS controlled machinery, targeted agronomy and data management. Farming Connect has supported farmers in trialling these tools for arable and grassland systems, testing their application for the wider industry.

The term precision farming can also be used to include the use of technology in livestock systems. Measuring the variability of livestock behaviour at an individual animal level is providing a wealth of knowledge to the farmer, useful in improving both animal performance and welfare.

The dairy sector has seen great advancements in the development and uptake of precision technology to aid management and both the beef and sheep industry is starting to follow suit, adapting technology to suit their sectoral needs. For example, Farming Connect has helped raise awareness of the benefits of high frequency weighing in both systems, combining this with EID management tools.

Farming Connect has supported farmers applying breeding advancements to help realise genetic improvements more rapidly, via the use of genomics in the beef sector, as well as other flock and herd management tools, including metabolic profiling and synchronised artificial insemination.

This booklet is an illustration of the wide range of projects that have taken place over the last three years and the outcomes which have been demonstrated to farmers. They highlight the potential for using technology to benefit farm business performance, helping manage those enterprises sustainably for the long term.

For more information on these projects and the services available through Farming Connect visit our website - **www.gov.wales/farmingconnect**

Dewi Hughes
Technical Development Manager, Farming Connect
Autumn 2020

Farming Connect - helping you drive your business forward

Eligible businesses registered with Farming Connect can tap into a wide range of Farming Connect support services, guidance and training.

Many services are fully funded, others are subsidised by up to 80%.

Visit our website to find out how you can:

- benefit from subsidised business support, tailored to your business needs
- benchmark your performance and work towards progress and growth
- develop your skills as part of our lifelong learning and development programme
- keep up to date with the latest innovations in technology through industry developments and the latest research projects

Trialling soil nutrient mapping and precision farming techniques

Commonly used methods for measuring in-field productivity can be very labour intensive, relying on in-field measuring to take direct readings. Recent advances in the availability of frequent optical and radar satellite data has been identified as a valuable source of information to assess and monitor crop growth.

Plas demonstration site on Anglesey is a mixed farm, with sheep, beef cattle and arable crops. Farming Connect supported the farm to trial the use of arable cropping technology in their grassland management systems. The project entailed mapping grassland fields to identify the precise nutrient status, using soil electronic conductivity techniques (EC), and then plugging that detail into the machinery on-farm to inform fertiliser application rates.

Using the nutrient and texture results, recommendations were created for each management zone within the field allowing application of nutrients at variable rates with tractor mounted Global Positioning System (GPS) software for that specific field to achieve optimum yields and maximum efficiency.

Although precision farming techniques are associated with the arable sector, the work at Plas farm showed such techniques can be adapted across the entire industry.

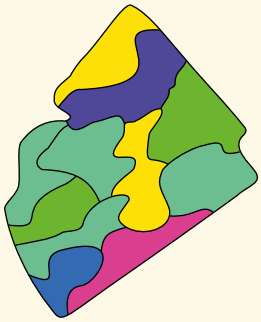
Project results

The variability within a field was surprising, despite fertilisers being applied uniformly in the past. The diagrams below show the recommended application rate of potash and phosphate for one specific maize field.

Muriate of Potash (MOP) requirements

Key: kg/ha

- 243
- 250
- 257
- 264
- 278
- 285



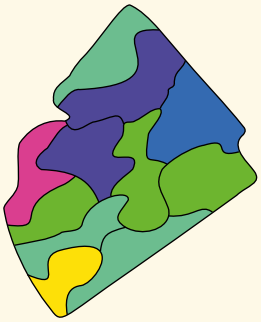
12 ha field. MOP fertiliser had been applied uniformly in the past.

Mapping has revealed a requirement variation of up to 42kg/ha MOP between different areas of the field.

Triple Super Phosphate (TSP) requirements

Key: kg/ha

- 101
- 109
- 120
- 142
- 153
- 176



12 ha field. TSP fertiliser had been applied uniformly in the past.

Mapping has revealed a requirement variation of up to 75kg/ha TSP between different areas of the field.

What is Electrical Conductivity (EC)?

Electrical Conductivity (EC) is a method of precision farming which measures how easily an electrical current flows through a material such as soil. The electrical conductivity of a soil sample will indicate the amount of salt, sand, clay, organic matter and water it contains. With GPS input such indications can be used to create soil maps. Measurements can be taken at two depths, referred to as a shallow array and a deep array measurement, with the relationship between the two providing valuable and useful information to farmers.

