Farming Connect Management Exchange

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Sustainable large-scale dairy production

England, Germany and Scotland

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My Background

Our farming system is a 1,100-acre family farm run by three brothers. The core of the business is an 800-cow dairy herd, with side-line businesses including agricultural contracting, (grass silage making and umbilical slurry spreading) and 15 holiday lets. The herd is split between two units with one herd milking 400 cows on a 44-point rotary parlour and the other unit milking 400 cows in a 20/40 herringbone parlour. The cows are out on grass during the summer and housed during winter, with all grass silage and slurry spreading completed by ourselves. The herd replacements, predominantly Holstein Frisians cross, are reared on-farm with two automated calf feeders providing milk 24 hours a day for up to 150 calves. The heifer calves are reared for the herd and the bull calves kept as beef cattle.

With the farm having obtained extra parcels of surrounding land, the plan would be to increase herd numbers closer to 1,000 cows. However, there are two points we would need to address, these two points were the main focus during my visits.

The first point would be to increase the capacity and automation of our milking systems. This is crucial as the workforce can be very busy when contracting away from the farm and having to also milk the cows twice a day. The current milking systems are fitted with enough room for expansion; however, the time has now come where we have outgrown our milking parlours. With the development of robotic milking making a massive breakthrough in the last 10 years, there is no better time to think about automating/semi-automating our systems such as milking and feeding to reduce our day to day workload significantly.

The second point that needs to be addressed is slurry management, as large dairy herds are being blamed for methane emissions and pollution of water courses. We have already taken steps to minimise the effect of our slurry on the environment by investing in an umbilical slurry system with a disk injector, but more can be done. We are looking to increase our slurry storage capacity so that slurry is only applied when it would be of most nutritional benefit to the fields and would be less susceptible to leaching.

This would also benefit us and the environment as we would be able to reduce our dependency on synthetic fertilisers.

These points were always kept in mind during the visits and were the two main topics of interest as they could possibly influence two large future decisions on our farm.

The decision was made to visit the Agri-Epi South West Dairy Development Centre in England as its main aim is to use new technologies and techniques to support sustainable, efficient and high health and welfare milk production. The next stop on the trip was only a few miles down the road to the famous Worthy Farm, where a 2 million-pound GEA robotic rotary parlour has been installed. Personally, a robotic rotary milking parlour would be the best fit for our system at home, therefore, this led to the visit of the DeLaval AMR robotic rotary milking parlour in Waldkirchen, Germany. The final stop of the trip was a visit to a farm in Inverbervie, Scotland where a large herd was milked using 6 Lely stall robots and a very interesting system was used for slurry management.

Agri-Epi South West Dairy Development Centre (SWDDC), England – 7 August 2019

The Agri-Epi Centre is one of four agri-tech centres delivering benefits from research to UK farming. They have three UK dairy facilities, one in Scotland's Rural College, Dumfries, one in Harper Adams University, Shropshire and the main dairy facility at Kingshay in Somerset.

The main aim of the SWDDC dairy facility was to combine precision grazing and technology to generate sustainable milk production.

Quick facts

- 180 cow herd
- Setup cost of £1.6 million
- 3 GEA robotic milking stalls
- GEA automatic feeding system
- 5G connected farm
- Grazing/silage fed

Fig 1. South West Dairy Development Centre

The SWDDC is a large fabric roofed building measuring 90m x 28m, that gives the cows shelter in a light and well-ventilated building that houses some of the most advanced technology used in UK dairy farming.

Fig 2. South West Dairy Development Centre

Due to the shed's translucent roof, 20% of natural light is let through, and with the automated gale breaker curtain open on the side of the building there is even more natural light and a massive improvement in the building's ventilation. The galebreaker is fully automatic, maintaining a set temperature in the shed at all times and monitoring the weather outside of the shed, therefore, allowing it to shut the sides if wind picks up or if it begins to rain.

All cows are housed together in one shed where all cows share a cubicle area, including the dry cows. All cows have access to the first gates that sends the cows into milking if they have permission or send them to the next set of gates. The second gate either turns the high yielding milking cows into their feed area, or it sends cows into the calving/sick cow pens or lets the cows continue on to another gate. At the third gate, low yielding cows are sent to their feed area or cows continue on to the fourth gate, where the dry cows can get to their feed area or the gate that allows cows go outside to the grazing paddocks.