The cost of this type of precision sampling ranges from £15-£25/hectare, and needs to be repeated every three to five years.

Project results

Dudwell focus site near Haverfordwest grows a range of cereals, including wheat, barley, oats and oilseed rape, as well as running a sheep flock, a suckler herd and store cattle system. Farming Connect supported the farm to assess the value of precision farming, gaining a better understanding of their farmland characteristics and provide more accurate information to guide fertiliser inputs.

Soil EC scanning was used to grid sample each field, splitting the field area into 1ha grids before taking samples from the centre of each grid. Soil testing for various nutrients then showed the soil nutritional status across the sampling grids.

Project results

Variations within fields was confirmed using soil EC.

In one field sampling showed a huge range in the phosphorus level, from a low of -1 in some parts to a high of +3 in others while potash ranged from 0 to 3+.

Only 25% of the field sampled matched the overall field average of 2- underpinning the benefits of taking a more specific approach to nutrient application.

The farm now uses a variable rate fertiliser controlled spinner linked to the GPS box on the tractor to apply phosphate as required across the different field zones.

Different soil nutrient mapping companies produce similar results

The project compared two different soil EC testing services. Both tested the selected grid zones and results were very similar, providing reassurance on accuracy and a sound basis for management decisions.

Soil nutrient mapping does not necessarily reduce financial costs associated with inputs but does reduce inefficiencies associated with standard applications

Precision mapping and soil EC resulted in:

- Informed management decisions.
- Reduced inefficiencies associated with standard applications.
- Potential environmental benefits by reducing over application of nutrients.

Pictured (left to right): Charles Rees and Tom Rees, Dudwell Farm and Ian Beecher-Jones, precision farming consultant

Take action for improved efficiency and productivity

1. Use a nutrient recommendation system, such as the Nutrient Management Guide (RB209)
2. Practice nutrient management planning. Several planning tools such as 'Tried and Tested' or 'PLANET' are available or contact Farming Connect for further information
3. Sample soils for pH, phosphate, potash and magnesium every three to five years
4. Improve accuracy by looking at samples for 'within field variations' and tailor applications accordingly
5. Check throughout the season for any visible crop deficiencies
6. Take soil or herbage/crop samples from good and poor areas of the field to help diagnose cropping issues

Measuring dairy cattle activity at pasture using GPS

Technology can play a greater role in mobility monitoring, to help identify and reduce lameness in the dairy herd. At Trawscoed innovation site near Aberystwyth, a 'Step Matrix' system was installed to measure the force and direction of hoof placement of cows exiting the parlour. This allowed daily analysis of data, earlier detection of locomotion changes and recovery monitoring. GPS technology was used to evaluate changes in the proportion of time spent displaying three behaviours – grazing, resting and walking.

A total of 55 Holstein dairy cows were followed in groups of 11 for 14 days per group between May and September 2017. Cows were each fitted with a GPS collar and variables measured were body condition scores (BCS), lactation levels and months in lactation. All variables were analysed for links between the behaviours, weather and grazing.

This information was then used to optimise their productivity and adjust management practices.

Project results

There was no association between behaviours, BCS and lactation

Cows in mid and late lactation grazed for an average of **31** minutes/day more than cows in early lactation

Field size significantly impacted the time spent grazing. With each additional hectare increase, grazing time increased by an average of three minutes

Grass allocation did not significantly alter the amount of time cows spent grazing, walking or resting

Cows spent the greatest proportion of time grazing immediately after turn-out in the morning and evening after milking with a very small proportion of time allocated to grazing during the night

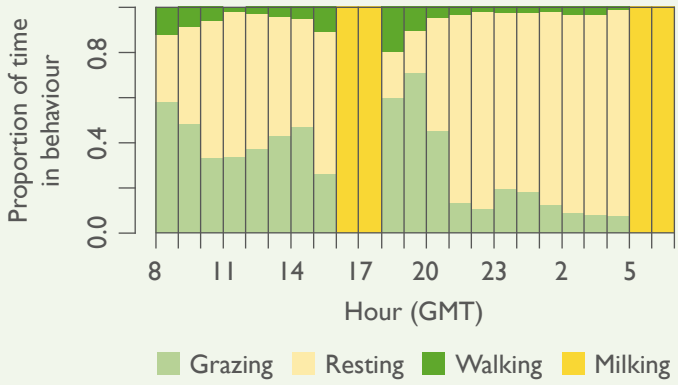
On average, cows spent:

414 minutes/day grazing

679 minutes/day resting

48 minutes/day walking

- Every 1°C increase in average temperature led to more grazing (+six minutes).
- For every 1 km/h increase in wind speed, grazing increased by seven minutes on average.
- Every one mm of rainfall tended to add approximately one minute to the time cows grazed.



Key messages

Cows in pasture-based systems are open to many more weather and grazing variables than those indoors which could impact their performance.

By using precision technologies farmers gain an insight into the daily patterns of cow behaviour and can use this information to optimise their production systems.

This work leads to a greater understanding of the conditions in which cattle perform best, providing information to tailor grazing strategies for individual farms.

High frequency weighing of lambs - putting 'big data' into practice

The overall performance and profitability of a sheep flock is largely influenced by the growth rate achieved by lambs. At Mynydd Gorddu innovation site, Aberystwyth, up to 1,000 lambs were weighed at regular intervals throughout the 2017 growing season (2-9 months of age) as an aid to flock health and grassland management. The weight information collected allowed tailored management, which helped ensure lambs all finished in a similar timeframe, reaching target weights.

Target weights and growth rates were set for all lamb types on the farm prior to starting the project. Mob faecal egg count (FEC) samples were analysed throughout the period to monitor worm challenge, along with trace element monitoring. Ram lambs were weighed seven times across the project lifetime, ewe lambs ten times.

Project results

Good lamb growth rates in relation to the **60%** target growth rate

The majority of lambs were achieving the **60%** target by July - October, with tupping in November

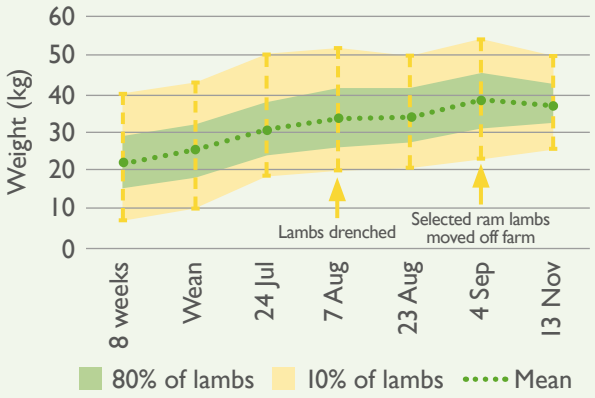
Growth rates of ewe lambs fell short of the target of **250 grams** per day in November despite managing grazing to build up a grass wedge

Trace element monitoring indicated that no further supplementation with selenium or vitamin B12 was required. Lambs would normally have been given a bolus at **12-16** weeks of age and so this represented a cost saving

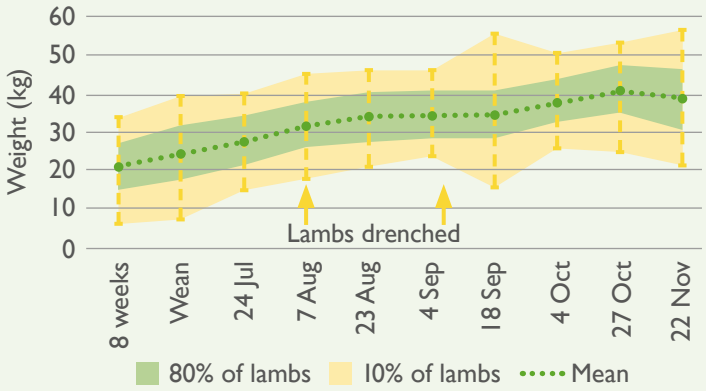
Worming was based on weight gain and FEC results; lamb growth needed to be below target or mob FEC results above **500** eggs per gram to treat