Figure 3 shows a simplified layout of the shed.

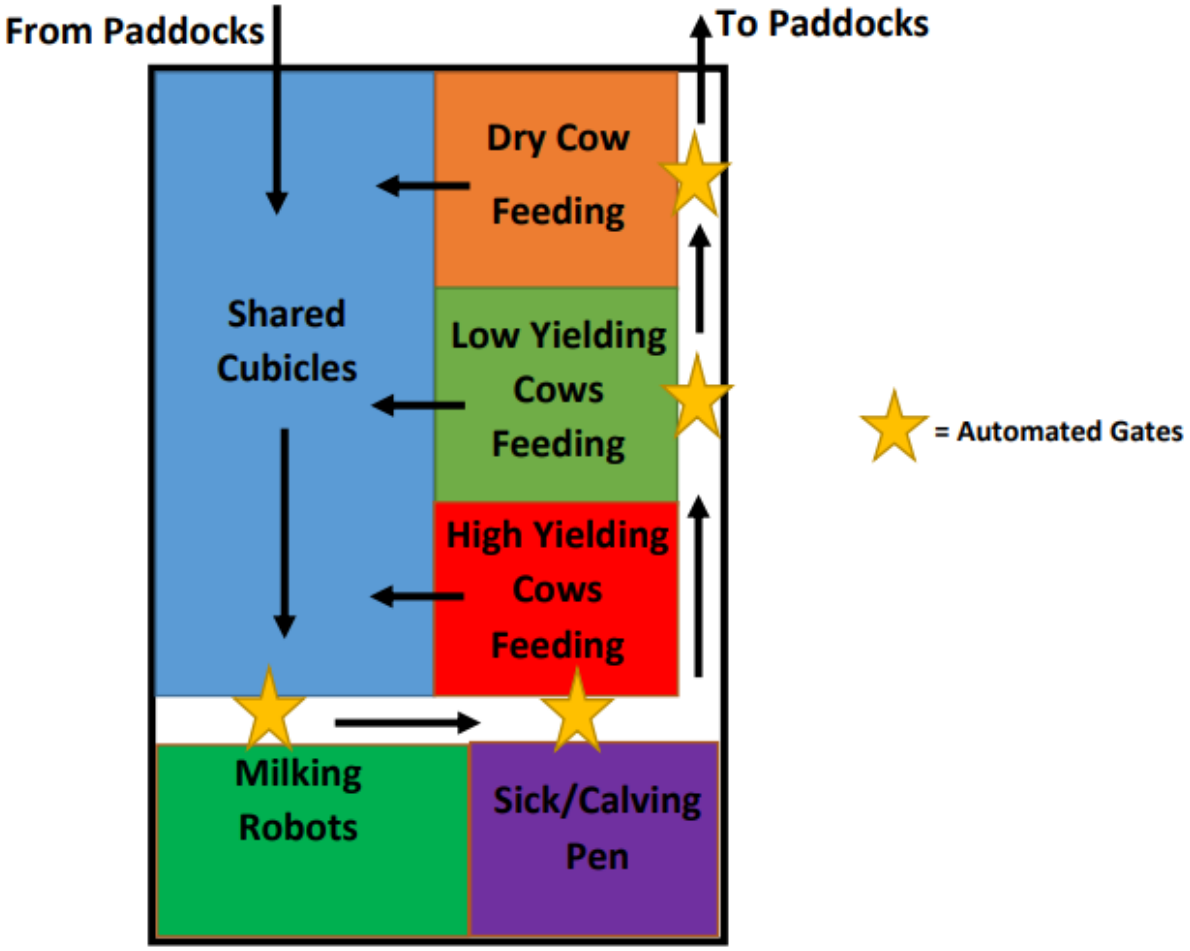


Fig 3. Layout of shed at SWDDC

Cows can return from their feed area to the cubicles via a non-return gate. Cows can also go to graze in paddocks outside where there is another set of gates as shown in figure 4. The dry cows strip-graze paddocks where they are grazed tightly, and the milking cows can strip graze paddocks that have a more generous serving of grass. The grazing area changes up to three times a day to ensure there is plenty of fresh grass in front of the cows; this is managed by the automatic gates system in the fields. All paddocks are within a walking distance of 600m from the shed.

Fig 4. Automatic gates system in the field

The TMR (Total Mixed Ration) for the three different lots of cows are mixed and fed by the GEA automatic feeding system where the grass silage, maize silage, whole crop silage and straw are kept in bunkers that are refilled every few days using a telehandler. Concentrates such as blend and minerals are auger-fed from tower silos/small hoppers. There is also talk of installing a molasses tank. The blend and parlour feed bins have weigh cells fitted so that the ForFarmers feed mill automatically delivers feed when the bins are nearly empty, this ensures a continuous supply of feed. The feeder is battery powered and drives along rails that are installed in the shed's roof. It drives under the bunkers/concentrates chutes to fill the desired TMR that backs up to a large electric motor that delivers the high power required to give all the ingredients of the TMR a sufficient mix.

Fig 5. Feeder parked under a bunker

Fig 6. Filling the feeder with silage

Fig 6 and 7. Silage and straw bunkers

Fig 8. Feeding of the TMR

The advantage of this style of feeding is that the cows have fresh feed little and often, which encourages feed intake and allows feeding to happen without the need for moving the cows or the use of designated feed passage. With the highly automated setup there is less stress

inflicted on the cows. The shed did seem to be a very peaceful place even with the milking, feeding and scraping robots running. The robotic milking not only reduces the amount of stress on the cows, but provides the herdsmen with a comprehensive set of data for each cow due to the sensors that are integrated in the robot that are used to analyse the milk. When a cow is milked, the first few seconds of milk is analysed (conductivity test and colour test) and dumped to ensure that the milk is the best quality. If the milk is up to standard from a quarter it will go into the main milk line to the tank, otherwise it will be milked into the dump line and the cow would be flagged on the robots' computer to let the herdsman know.

Fig 9. One of three milking robots with a touch screen to monitor milking and change settings

Fig 10. Feed is given during milking

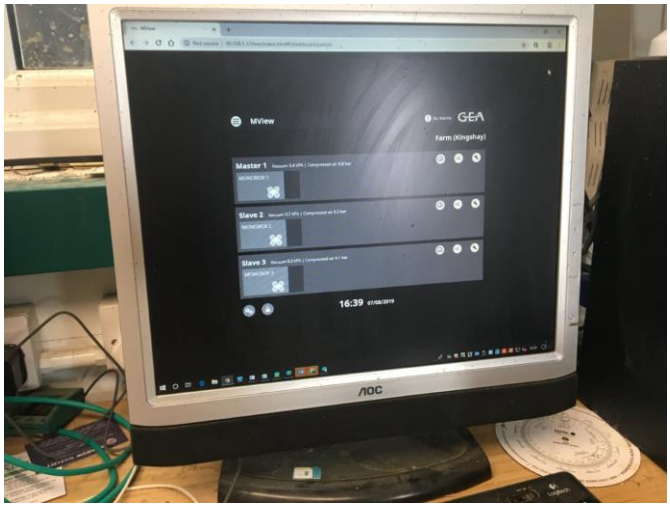


Fig 11. Robots could also be monitored using the computer in the farm office

The farm office is armed with information fed from the milking robots. There are three different transponders fitted to the cows to allow better monitoring 24 hours a day. With the shed being one of the few places in the UK at the time to have a 5G internet connection, the ability to have mass data collection over the cloud plays in favour of the herdsmen when it comes to the health, fertility and welfare of the cows. The three transponders are:

1. GEA Transponder – Used for the milking robots and the auto gates
2. Afimilk Silent Herdsman – Monitor activity, heat, and rumination

3. Zoetis SMARTBOW – Monitor rumination, heat and live cow location tracking in shed

Fig 12. Live cow location tracking with yellow points highlighting cows that may require attention from the herdsman

A body condition scoring camera is also used by the South West Dairy Development Centre to monitor the condition of the cow every time they go through the sorting race; this is another tool in the herdsman's belt to closely monitor the herd.

Fig 13. Body condition scoring camera positioned above automated cow sorting passage

The South West Dairy Development Centre are working towards achieving 4 milkings a day and to achieve 40% of milk production from grass and 60% from silage and concentrates.