Growth rates of ram lambs and ewe lambs

Graph 1: Growth of ram lambs



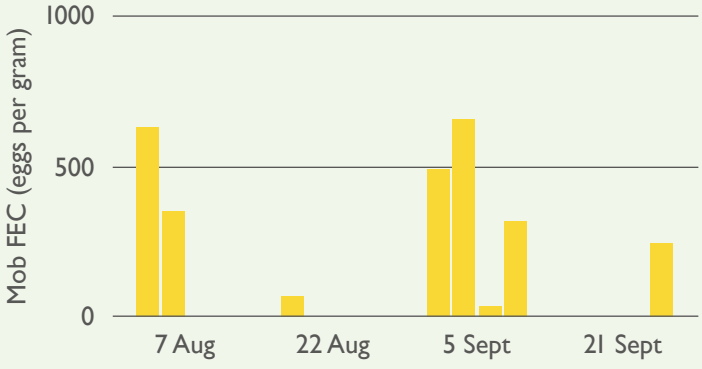
Graph 2: Growth of ewe lambs



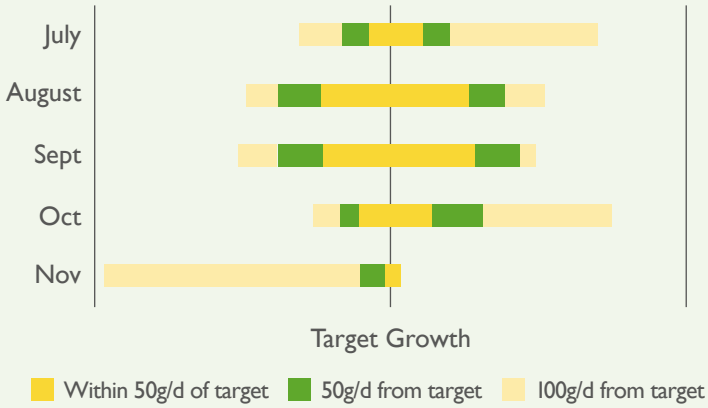
Key messages

The frequent monitoring of growth rates provided management information used to improve productivity	
Timely intervention to safeguard individual animal performance	• Lambs achieving poor growth should be split into separate grazing groups and grazed at lower stocking rates than the main mob • Allow underperforming lambs to graze ahead of the main mob in the rotation • This will allow those lighter lambs to achieve a higher growth rate and 'catch up' with the main mob • These lambs should also be investigated for other possible reasons that may be causing underperformance e.g. lameness
Making more timely and proactive animal health treatments	• Health problems such as lameness should be addressed promptly. A combination of regular monitoring and routine weighing and foot bathing will reduce cases • Monitoring growth rates and FEC will inform decisions on worm treatments • Monitor trace elements to see if supplementation of selenium or vitamin B12 is required
Preparation for tupping ewe lambs	• Groups of ewe lambs should be monitored closely to achieve a target of 60% of mature weight at tupping

Graph 3: FEC counts



Graph 4: Lamb growth rate in relation to target



Using electronic identification (EID) and weighing to drive beef cattle performance

Reducing costs without compromising performance is a key focus for beef producers looking to ensure their beef systems are profitable. Using weighing to ensure the finished animal is meeting target specifications, and combining this with management information from using an EID system was a focus site project at Rhug Estate near Corwen. The estate manager, with the support of Farming Connect, wanted to assess the current organic Aberdeen Angus grass based beef finishing enterprise to ensure that it was running profitably. This included the trialling of EID technology in the business to help with market planning and monitor performance.

This project was established in response to the challenges facing winter beef finishing systems. With tight margins, finishers are looking to gain a better understanding of their costs to see where savings can be made and develop a strategic approach to beef finishing.

Why install a cattle EID system?

- Data collection on a regular basis
- Data collection is easy and practical for farm staff
- All data recorded will aid in decision making on the primary goals of cattle growth and finishing
- Allows the farmer to assess feed demand and adjust rations accordingly

Project results

Frequent weighing has meant that cattle can be set up in management groups with tailored feeding for each group

Growth rates were assessed and feed budgets established for each group

Weighing plus EID has resulted in better silage and supplementary feed planning

Dosing and other health treatments are now given based on animal weight, rather than taking a blanket herd approach to dosage volumes

Key messages

Information on weights and the ability to manage each animal individually via EID provides a strong platform for performance improvements.