Worthy Farm (Glastonbury), England – 8 August 2019

Worthy farm is run by Michael Eavis and family and is famously home to the Glastonbury festival that attracts an attendance of approximately 200,000. Built within the stone clad cowsheds there is a state of the art GEA robotic rotary milking parlour costing upwards of £2 million pound.

Fig 14. Outside of milking parlour

Fig 15. Stone clad cow sheds and milking parlour building with slurry lagoon

Fig 16. Wide view of inside the milking parlour from the viewing area

Quick facts

- 450 cow herd
- Setup cost of £2 million +
- 36-point GEA robotic rotary
- Twice a day milking
- Anaerobic digester and solar panels on farm

The milking parlour allows a member of staff to milk all 450 cows in four hours and it contains 36 stalls that all contain arms as shown in the photo below. A camera guides the clusters onto the teats and then the teats are cleaned within the cluster. The first 10 seconds of milking is analysed and dumped into the dump line, if the milk is up to standard it is then released into the main milk line, then into the ice bank, and then into the tank. Any milk that is not suitable for human consumption is dumped into the dump line and can then be fed to

Fig 17. The robotic cluster arm with the camera

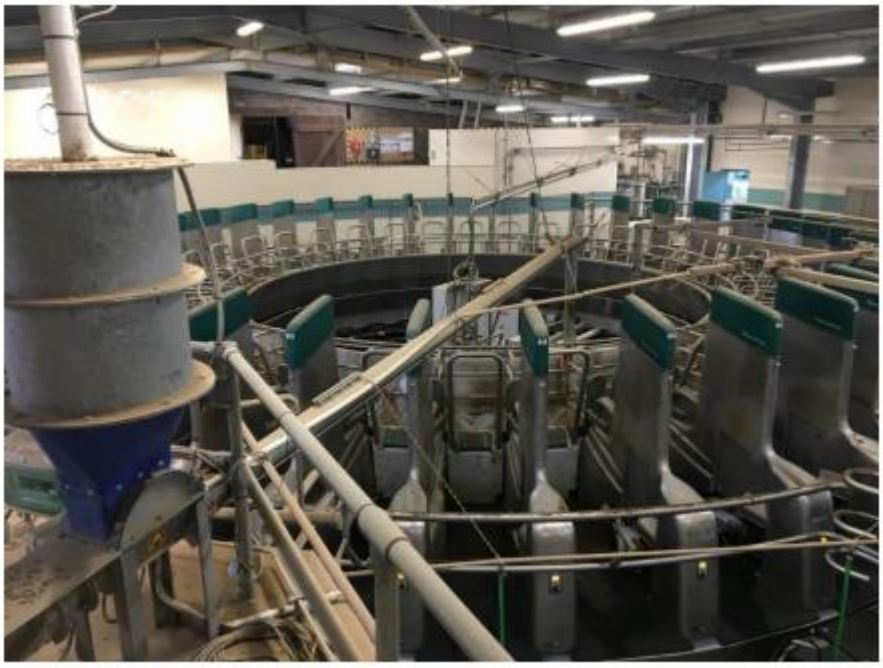
calves.

Once milking is complete, post-milking teat spray is applied through the cluster and then the cluster will flush itself.

The robotic arms are identical to the ones fitted in the South West Dairy Development Centre a few miles up the road, meaning both units can share some replacement parts. This also explains why the rotary is so expensive as it is the equivalent of having 36 of the GEA Single Stall Robotic Milkers on a rotating platform! The deck of the rotary weighs 25 tons when empty of cows and is driven by three drive units.

Inside of the rotary milking parlour accessible via an underpass

Fig 18. Inside of the rotary milking parlour accessible via an underpass



In Parlour Feeding System

Fig 19. In parlour feeding system

Deck Mounting/Dismounting area with gantry to remove robot units for service

A screen to offer an overview of all stalls with more detail available if a stall is selected

Fig 20. Deck mounting/dismounting area with gantry to remove robot units for service

Fig 21. A screen to offer an overview of all stalls with more detail available if a stall is selected

Fig 22. All the information provided by the Q-View screens

The screens used on the rotary can also be used to diagnose faults and monitor things such as vacuum pressure, cleaning status during wash cycles, water pressure, cleaning chemical levels, pre/post milking dip levels and much more. The milk from the rotary is cooled first using a plate cooler, then into an ice bank before entering the bulk milk tank.

Fig 23. Bulk milk tank that had a sensor fit that milking could not commence without putting the pipe into the tank

The compressors that cool the milk tank and ice bank have a heat exchanger fitted that allows the heat generated by the compressors to be used to heat water to a temperature of 60°C. This is used to heat the farmhouse and a few surrounding buildings and is also used to preheat water for parlour washing cycles.

Vessels storing the water heated by the cooling compressors

Fig 24. Vessels storing the water heated by the cooling compressors

All of the walls in the milking parlour were tiled to allow ease of cleaning and it was very decorative!

Fig 25. All of the walls in the milking parlour were tiled to allow ease of cleaning and it was very decorative.

The biggest drawback of this system is the cost. A significant cost reduction would be required before it would become a more widespread technology adapted by dairy farmers. But the parlour does make large strides in labour reduction of milking and it also has a rather high throughput for a robotic milking parlour.

Bauernland AG (Waldkirchen), Germany – 13 August 2019

Bauernland AG is a farm in west Germany that have the latest version of the DeLaval AMR robotic rotary milking parlour fitted.

Fig 26. Shed housing collecting yard and robotic rotary parlour

Fig 27. Looking down on the DeLaval AMR

Unlike the GEA robotic rotary parlour the DeLaval AMR has 6 task specific robot arms that are static inside the rotary, 4 arms are positioned where the cows enter the deck of the rotary and 2 arms are mounted just before where the cows dismount the deck.

Quick facts

- 480 cow herd
- Produce an average of 15,500 litres of milk per day
- Setup cost of €1 million
- Was 30% funded by EU/German government for building a sustainable system
- 24-point DeLaval AMR robotic rotary parlour
- Twice a day milking (early lactation cows are milked three times, at the start and end of morning milking, and evening milking)
- Heated and insulated milking parlour due to high levels of frost during winter

The six robots undertake the following tasks:

1. Cleaning and pre-milking rear two teats
2. Cleaning and pre-milking front two teats
3. Attaching individual clusters to rear two teats
4. Attaching individual clusters to front two teats
5. Robotic post-milking teat sprayer

6. Robotic cluster flusher and exterior cleaner

Fig 28. First four robot arms

Fig 29. Teat cleaning and pre-milking arm

Fig 30. Fourth robot arm attaching the front two clusters

Fig 31. 4 Individual clusters

The advantage of this robotic rotary is that there is less robot arms and they are controlled by a simpler hydraulic system rather than several electric motors. Another advantage of this system is that the teat cleaning and post-milking spraying is completed by designated arms therefore there is no contamination of the milk when the milking cluster is attached. Due to the arms being static on the DeLaval rotary, if a cluster drops off it is not automatically re-attached; this could either be done by hand or the cow will be sent back into the rotary by automated gates to milk that particular quarter.

If a cow is a bit wild or difficult for the robots to milk, clusters can be put on manually if needed. To make life easier for the cows the deck of the rotary will stop for the cows to embark/disembark the platform. This makes life easier for anyone overseeing the milking operation as they can go out of the parlour to perform other tasks, at Bauernland AG there was only one staff member overseeing the milking and that staff member would be responsible for watching the milking parlour, getting the next batch of cows into the collecting yard for the automatic backing gate to drive cows into the rotary and also cleaning the cubicles. It was surprising how well the cows went into the parlour, considering that there was no in-parlour feeding.

Milking takes place between 4:30 and 12:00 in the morning and between 17:00 and 23:30 in the evening. This is a relatively long time to milk 480 cows, but this operation only requires one staff member who is free to undertake other tasks whereas a conventional rotary would require around three staff members continuously working in the parlour for an efficient operation. As mentioned, the morning milking is longer due to a batch of the early lactation cows being milked at the start and at the end of the morning milking period. This has delivered an increase of 10-15% in yield that justifies milking these particular cows three times a day. Only the elite cows are milked three times a day in their early lactation, first time calving heifers and older cows are only milked twice a day which reduces the demand on these cows.