- Review the figures alongside silage stocks and quality - weight gain is driven by the quality and availability of forage
- Analyse grass and arable silage produced
- Formulate a suitable ration, working with a beef nutritionist
- Focus on high quality grass and silage in order to achieve the daily liveweight gain (DLWG) and finished animal required
- Maximise home grown forages to reduce the need for buying in feed which for organic systems is costly
- If able to grow cereals and forage crops, focus on those which will result in good weight gain

How much silage is available?

↓

What is the quality of the silage?

↓

What is the target DLWG throughout winter?

↓

Is supplementation required to achieve this target and in what form?

Using synchronised artificial insemination (AI) to improve beef cattle productivity

An extended calving pattern can lead to high costs for beef producers, with a reduction in potential live weight gains and an extended rearing period which will have a negative impact on profitability and herd efficiency. This can be overcome using oestrus synchronisation, as trialled at Fferam Gyd focus site, Anglesey.

In 2017, 87 of the 120 spring calving Limousin/Limousin cross herd calved over a 12 week period and the remainder over an eight week period in the autumn. The aim of the project was to get the majority of calves born in the first three weeks of those two calving periods. It compared the potential benefits of combining oestrus synchronisation with artificial insemination against conventional servicing with a stock bull.

What was done?

- Synchronised AI was used on 55 spring calving cows and natural service on 32
- A ten day synchronisation programme was followed with input from a breeding specialist
- Cows in the synchronised group were inseminated twice, on two consecutive days in June
- Pregnancy diagnosis 40 days later showed that 42 (76%) cows were in calf (target was 60%)
- Of the 13 that didn't hold to service, 11 were repeated and of the original 55 cows, 53 became pregnant

Project results

- 2016-17 achieved 42 out of 55 in calf (76.4%)
- 2017-18 achieved 42 out of 51 in calf (82.3%)
- Tighter calving with 75% calving in the first two weeks
- Higher average weaning/sale weight - estimated at 30kg, worth £72 per animal
- Enabled calves to be managed better as a tighter group
- Allowed for better planning of labour, buildings and other resources
- Allowed for earlier creep feeding of the bigger calves

Getting cows in calf at the first service resulted in a 1.2kg DLWG advantage over calves born from repeated heats

↓

Average reduction in calving interval of 25 days at 1.2kg DLWG means they were 30kg heavier

↓

At £2.40/kg that resulted in an increased value of £72 (this easily pays for the costs of synchronising)

Key messages

1. Attention to detail is critical in order to get results
2. Good handling systems are essential for practicality and safety of animals and operators
3. Available space in both buildings and fields adjacent to the yard is important for a more efficient cattle handling routine
4. Always turn bulls in after service and monitor closely for repeated heats
5. Set aside a field close to the farmyard for grazing during the synchronisation and AI period. This keeps cow stress levels down, due to shorter walking distances
6. Tighter spring and autumn calving patterns have been proven to result in higher average deadweight, with a 10kg difference in carcase weight between March and July born calves
7. As well as tightening the calving pattern, synchronisation and the use of AI can reduce bull replacement costs

Metabolic profiling of ewes to improve efficiency and production

What is metabolic profiling?

Metabolic profiling of an animal involves analysis of a blood sample to evaluate its internal functions; the results can then be interpreted to assess health and nutritional status.

Metabolic profiling requires a blood sample from the animals. The time of sampling related to feeding is important, as feeding management should be consistent across animals to ensure accurate and representative results. The blood is then analysed to provide information on the health and nutritional status.

The process is able to cope with large flock sizes and provide accurate, in-depth and cost-effective analysis. It is also essential that a metabolic profile is combined with other information including flock and animal records, facilities and rations to ensure its effectiveness as a diagnostic tool.

Aberbranddu demonstration site, near Pumsaint, selected 20 ewes of different body condition scores (BCS) to undertake metabolic profiling three weeks prior to lambing in 2018 to investigate the nutritional status of the ewes. The objective was to use the results to alter the ration before lambing if needed and make better decisions on nutrition in the following year. At testing the ewes were on a diet of ad lib grass silage and 300g/head/day of a 32% protein nut.

Irwel Jones

Project results

Although the results showed that their energy balance and protein status were generally good, in the thinner ewes levels of beta hydroxybutyrate, produced in response to an energy deficit, were slightly high.

This shows the importance of achieving correct BCS at tupping and leading up to lambing as foetal growth has a high energy demand especially on low BCS ewes.