The DeLaval AMR has a throughput of 80-85 cows an hour and has a maximum capacity of 1,500 milkings a day. Again, it is a system that allows the herdsman to collect a massive amount of data about his herd through the use of milk analysis sensors. This is shown on the DelPro software as displayed in figure 32.

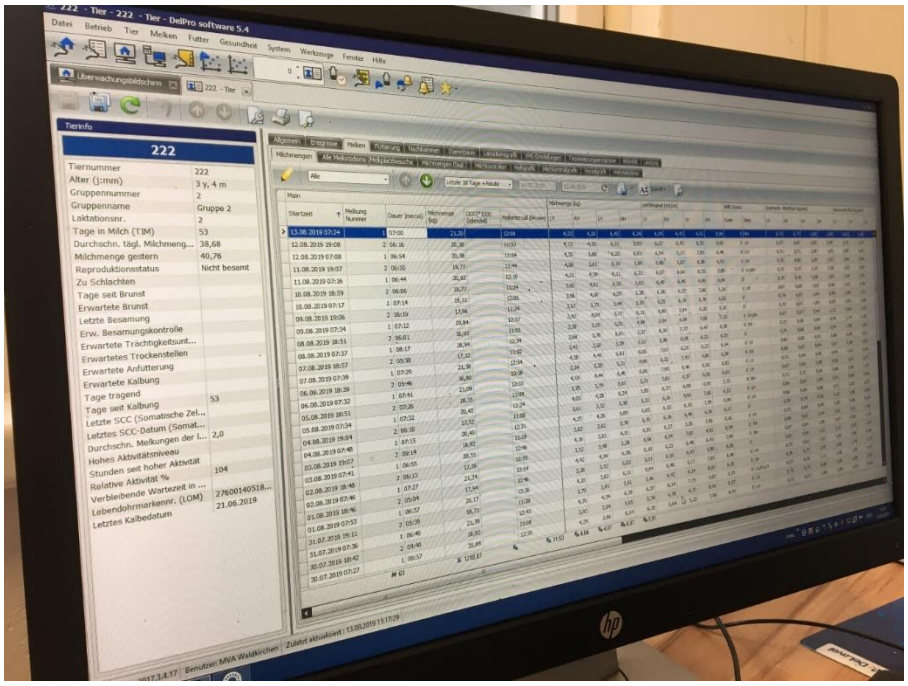


Fig 32. A comprehensive set of data for cow number 222

The data from the milking parlour combined with the herd management software gives an indication of a lot of problems even before they become visible.

Fig 33. A typical cow ‘box’ that contained a bank of 24 cubicles (24 boxes in the shed)

Fig 34. Bright and airy shed with the ridge of the roof opening and closing automatically

Fig 35. The old dairy

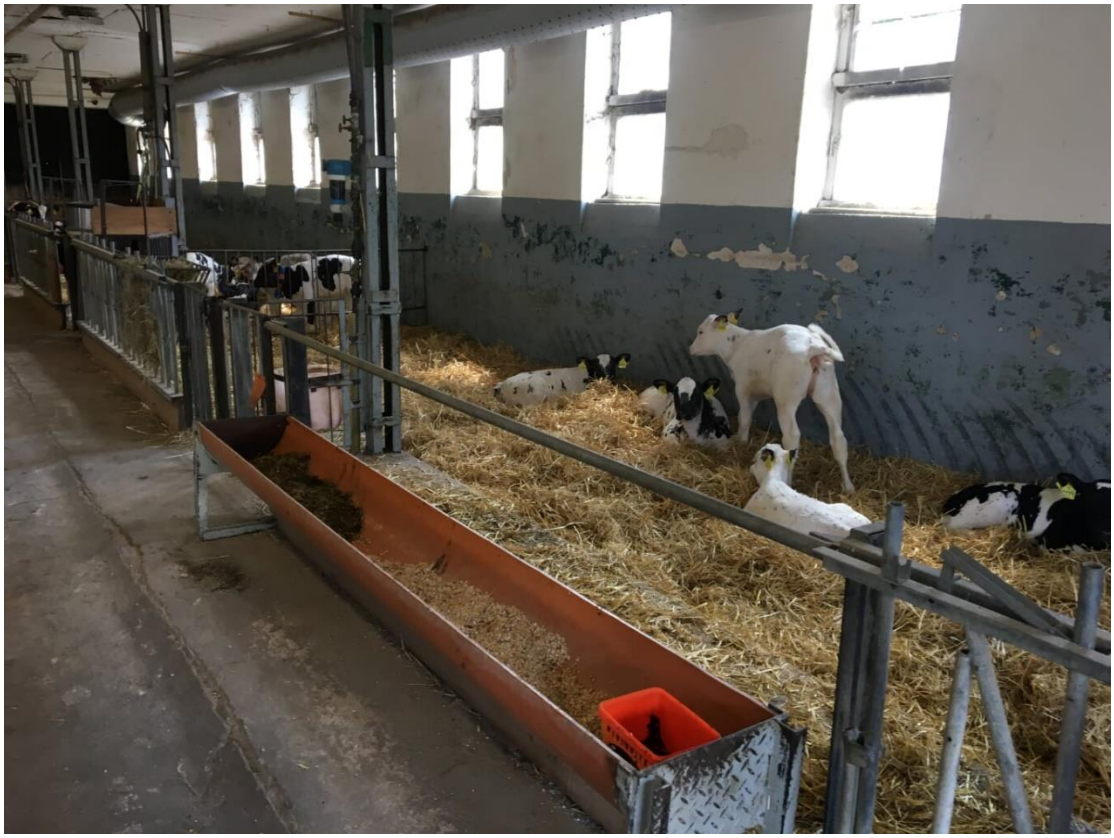


Fig 36. Happy and healthy calves in the old dairy fed using an automated feeder

Fig 37. The older cow shed now used as calving pens/sick pens on loose housing, a vacuum line is in the building to allow the milking of any cows on antibiotics or freshly calved cows using a dump bucket

The cows were housed all year round, except the dry cows which are out over the summer. During winter, the extremes in temperature could cause problems in the parlour due to frost therefore the parlour is fully heated and insulated. During the summer, the ridges of the roof open and close automatically to reduce the risk of overheating in the parlour. Also, to combat the harsh frost and snow that the area often receives during the winter months, there are two bulk milk tanks that can be used as buffer storage when a tanker cannot reach the farm due to snow.

Fig 38. Automatic venting roof ridges and the heaters installed (currently oil heated but looking at wood chip heating)

9,000l and 20,000l milk tanks

Similar to the GEA systems there are several screens to keep the operator informed of what's going on during milking

Fig 39. 9,000l and 20,000l milk tanks

Fig 40 and 41. Similar to the GEA systems there are several screens to keep the operator informed of what's going on during milking

Another little system that was very simple but effective was the parlour deck wash which used recycled water from the cluster flushing system. This ensured the deck was clean at all times and that any dropped clusters stay clean.

Deck washer

Fig 42. Deck washer

Dendoldrum Farm (Inverbervie), Scotland – 15 August 2019

Dendoldrum farm is run by Gregor Colquhoun and family and is a multi-award winning, high yielding dairy farm south of Aberdeen.

Two of the Lely Astronaut robotic milking stalls

Fig 43. Two of the Lely Astronaut robotic milking stalls

Main cattle shed housing the 6 Lely Astronaut Robots, high open peak on the roof to allow cool air to flow in through the open sides and the hot air to flow out through the roof.

Fig 44. Main cattle shed housing the 6 Lely Astronaut robots, high open peak on the roof to allow cool air to flow in through the open sides and the hot air to flow out through the roof.

Quick facts

- 650-700 cow herd
- Six Lely Astronaut stall milking robots (the seventh was awaiting to be installed)
- Located in a Nitrogen Vulnerable Zone
- Green bedding system
- 800kW biomass boiler
- Three 500kW windmills
- Three ground source heat pumps

Fig 45. The Lely Astronaut Robotic Milker

The farm is using the six robotic stalls to milk 300 of the cows while the remainder are milked through the old 20-20 Alfa Laval parlour. It was interesting to see how a large dairy operation is using individual stall robots to milk a large quantity of cows as they wandered into the stalls instead of batch milking. The robots have played a key part in getting the cows to be milked on average 3.3 times a day.