As a result the ewes were housed in groups according to their BCS to ensure the thinner ewes were not competing with the fitter animals for feed.

Some of the twin-bearing ewes were also shown to have low albumin levels, an indicator of possible disease issues. They had previously been treated with a flukicide after the post-mortems of barren ewes identified low to moderate levels of fluke.

Albumin is a long-term measure of protein status and, as levels can take months to recover from previous disease problems, it is important to consider recent treatments when basing management decisions on metabolic profiling results.

As a result of the project, prolapse and twin lamb disease incidence lowered, reducing the number of difficult lambings and improving milk quality.

Metabolic profiling to reduce antibiotic usage

Another 2018 Farming Connect metabolic profiling project at Llysun focus site near Llanerfyl resulted in management changes following the investigations. Three groups were tested – two groups of twin-bearing ewes, one with a BCS average of 2.5 and the other at 3.5, and the third involved triplet-bearing ewes at a BCS of 2.5. The flock was on a diet of ad lib haylage with twin-bearing ewes receiving 0.5kg/day of compound and those carrying triplets receiving 0.7kg/day. A farm objective was to reduce antibiotic use at lambing; antibiotics had been routinely used due to issues with joint ill.

Project results

Overall energy balance was satisfactory but the majority had marginally low albumin results. A possible contributing factor was poor protein intakes prompted by exceptionally cold weather in the previous two months.

Faecal egg count (FEC) sampling was recommended to rule out fluke or worm infestation and post mortems were also carried out on dead ewes. Ewes had been previously treated twice post tupping so further investigations to thiabendazole (TBZ) efficacy was recommended.

Key messages

Using the metabolic profiling data to group ewes according to condition and the number of lambs they were carrying, analysing forages and implementing strict hygiene protocols at lambing resulted in a 50% reduction in antibiotic use.

To monitor colostrum absorption, blood samples were taken from lambs between two to five days old.

Levels of immunoglobulin, an indicator of the quality and volume of colostrum absorbed, were good. Those with poorer levels were born to ewes with a lower BCS.

Metabolic profiling provides essential information to help the farmer:

- Optimise nutrition
- Optimise productivity
- Reduce costly vet bills
- Avoid animal losses

Group ewes according to the number of lambs they are carrying in addition to their BCS to provide targeted feeding

What is the optimum BCS for ewes at various stages in the reproductive cycle?

Stage	Hill ewes	Upland ewes	Lowland ewes
Weaning	2	2	2.5
Tupping	2.5	3	3
Mid-pregnancy	2	2.5	3
Late pregnancy	2	2.5	3

Mineral Levels

Mineral levels play a key role in the production of sheep, in particular calcium and magnesium. Normally, these minerals are carefully balanced by the internal functions of the animal; however, in negative energy balance this is often disrupted.

Additionally, in sheep, no magnesium stores are contained within the body and calcium is rapidly utilised in the production of milk and bone generation in the foetus leading to deficiencies.

A metabolic profile may be able to predict mineral deficiencies before symptoms begin to show, allowing prompt treatment and reducing the risk of complications.

Using genomics to boost dairy productivity

Genomic testing of black and white stock bulls

Many commercial dairy producers often use beef or dairy stock-bulls to sweep up any repeats after a period of artificial insemination. Bulls are bought either privately or through specialist bull sales and are often set to work on bulling heifers as well as cows.

Untried and untested bulls are often bought on parent information along with the look and conformation of the bull itself, but genomics allows the farmer to select with more precision, on health and production traits.

Three yearling bulls at Shordley Hall focus site near Wrexham were genomically tested through Holstein UK and AHDB Dairy's genomic evaluation service.

Project results

Genomic proofs for the bulls demonstrated reliability for various traits of between 58% and 68%, which doubles that of parental average alone.

Production, health and conformation traits from the genomic proof of three young bulls bred at Shordley Hall					
Name of bull	£GPLI	Milk kg	Somatic cell count (SCC)	Direct calving ease (DCE)	Type Merit (TM)
Aintree Squire	£522	560	-18	0	2.82
Aintree Sterling	£454	101	-17	-0.1	1.61
Aintree Wesley	£463	417	-12	0.2	2.47

Aintree Squire ranked in the top 30 genomic young bulls according to the UK genomic type merit index and just inside the top 500 young bulls for £PLI if he was available commercially.