The use of green bedding was something I found particularly interesting, having previously worked as a design engineer for a company designing and manufacturing slurry equipment during my year in industry whilst at Harper Adams College. The swapping of sawdust for the green bedding saved the farm £70,000 annually. It works by separating the fibrous part out of the slurry using a screw press separator. The separated solid has then a low enough moisture content to be used as bedding. But at Dendoldrum, this is taken a step further, where the separated solid is dried on a drying floor to reduce the moisture content further. Heat for the dryer is provided by the 800kW biomass boiler and the ground source heat pumps, which are powered by electricity from the farm's three wind turbines.

Storth Green Bedding Separator with the drying floor to the left

Fig 46. Storth green bedding separator with the drying floor to the left

Fig 47. 800kW Biomass boiler

Heater for bedding dryer

Fig 48. Heater for bedding dryer

During my visit, the farm was on a break from using the green bedding; the farm has a two week break twice a year. During this break, sawdust is used for bedding to break the cycle of the same green bedding being recycled continuously.

With a large volume of the slurry separated and then pumped into a lagoon, the slurry was then taken by a large number of surrounding arable farmers for use on their fields. This was particularly useful with the farm residing in a Nitrogen Vulnerable Zone (NVZ).

The farm had an approach that worked well with regards to calf care where new-born calves are fed pasteurised colostrum only from their mothers and they were housed on straw, slatted pens in pairs. They would stay in these pens for four to five days before being moved into larger pens that were fed by machine. Bull calves were kept and then sold at an age of two months, and the heifers kept on as replacements.

Fig 49. Slatted calf pen for two calves

Fig 50. Colostrum pasteuriser

Fig 51. Some older calves machine fed in a large pen

Fig 52. View from the calf shed out onto the arable land surrounding the farm on a dry August day

Fig 53. Fans fitted inside the shed due to high temperatures that are occurring more often during summer, these are important with the cows housed all year round

It was very interesting to see a family farm using a very different slurry management system and also implementing robots gradually rather than investing heavily in robots for the whole herd, as this could be a massive outlay that can be very risky in these uncertain times.

Next steps

With both milking parlours becoming older and reaching full capacity at home it is certainly time to begin looking at how milking technology has developed in the last 10-15 years since

we have installed our parlours. Automation was a massive focus point for me as a MEng agricultural engineering student at Harper Adams University. Seeing how automation has made great strides in sectors such as arable, it was only a matter of time until the dairy industry harness newly developed technologies for their use. Seeing the four farms and how they have implemented this technology into the daily running of their farms has given me confidence that the technology available could be used to improve the sustainability of our family farm.

In regards to slurry management it was extremely interesting to see the green bedding system and how it worked. If the crisis does continue in the UK timber industry and trees become even scarcer, alternative bedding systems such as green bedding or sand will need to be considered. In terms of slurry storage, it is difficult to predict what is on the horizon in terms of legislation of slurry spreading and storage, therefore it will be a waiting game to find out what the UK government is going to impose on dairy farmers

Key messages to the industry

1. Technology is our friend - Farming is seen as a traditional and dated industry but we need to harness technology to help us produce food in a manner that satisfies today's modern trends with consumers in a sustainable manner.
2. There is never too much data - The increased use of technology on dairy farms allows more and more parameters to be measured and masses of data recorded like never before. If the data is analysed correctly by the farmer/herdsman it could be used as an extremely powerful tool that could even detect problems before they occur.
3. Cost - In terms of a large-scale dairy unit, the cost of installing robots is massive and is a decision that should not be taken lightly. It is only a matter of time before these companies will make robotic rotary milking parlours at a lower cost and with increased throughput/functions that make them appeal to a larger segment of the market.
4. Seeing is believing - Some of the technologies I have seen during my visits were initially thought as complex and things of the future, but upon closer study it can be broken down to a simpler system with different parts undertaking different tasks (this was particularly true when visiting the DeLaval AMR).
5. Go on farm visits – All of the little techniques, systems and methods that other farms use on a daily basis could be passed on and make a difference to the way your farm is run, it could save you a few seconds, minutes or pounds every day. They say knowledge is power and farm visits are an excellent way to transfer knowledge.

I would like to thank Farming Connect for giving me the opportunity to travel to these four farms and I would like to thank the four farms for taking time out of their day to show me their farming system.