All three bulls had favourable negative somatic cell count values and were above £450 on £PLI.

It would be wise to consider the relative average calving ease score of the three bulls before using widely on maiden heifers.

Key messages

- With a single test costing around £100, sellers of black and white stock-bulls should consider the possibility of testing and providing buyers with the additional reliability and information a genomic proof provides.
- Genomic detail can be used to select which bull to use on the home farm herd, and also provide buyers with additional reliable information regarding production, health and conformation potential.
- The information provides the equivalent reliability to that of any young genomic bull semen sold by any breeding companies.

The value of genomics in dairy heifer selection

Using genomics to breed the best dairy females will increase the genetic value of replacements and reduce the number of lower-genetic-merit animals coming into the herd.

Genomically testing females works on the same principle as genomically testing young bulls. By taking a DNA sample from a young heifer, it is possible to get an immediate indication of genetic merit, rather than having to wait for that animal to calve and start milking. Specific animals can then be selected to produce replacements depending on individual farm breeding requirements.

Genomic testing gives the cow a Profitable Lifetime Index (£PLI), providing an indication of the value of that animal to the herd.

Trialling the use of genomics with dairy heifers. At Marian Mawr demonstration site near Rhyl, tissue samples were taken from heifers using NMR's GeneTracker service, comparing the use of parental average figures with genomic testing results.

Project results

A positive £PLI for all but one of the animals

Reiteration of the importance of matching the herd potential with the milk contract requirements. The project identified a cow with poor £PLI score for milk kg, but good £PLI score for butterfat and protein. Therefore a poor performer for a liquid milk contract, but good for a manufacturing contract.

Key messages

- Genomic testing has an accuracy rate of 70% compared to between 30-35% from using parental average figures
- Breeding from £PLI positive females helps improve herd productivity
- Conversely, there is an economic disadvantage breeding from an animal with a negative £PLI
- If negative £PLI cows are kept, breed them to a beef animal, and don't breed your dairy replacements from them
- It is important to remember that herd management is also a major contributing factor. Genetics can only take you so far; it is down to the farm environment and herd management in order to make sure that animals reach their genetic potential

Metabolic profiling of dairy cows to improve efficiency and production

Metabolic profiling can be used as a diagnostic tool or to predict disease risk to help prevent or treat economically significant diseases (such as ketosis, fatty liver or milk fever). It involves blood analysis to evaluate internal functions and how these might affect the animal as a whole. The results are used to assess the nutritional state and fertility of animals, particularly those in the transition period - this is the time three weeks before and three weeks after birth.

At Sychpant focus site near Cardigan, metabolic profiling was used to investigate the impact of nutrition on fertility in the three times a day milking system. Cows are fed a total mixed ration (TMR) and are high yielding as a result, but the trade-off is that any nutritional problems will quickly affect not only milk yield and quality but also fertility.

Using a herd sample, the project measured the cows' metabolic profiles throughout the season, monitoring the changing ration and the reaction of the cows. Feed cost efficiency was analysed, and cows were BCS as an on-going benchmark.

Project results

Blood tests carried out on dry cows highlighted energy problems with their diet. These dry cows looked to be struggling prior to calving, with all of the "close up" dry cows tested having high butyrate, low glucose and/or raised non esterified fatty acids (NEFA) values.

Energy balance in the mid lactation group at an average of 3 months after calving looked good. The milking cow ration at time of testing was therefore meeting their energy needs for the high levels of milk production.

Further investigations indicated dry cow dry matter intakes were too low at 9kg DM/day. The recommendation was to aim for intakes of 12-15kg DM/day, achieved through feeding a good quality silage rather than increasing the amount of concentrates.

Key messages

- Metabolic profiling allowed the business to identify issues prior to them impacting negatively on cow health and productivity
- The bespoke advice resulting from the testing provided valuable management information, for example:
    - Focus on ensuring dry cows get sufficient forage in the run up to calving
    - Long fibre must be chopped and properly mixed through the diet to ensure intakes
- These "close up" dry cows require fresh, palatable ration in front of them 24 hours a day to enable them to eat to their potential
- The ration needs to be fed fresh each day, with spoiled feed cleared away before fresh ration is put out

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